Field-Based Laboratory Instruction in Teaching Forces, Motion, and Energy

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of the Requirements for the Degree
Master of Arts in Teaching
Major in Physics

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APPROVAL SHEET

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DEDICATION

To God, the source of wisdom

For His divine providence …

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For her expertise and professional assistance…

To my students and future researchers, the recipients and beneficiaries of this work, for the inspiration…

To my friends and colleagues, loyal companions

For believing in me…

To my family, the source of my strength,

For the encouragement and love…

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ABSTRACT

This study evaluated students' and teachers' experiences in a field-based laboratory in teaching motion, force, and energy. The researcher also utilized a phenomenological research approach for the student-participants' experiences on the conducted activities on FBLI, and it is for the identification of themes that supports the advantages and disadvantages of the intervention. For the teacher who did the FBLI, the narrative research approach is utilized for the same purpose as the student-participants. The performance of students before exposure to FBI has a mean equivalent performance of 69.30, an indication that they did not meet expectations as to topics force, motion, and energy. However, upon utilization of FBI there is an increase in the mean performance of students, from not meeting expectations to fairly satisfactory. Results implied that there is a shift in the students' performance with the use of FBI. The use of Field-Based Laboratory Instruction improves students' performance on the topics force, motion, and energy, from not meeting expectations to fairly satisfactory.A well planned Field-based laboratory instruction delivers the lesson correctly, however, preparation of instructional materials and classroom management up to the precautionary measure are also things for considerations. It is suggested that Science Teachers should prepare activities align to Field-Based Laboratory Instruction and design activities that are contextualized and suited to the learners need for them to enjoy teaching-learning process.

TABLE OF CONTENTS

CHAPTER I

THE PROBLEM AND ITS SETTING

Introduction

Science is a major subject in any educational system. In terms of instruction, it is handled and managed differently from other disciplines (Darling-Hammond et al., 2019). Science in the new K to 12 curricular programs is a progression in content that topics are continuous from grades 1 to 12. The new system requires students from grades 1 to 12 to have in-depth retention in terms of content and analytical skills.

Science teaching in K-12 curriculum is an integration of various Science disciplines such as Biology, Chemistry, and Physics) and spiral in the content taught in Junior High School (De Ramos-Samala 2018), which will build the student's ability to think critically, analytically, and holistically. The teaching and learning process in Science must be contextualized and based on the experience of the students. Thus, bringing students closer to the environment plays an essential role in science education (Mcdaniel, 2020).

Science teaching in most schools today is a teacher-centered and confine inside the classroom; teacher dominates class discussion by giving information to students through the conventional method of talk and chalk. It contributed to students' poor performance in sciences, as observed by many scholars (Kola et al., 2013). Based on the results of the Program for International Student Assessment (PISA) last December 2018, Philippines obtained an average score of 357 points for scientific literacy which is significantly lower than the average Organization for Economic Co-operation and

Development (OECD) points of 489 among ranked countries. The mean scientific literacy score is within Proficiency Level 1 (DepEd, 2015).

On the other hand, the 2018 NAT results revealed for the last consecutive three years that is from 2015-2017, the national average Mean Percentage Score (MPS) in the Grade 6 NAT continued to decline at 37.44, which is the weakest performance in the history of the standardized examination of the DepEd. Meanwhile, the Grade 10 MPS of 44.59 improved by 0.51 over the score in 2017 of 44.08. The results obtained clearly defined that the Grade 6 takers in the 2018 NAT got less than four correct answers out of every ten items, while the Grade-10 takers averaged is four out of ten. Both scores, fall under the "low mastery" level in the (Dumo, 2019).

This is a similar scenario with DepEd Samar Division, although the division has no NAT results in the last three years their Mean Percentage Score although above passing percentage which of 75%, their MPS are relatively at low mastery level. For the school year 2017-2018 it pegged at 74.24, for 2018-2019 it depicted at 77.14, and for 2019-2020 is 79.11 percent (DepEd Samar, 2020). There is a need to make Science learning more engaging through student-centered instructions (Granger et al., 2012).

The study of Gomba (2010) on the field-based laboratory for teaching water resources engineering concluded that the post-test scores of the students were significantly higher than the pretest, which showed that the students gained more knowledge and skills from their assigned tasked. Sontay et al. (2018) also found out from their study the effect of the out-of-school science learning environment on

understanding the nature of Science of the 7th-grade students in secondary school. The conclusion that the educational trip to the out-of-school learning environment positively influenced the 7th-grade secondary school students' understanding of Science.

The studies mentioned that the integration of field-based instruction to develop students' learning on the subject matter was an effective teaching methodology. Field-based education needs preparation, awareness, engagement, and meta-learning, build upon, illustrated, and asses, according to Queens University (Queen's University, 2019). Development of the said learning instruction is through the formulation of activity sheets and daily lesson plans made by the teacher (Dep.Ed Order 42, 2016). The distribution of these materials to the students is during the orientation, before the conduct of field-based instruction.

The field-based instruction is congruent with the performance standards found in the curriculum guide at the Learning Resources Management and Development System (LRMDS). The design of this system is to support distribution and access top learning, teaching, and professional development resources at the Region, Division, and Schools level of DepEd. The performance standards indicated in the curriculum guide is doable in the field. Learners need to propose ways to enhance sports related to projectile motion, create a device that shows conservation of mechanical energy, analyze how power plants generate and transmit electrical energy (DO 31, S. 2012 – Policy Guidelines on the Implementation of Grades 1 to 10 of the k to 12 Basic Education Curriculum BEC).

The field-based laboratory requires appropriate and contextualized instructional materials, which are very important in science teaching and learning in any teaching methodology used (Ingrid, 2020). The implementation of the K to 12 Curriculums in the Philippines demands updated and contextualized instructional materials prepared explicitly for specific teaching methodology.

Proper planning prevents poor performance the very reason why teachers need to prepare lesson planning to avoid inadequate classroom discussions. The teacher must be academically equipped and physically ready to handle field-based instruction. To do this innovation, proper planning with appropriate teaching-learning materials. Lesson planning for field-based teaching helps teachers conceptualize and design activities to teach to the students, and focus on the basic knowledge first then take students towards the higher concept (D'hondt, 2017).

The teacher must prepare teaching guide to help students recall students' performance in schools through the use of activity sheets or written guide which utilize in performing students activities and teachers make sure that the objectives of the events are understandable and measurable by the students also teachers prepare and use different methods for the students to understand the topic and one of the methods include giving or exposing students into real-life artifacts to assist better understanding and remember the subject to be taught (Carnegie Mellon University, 2020).

This study is conceptualized and done to utilize field-based laboratory in teaching Physics in Grade-9. The inclusion focused on specific topics in Motion, Force, and Energy, these topics are appropriately used outside the classroom with a localized setting and contextualized contents.

The researcher determined the most appropriate teaching-learning materials and its delivery related to the students. The study hoped to increase the performance of the students on the topics above as well as the experiences of the students and teachers using the field-based laboratory.

Statement of the problem

This study evaluated students' and teachers' experiences in a field-based laboratory in teaching motion, force, and energy. Specifically, this study sought answers to the following questions:

1. What field-based laboratory workbook guides may be developed in teaching motion, force, and energy?

2. What are the performances of the students along with the following:

    2.1 pre-test, and

    2.2 post-test after exposure to field-based laboratory instruction?

3. Is there a significant increase in the performances of the students during pre-test and post-test using field-based laboratory instruction?

4. What are the students' experiences in using field-based laboratory instruction

5. What are the teacher's experiences in using the field-based laboratory instruction?

Hypothesis

1. There is no significant increase in the performances of the students during pre-test and post-test with using field-based laboratory instruction.

Theoretical Framework

This study is anchored on the theory of pragmatism by Dewey (1938), which focuses on the teaching and learning approach that is keeping things practical. According to Sharma et al. (2018), there are four principles of pragmatism for teachers to know about: Unity, Interest, Experience, and Integration.

Pragmatism in education involves practical lessons that have value to the lives of the learners; that is why the following are the example of pragmatism in school: 1) Experiential, Experimental, and Project-Based Learning 2) Play-Based Learning 3) Group Work and Negotiation (Drew 2020).

Dewey (1938) and Drew (2020) theories are useful in the study at hand, in terms of unity there are group activities and presentations that were included. As to interest the students are very much participative because the activities are hands-on which also takes account to their experience. The activities are familiar to them and resources used are available in the community. However, the current utilization focused more on the delivery of lessons rather than contents.

Experiential learning established by Kolb (1984:38), were he defines learning as the process whereby knowledge is created through the transformation of experience. Kolb's experiential learning theory works on two levels: a four-stage cycle of learning style theory and four separate learning styles.

Four stages typically represent Kolb's experiential learning style theory: 1) concrete experience, 2) abstract conceptualization, 3) reflective observation, and 4) active experimentation (Mcleod,2017). Real experiences are the basis for observations and reflections. It is through these reflections that the learner can understand

abstract concepts. Abstract concepts producing new implications for action, which can be 'actively tested,' create new experiences. (Kolb & Chapman, 2013). It is through experience-based learning activities that students become actively engaged in real-life learning. These activities allow students to process information deeply. The outcomes of experience-based learning activities are more endearing than those from teacher-directed education (Mcdaniel, 2020).

Active learning is when a person progresses through a cycle of four stages: of (1) having a real experience followed by (2) observation of and reflection on that experience which leads to (3) the formation of abstract concepts (analysis) and generalizations (conclusions) which are then (4) used to test a hypothesis in future situations, resulting in new experiences (Terrab &Wdhb, 2020)

In this study, experiential learning took place in the field to link classroom learning to the real world (Educational Development Centre, 2018). This approach takes students into their immediate surroundings to facilitate learning from their experiences. When students purposefully interact in their local surroundings, they can relate more closely to their world (Knapp et al., 2006).

Alkan (2016) further stated that the experiential learning model plays an integral part in the learning process. It is a valid theory on academic achievement and scientific process skills. Experiential learning applications expand the course content and improve students' knowledge levels through real-life practice while encouraging students to think effectively and come to conclusions using the data obtained through questioning. Teaching strategies that ensure active participation of students with the help of scientific research such as experiential learning improve conceptual learning more when compared to more passive techniques (Ernst, 2013).

Conceptual Framework

The conceptual framework in Figure 1 shows the respondents of this study- the grade 9 students. This study is conducted during the school year 2019-2020.

The left frame shows the preparation to be considered in doing the research, workbook guide, Instruction to Students, Daily Lesson Log (DLL), and Activity Sheets. This preparatory procedure was used as a basis in conducting Field-Based Laboratory Instruction in teaching motion, force, and energy, considering the Site Selection, Weather Condition, Logistics, Time, Materials, and Students' security represented by the upper and lower circle found in the middle of the conceptual scheme. This concept of preparation is similar to Dewey's (1938) pragmatism wherein necessary materials are prepared that would address the needs of students.

Pre-test and post-test were conducted after the intervention made by the researcher to measure students' performance, represented by the arrow pointing to the left and interviews were made to determine students, teacher experiences and attitude towards field-based laboratory instruction to contribute for the excellent performance of the students in motion, force, and energy represented by the right frame of the conceptual scheme. These quasi-experimental phase is relatable to the work of Kolb's experiential learning (as cited by Mcleod, 2017) which contributed to the idea of observations and actualizations.

The interviews served as documentation of the actual experiences of the students. As shown in the right upper frame, it would validate the results of students in the post-test as Alkan (2016) theory proposed that experiential learning takes part in the teaching-learning process.

Actual experiences are also the bases for providing explanations to phenomena, thus enable students to reflect and connect to reality.

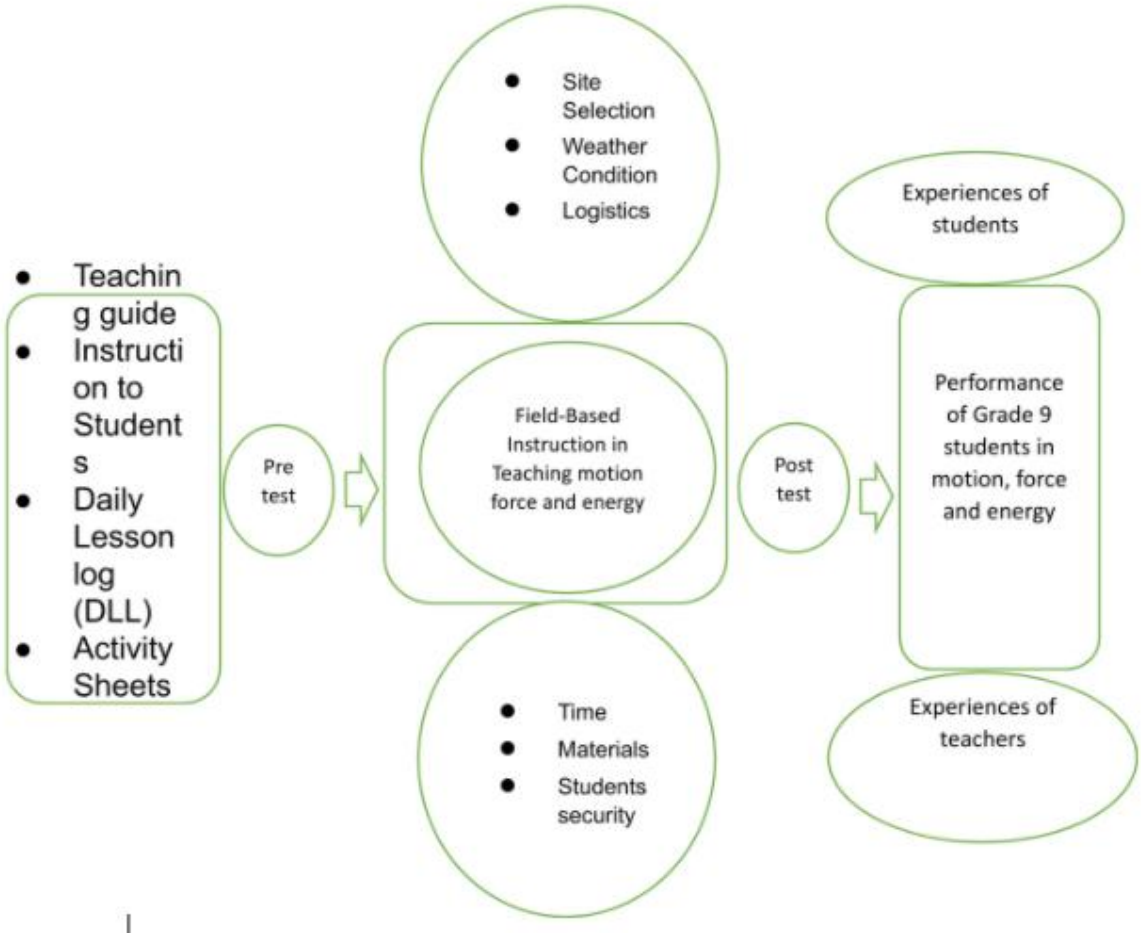


Figure 1. ***The Schematic Diagram of the Conceptual Framework of the Study***

Significance of the Study

This study would provide advantages because it is designed to assist the teaching-learning process and cater to the learners' various needs and interests. This study is beneficial to the following:

Students. This study would help discover students' interest in a science subject, develop the necessary skills, and increase students' knowledge and awareness that his/her environment is full of learning resources and to preserve our environment for Science learning. The field-based instruction provides students meaningful and hands-on learning experience.

Teachers. This study served as the basis of the teacher in addressing the students' poor performance in Science. This study would help the teacher to determine the appropriate teaching method in the delivery of science lessons and to appreciate the importance of the environment as the best classroom in the teaching and learning process. The field-based instruction would enable teacher to engage the students and it is a good intervention to increase their class Mean Percentage Score.

Principal. The result of this study would serve as a framework for various programs to be employed on the school improvement planning, and it is also possible to have a quarterly consultation with the result of Mean Percentage Score (MPS) in science subject so that the principal can help and assist teachers in improving the performance of the students.

School Administrator. It would help the superintendent to know the needs of the school and to plan for the support system that the school administrators need to prioritize when it comes to the performance of the students. It will also identify the gaps and weaknesses of the secondary schools at the Wright II-SJB District regarding the improvement of the students' performance towards Science.

Future Researchers. The study results are useful for future researchers to conduct similar studies in other areas on how to improve students' low performance and interest in Science.

Scope and Delimitation

The study focused on Field-based Laboratory Instruction specifically on topics Forces, Motion, and Energy which used both qualitative and quantitative research designs to measure the Grade 9 students' learning after exposing to the said teaching approach. The students are provided with pre- and post- paper and pen tests to measure the knowledge gained from the utilization of Field-Based Laboratory Instruction. The interview is collectively done to validate if Field-based Instruction improves science performance of students. It is conducted within the vicinity of Lawaan National School, Paranas, Samar during the school year 2019-2020.

Definition of Terms

To fully understood this research, the following terms were defined as conceptually and operationally.

Classroom Activity. It refers to the activity done by student inside the class as part of applying or doing the practical part of the lesson after listening to the theoretical part which is presented by the teacher (Haroun,2020). In this study it refers to the student's participation in performing related task of the topic during class discussion.

Contextualization. It refers to the educational process of relating the curriculum to a particular setting, situation or area of application to make the competencies relevant, meaningful, and useful to all learners (D.O. 32, s. 2015). Similar context is used in this study.

Curriculum Guide (CG). It is a structured document that delineates the philosophy, goals, objectives, learning experiences, instructional resources and

assessments that comprise a specific educational program. Additionally, it represents an articulation of what students should know and be able to do and supports teachers in knowing how to achieve these goals (Kranthi, 2017). In this study, it refers to a way of determining what to teach, how to teach and help teacher to teach things in a certain diverse group.

Daily Lesson Log (DLP). It is a template that teachers use to log parts of their daily lessons. The Daily Lesson Log covers a day's or a week's worth of lessons (Deped, 2016). In this study, it provides teachers with an opportunity to reflect on what students need to learn, how learners learn and how to facilitate the learning process.

Field-based Laboratory Instruction (FBLI). This refers to a method of active learning, allowing students the opportunity to obtain a more "real-world" perspective on the subject matter (Kozar & Marcketti, 2008). In this study, it focusses on exposing students directly into the environment to perform a hands-on activity that will give a practical experience to the students.

Instruction. is the act of educating, giving the steps that must be followed, or an order (Your dictionary, 2020). In this study, it is the teaching of particular skills or subjects to the students.

K to 12 Program. It covers Kindergarten and 12 years of basic education (six years of primary education), four years of Junior High School, and two years of Senior High School [SHS]) to provide sufficient time for mastery of concepts and skills, develop lifelong learners, and prepare graduates for tertiary education, middle-level skills development, employment, and entrepreneurship. In this study, it refers to the educational system were students are enrolled.

K-12 Teacher's Guide (TG). These are resources used in preparing daily lessons. Additional resources include materials from the Learning Resources Management and Development System (LRMDS) portal, textbooks, and others supplementary materials, whether digital, multimedia, or online, including those that are teacher-made (Mark, 2020). In this study, it refers to a scripted standard outline offering a step by step way of teaching the lessons.

Learning materials. Any resources a teacher uses to help him teach his students (Janovsky,2020). In this study, these include textbooks, teachers and curriculum guides, Daily Lesson Log (DLL), and activity sheets.

Laboratory. A place equipped for experimental study in a science or testing and analysis. (Merriam-Webster, 2020). In this study, it is a place that provides an opportunity for the students to performed experimentation and observation.

Learning Resources Management and Development System (LRMDS). A design system to support distribution and access top learning, teaching, and professional development resources at the Region, Division, and Schools level of

DepEd (DepEd, 2016). In this study, it refers to learning resource portal were teachers can access a quality resources to support students learning like curriculum guide and teaching guide.

Mean. It implies average and it is the sum of a set of data divided by the number of data (Dudovskiy, 2020). In this study, it refers to a certain formula where teacher can use to analyze students results after the assessment. It can be calculated by dividing the total score of students to the number of students who took the test.

Mean Percentage Score (MPS). It indicates the ratio between the number of correctly answered items and the total number of test questions or the percentage of correctly answered items in a test (DepedOrderNo.73, s.2012). in this study it refers to a certain formula used by the teacher in analyzing student's assessment results it can be calculated by multiplying the computed mean by 100 and dividing by the total numbers of test item.

National Achievement Test (NAT). It is a Philippine -made standardized test designed to determine pupils/students' achievement level, strengths and weaknesses in five key curricular subject areas at the end of the school year (Glavin,2014). In this study, it refers to a set of examination taken by the students from Grade 3,6,10 and 12 to measure students understanding, comprehension, knowledge and capability in a certain subject area.

Pre-test. Preliminary test administered to determine a student baseline knowledge or preparedness for an educational experience or course of study (American Heritage Dictionary of the English Language, 2011). In this study it refers to a form of assessment given at the beginning of the lesson to measure students' prior knowledge with regards to the topic.

Post-test. A test given to students after completion of an instructional program or segment and often used in conjunction with a pretest to measure their achievement and the effectiveness of the program (Merriam-Webster, 2019). In this study, it refers to a test given at the end of the lesson to insure if students learned during discussion.

Student-centered instruction. Students and instructors *share* the focus. Instead of listening to the teacher exclusively, students and teachers interact equally (Share Team, 2020). In this study group work is encourage during the discussion, students learn to collaborate and communicate with one another.

Teacher-centered education. Students put all of their focus on the teacher. You talk, and the students exclusively listen (Share Team, 2020). In this study it refers to students work alone and collaboration is being is discouraged.

Technology. The application of scientific knowledge to the practical aims of human life or, as it is sometimes phrased, to the change and manipulation of the human environment (Encyclopedia Britannica, 2020). In this study, this refer to the application of scientific knowledge using gadgets (cellphone, timer, and some laboratory apparatus) during in the teaching and learning process.

CHAPTER II

REVIEW OF RELATED LITERATURE AND STUDIES

The significant literature and studies taken from books, published thesis, dissertations, journals from library and internet sources related to the study were presented in this chapter and had undergone concepts organizing, which contributed to the formulation of the ideas and other information vital to this study.

Related Literature

Learning physics requires students the ability to comprehend easily the concept of the subject and this can be done if the students unfold their curiosity, interest, and enjoyment towards the subject through a teaching method that gives connection, motivation, and relevance to the students' lives.

Philippines Science K to 12 curriculums are focused on its content and process, without the content learners will have difficulty in utilizing science process skills because these processes are best learned in context. Let learners arouse their curiosity from situations and challenges that motivate them to learn and appreciate science as relevant and useful. Rather than relying solely on textbooks, varied hands-on, minds-on, and hearts-on activities will be used to develop learners' interest and let them become active learners (K to 12 Science Curriculum Guide, 2016).

Since teaching is what matters and what is measured, sometimes instruction that is mostly lecture-driven and learning, mostly passive, receptive enterprise. In other words, students should come to class, listen carefully, take good notes, and be

grateful (Keeling & Hersh, 2012). This kind of teaching has a domino effect on the performance of the students in the school because many educators and graduate researchers students have identified that the quality of teachers, the teaching-learning process, instructional materials, the curriculum, and administrative support are the main reason behind why Filipino students have low performance in the national or international standard test for science SEI-DOST & UP NISMED, (2011) as manifested in the result of the Programme for International Student Assessment (PISA) of the Organization for Economic Co-operation and Development (OECD) in 2018, where Philip pines scored 353 in Mathematics, 357 in Science, and 340 in Reading, which all below the average of participating OECD countries (Villapando, 2019).

There are commonly teaching method being used in the field of teaching physics some of this are lecture method, which focuses on teacher-centered and does not develop students' practical skills and a teacher demonstration, a popular method of teaching in most of the schools if were the resources are limited and this method is restricting students to practice skills especially handling skills which turn into a teacher-centered and leaving the learners more passive most of the time. Project work in physics is given to the students at the end of the chapter or module of the learning areas although this method gives an ample time of the learners to finish the output with the advantages on the side of the students, in this case, teachers field to supervise the projects and tend to not directly examined by the teacher. Lastly, student's practical work where on this approach student intellectually involve in rigorous thinking activity. This is an experiential method of teaching that allows the learners to learn and practice handling and process skills and this approach

motivates students to learn the content of the topic. This will also give a high degree of retention of the lesson content as compared to the lecture and demonstration method (Maera, 2016).

There are some design principles for effective physics instruction on which Physics and Everyday Thinking (PET) are based. This curriculum was developed of five design principles derived from research in cognitive science and science education. These principles are based on the idea that teachers must create learning environments in which students articulate, defend, and modify their ideas as a means for actively constructing the main concepts that are the goals of instruction. The design principles are the following, first learning builds on prior knowledge which has a vital role on how and what students learn followed by learning as a complex process requiring scaffolding, learning is facilitated through interaction with tools, learning is facilitated through interactions with others and lastly learning is facilitated through the establishment of certain specific behavioral practices and expectations (Goldberg et al., 2010).

Engaging students in learning by doing helps students perform better in science especially on angular momentum where students perform a hands-on activity by using two bicycle wheels that spun independently on a single axle which allowed students to understand the concept of angular momentum. A post-test showed that those who had actively participated in the experiment outperformed compared to the group who simply observed. As concluded when students have a physical experience moving the wheels, they are more likely to activate sensory and motor areas of the brain when they are later thinking about the science concepts they learned about and those students who physically experience difficult science

concepts learn better, perform better in class and on quizzes the next day, and the effect seems to play out weeks later, as well (Ingmire, 2015).

The result of the student's performance in school is based on the teaching and learning process. Teaching method must be unique and intriguing to avoid poor interest on the side of the students and this can be achieved using a combine instruction that will develop students learning in school because some students are easy to understand and remember the topic and others have difficulty absorbing it (National Academies of Sciences, Engineering, and Medicine, –2018).

There is a need for a teaching strategy that teachers must integrate into the teaching-learning process of science so that students will develop the necessary skills needed for their development. Field-based laboratory enhances students' skills in observation, description including measuring, writing and sketching, Starting and maintaining a field notebook, and Working in a group. This method not only develops skills but also it builds community, it raises expectations and standards, it increases connection, it builds culture and it develops positive feelings and memories around the school and the outdoors which these developments also notice by the researcher during the conduct of his study among the students (Macdonald, 2020 & Becker, 2016).

Field-based instruction is part of the Geoscience Curriculum at Washington and Lee University, it is the main core of their geology instruction. They stress out fieldwork at all levels of their instruction from the field-based introductory courses to their senior theses because it is important for their students to have well-developed skills in field methods, in analytical techniques, in computation and

modeling, and in synthesis and presentation which integrated into their geology courses (Knapp et al., 2006).

Field-based learning experiences provide students with a window to the real world that they do not get in the classroom. Field-based learning experiences provide students with a better foundation to apply classroom knowledge and application in an environment outside of the school Learning outside of the classroom is useful because it demonstrates the applications of classroom learning in the real world, engages students by using authentic tasks and or tools, and teaches them skills that may not be learning at school (Aulenbacher, 2016 & Alfred et al., 2013).

Field-Based Instruction is an Effective Teaching Strategy because students are engaged in an active learning design it gives a deeper level of learning according to the researchers in the past. They measure active learning through two field assignments created for two separate undergraduate courses at different four-year institutions. The main goal of the assignment was to increase students' learning experiences and knowledge. As a result, the authors found that in both settings, field experiences proved to be meaningful because it develops students understanding of the subject matter and help on students' retention. Based on these observations the authors propose that instructors must implement a field-based instruction as a method of active learning into their courses whenever appropriate by allowing students the opportunity to obtain a more "real-world" perspective on the subject matter (Hartikaine et al., 2019).

When the bodies become part of the learning process, it understands better the learning areas, because when it is experience directly it geared students with

higher order thinking skills which is comparable than just reading the concept in the textbook or even just seeing a demonstration in a class. Teacher needs to consider the way they teach science because teacher actions matter for how and what students should learn (Ingmire, 2015).

Learning in the field results in cognitive and metacognitive gains for students; produces affective responses that have a positive impact on students learning; afford types of learning that cannot be easily achieved in other, more controlled environments; facilitates the creation and cannot be easily achieved in other, more controlled environments; facilitates the creation and use of representation of nature in learning (Darling-Hammond et al., 2017).

Quasi-experimental design, the non-equivalent pre-test, and post-test control group design were being used to determine the effects of using outdoor school activities strategy to enhance students' academic achievement and retention in science were using this teaching strategy, outdoor science activities can be an option in promoting students' academic achievement and retention in science students. Based on this, it was recommended that science teachers should adopt outdoor science activities in teaching science at the secondary school levels and that the Government should provide an essential outdoor learning environment in schools to facilitate outdoor science activities (Oyovwi, 2020).

Related Studies

Many studies have been conducted about field-based teaching strategies to enhance student's performance in school. As early as 1985, field courses, field camps,

field trips, field labs, and field investigations have been part of the foundation for careers in geology, ecology, environmental sciences, and archeology.

According to Firmansah and Suryadarma (2019), there is a different result of using outdoor learning instruction between the experimental and control class on their study about the influence of outdoor learning model in biology instruction on the environmental care attitude of the Senior High School student were, it was revealed that the result of the pretest of both classes is contiguous but on the post-test result showed that the score of the experiment class students was much higher than the control class. Based on the results of the research it can be concluded that biology learning by using the outdoor learning model is more effective to improve environmental care attitude of a high school student on environmental care material when compared to biology learning using conventional learning. This study gives an insight to the researcher to utilize the environment to introduce field-based instruction in teaching physics concepts. The study mention is similar to the present study because in the teaching-learning process the environment will serve as a venue in teaching physics concepts force, motion, and energy which students will appreciate its importance and role as part of their learning physics.

The study conducted by Feig et al. (2019) on Achieving Inclusive Field-based Education: Results and Recommendations from an Accessible Geoscience Field Trip stated that Field instruction is an experiential process that develops the understanding of the scale, rate, and timing of Earth processes such as mountain building, river channel movement and climate change (Garrison & Endsley, 2005) and it develops student's scientific teamwork, self-management and communication skills (Petcovic et al., 2014 & Quality Assurance Agency, 2014). This study gives an

idea to the researcher to include students with a person with a disability (PWD) to experience the field-based instruction. This present study also used the experiential process to test the effectiveness of field-based instruction as a teaching strategy in teaching force, motion, and energy and to develop students' scientific skills that are required in learning science.

Miller (2018) shown in his study about the effect of using outdoor instruction on increasing students' academic achievement and attitudes towards the environment that students showed significant growth in their learning during the treatment unit. Based on the research and data show that experiential outdoor education is effective and students gain a positive insight and experience doing the activity which clearly stated during their small group interview "Doing things hands-on helps me remember; you remember experiences more this way than what you learn in a classroom". Students expressed positive attitudes about their interests in learning about environmental science because of their experiences outside in the classroom. This ultimately had a positive impact on their attitudes and willingness to learn. There is a similarity on the above study to the present study because the researcher gains an understanding on the hands-on learning interaction with the natural instructional material present in the environment to increase students' academic learning in science

On the other hand, Yildirim (2018) conducted the study on The Impact of Out-of-School Learning Environments on 6th Grade Secondary School Students Attitude Towards Science Course where half of the participated students are the control group and other half undergone experimental process. The experimental group students visited out-of-school learning environments with the guidance of the

science teacher. The Science museum, anatomy museum, planetarium, nature trip, science festivals, energy park, and aqua park are among the out-of-school learning environments. As a result of the study, it was seen that the attitudes of the students towards science courses in the experimental group were increased at a significant level, and no significant improvement was realized in control group students' attitudes. This study gives an idea to the researcher to maximize all applicable areas in the community to use as a venue in performing science activities. This study is similar to the present study because students will undertake the experiential process, they will be exposed to the different venues like a river, tall house, slope surfaces and open field in performing the activity. The students also will be motivated in coming to school because of the new teaching strategy that will be introduced to the students.

Accordingly, Padmadiwa and Pamulasari (2017) describe the impact of the outdoor learning model on physics achievement for dynamic fluid using syllabus, lesson plans, worksheets, and four core competencies of assessment instruments as a tool in the teaching-learning process of physics. The results of the study indicate that the outdoor learning model through fieldwork can improve the core competencies of learning outcomes in the dynamic fluid. This study gives an insight to the researcher to use the curriculum guide, lesson plan, and worksheet as an instructional material in doing the research. These instructional materials will be developed by the researcher to determine the effectiveness of field-based instruction.

According to James and William (2017) on their study about the "Experiential Outdoor Education: Neglected Necessity" based on the interview's responses from the seventh- and eighth-grade students, revealed that outdoor experience, post-camp,

and outdoor education to be a valuable experience. Mostly of the seventh and eighth graders indicated that the outdoor education camp was worthwhile. Middle school student responses indicated that they enjoyed learning environmental science concepts in a hands-on, active, and experiential way. This study is similar to the current study because students will also experience a hands-on activity under the experiential process.

Additionally, there is another experimental study about the effects of field-based experiences on students' understanding of ecological concepts and biology. This study was conducted by Hayes et al. (2017) where the major findings of this study included: students' understanding of ecological concepts was below standard, students' understanding of ecological concepts with field-based was higher at end line test when compared to the baseline measurement. The achievement of students in the field-based group was higher than the traditional(control) group. It was concluded that field-based experiences improved students' understanding of ecological concepts, enhanced students' understanding of ecology, and significantly influenced their achievement. This study gives an insight to the researcher to expose students to the environment to have wide and deep learning in physics. This study has a similarity to the present study because students will be brought directly into the environment to perform the required activities of the lessons to understand easily the topics.

A dissertation conducted by Spray (2015), The Schoolyard as an Outdoor Classroom: Learning through Experience. The results of this study provide insight into the importance of engaging African American students in meaningful learning experiences by utilizing the schoolyard to learn about the environment of the local

places instead of faraway spaces. These experiences will not only assist African-American students with increasing their critical thinking and problem-solving skills but will also help African-American students develop bonds with nature, which can ultimately change their attitudes toward the environment. By developing bonds with nature and creating more positive attitudes toward the environment will encourage African-American students to have more pride in their community.

The study of Spray (2015) revealed as significant in the conduct of the present study by means of localizing the concept using the school community as a place for the development of the student's critical thinking and problem-solving. The study has also a similarity to the present study because students will have direct experience in a natural setting in which students will grow their environmental awareness of their environment.

The study of Hidaya (2015) revealed the benefit of Teaching and Learning Activities Outside the Classroom Which Improve the Quality of Students Teaching and learning which become and student-centered when moved from the borders of the classroom into the world at large. The potential benefits of teaching and learning outside the classroom activities can be enormous. Make learning more engaging, make learning relevant, Nurture creativity and imagination, develop learning through play and experimentation, improve attendance, reduce behavior problems, develop an interest in the environment and wider surroundings, expose children to new opportunities, keep healthy, Enjoy almost limitless resources. This study provided the researcher with the idea of looking for a student-centered teaching strategy. The study mentioned has a similarity to the present study because its focus is also on learning that is more engaging, relevant, nurture creativity and

imagination, develop learning through play and experimentation, improve attendance, reduce behavior problems, develop an interest in the environment and wider surroundings, expose children to new opportunities, keep healthy and to enjoy almost limitless resources that is contextualization has.

Moreover, in the study of Estevesa et al. (2015) "A Field-Based Approach to Teach Geoscience: A Study with Secondary Students", showed that field-based method was effective in helping students to obtain required knowledge to accomplish the Natural Science syllabus learning objectives, as well as to develop other competencies such as scientific reasoning and inquiry capacities. Findings indicate from the study that both participants and an external observer consider the outdoor learning environment as beneficial in increasing motivation and interest, meaningful knowledge, and understanding. On the other hand, a field-based teaching approach is effective in developing students' critical thinking skills. This study gives an idea to the researcher to help students to enhance their scientific and reasoning ability. It has a similarity to the present study because of utilizing a field-based instruction strategy to motivate students' interest and to increase their knowledge and understanding of physics concepts.

A study conducted by Alexandar and Poyyamoli (2014) on Teaching Biodiversity in Freshwater wetlands - A field-based teaching strategy for school students where he pointed out the importance of environment-based education on their own native place which can increase specific critical thinking skills central to good science questioning, investigating, forming hypotheses, interpreting data, analyzing, developing conclusions, and solving problems and emphasizes cooperative learning (working in teams or with partners), critical thinking and

discussion, hands-on activities, and a focus on action strategies with real-world applications. As a result, students who study Environment based education develop and practice the following leadership skills: working in teams, listening to and accepting diverse opinions, solving real-world problems, taking the long term view, promoting actions that serve the larger good, connecting with the community and making a difference in the world. This study gives an idea to the researcher to come up with a new teaching strategy a field-based instruction with the use of the environment. It has a similarity to the present study because of its goal to enhance students' scientific skills in science under environmental-based education, maximizing the capacity of its local resources to be used in performing students' activities.

Additionally, Ting and Siew (2014) conducted the study to investigate the effects of outdoor school ground lessons on Year Five students' science process skills and scientific curiosity. The participants in the study were divided into two groups, one subjected to the experimental treatment, defined as an "eco-hunt" group and the other had no experimental treatment, defined as the control group. This study used intact four classes which consisted of 119 students and randomly assigned to the treatment Students' science process skill was measured by a self-developed Science Process Skills Test and students' scientific curiosity was measured using Children Scientific Curiosity Scale adapted from Harty and Beall (1984). This study provided ideas to the researcher in handling outside classroom activities. It has a relation to the present study because of its goal to determine the implications of outdoor education on the development and performance of the students in science.

A study conducted by Gomba (2010) on the involvement of Civil Engineering Students in Water Resources Projects: A Field-Based Laboratory" resulted that students involved in the water resources field-based laboratory-acquired more knowledge and enhanced their skills in the different water-related courses including the use of computer-based tools/software for map generations and water-related simulation models. The study also found out that the working attitudes and values of the students were improved after the involvement activities. Thus, it is strongly recommended that engineering schools should look for opportunities to establish a field-based laboratory for students' involvement in community projects. The study of Gomba contributes an idea to the researcher to use field-based instruction in teaching physics concepts. It has a similarity to the present study since both studies are focusing on the exposure of students into an environment using a student-centered teaching strategy to enhance students' scientific and analytical thinking skills.

Based on the above-mentioned studies by the different authors, the researchers believe that exposing our students to a hands-on learning environment, a field-based laboratory instruction will create active learning that will increase students' academic achievement, self-improvement and attitude towards physics. Thus Field-based instruction must be incorporated in the teaching-learning process to enhance student interest and motivation towards science.

CHAPTER III

METHODOLOGY

This chapter presents the research design, instrumentation, validation of the instrument, sampling procedure, data gathering procedure, and statistical analysis of the researcher to be employed in analyzing and interpreting the variables of this study.

Research Design

The study used descriptive with quasi-experiment research designs supported phenomenological and narrative research approaches. The descriptive with a quasi-design enables the researcher's description of the performances of the students-respondent before and after exposure to Field-Based Laboratory Instruction (FBLI) in teaching Physics Concepts using a questionnaire. The quasi-experiment was sought because it is challenging to conduct random assignment to the respondents to be involved in this study (Cowell 2012). The respondents took the pretest prior to exposure to FBLI and posttest was also conducted after exposure to FBLI to check if there is a significant increased on their performance.

The researcher also utilized a phenomenological research approach for the student-participants' experiences on the conducted activities on FBLI, and it is for the identification of themes that supports the advantages and disadvantages of the intervention. For the teacher who did the FBLI, the narrative research approach is utilized for the same purpose as the student-participants.

Instrumentation

For the pre and post-tests, the use of a researcher-made test that follows the competencies and standards set by the Department of Education was utilized for the FBLI. The Daily Lesson Log is also anchored to the standards set by the Department of Education, validated and checked by the educational experts.

The pre-and post-tests are of the same contents, with 52 items subdivided to competencies on topics Force, Energy, and Motions. There are 13 competencies, four questions for each skill, and tiered with definition, description, and two (2) different applications. The test is not yet standardized, but improvement could be carried out for future utilization of other researchers.

The interview guide for the students and teachers is solely designed to collect their experiences on the exposure to FBLI, it is constructed after quantitative analyses were performed.

Validation of Instrument

The researcher-made pretest and posttest followed the expert validation with the assistance of the thesis adviser. The draft questionnaire was presented to three (3) experts in teaching Physics concepts for their inputs, suggestions, and recommendations. The revised test was dry-run in Casandig National High School, Paranas Samar, using the Grade 9 science classes. The self-made test was revised until the experts and the research adviser approves the said test for fielding.

Sampling Procedure

The study used complete enumeration wherein all students in Grade 9 Science class in Lawaan National High School considered as the study respondents. The research respondents have a total of 34 students. They are selected as study respondents because the competencies in the grade level are mostly applicable for outdoor activities such as Force, Motion and Energy, thus field-based laboratory instruction is possible.

The teacher who is handling the class is also considered as key informant to narrate his experiences in conducting and facilitating the Field-based Laboratory Instruction.

Data Gathering Procedure

The researcher sought permits from school head and parents of the students to allow them to have a field-based class in Grade 9. The barangay officials were also informed about the said field-based activities.

The data gathering starts by giving pre-test to students in Grade 9. The researcher oriented the students on the field-based laboratory strategy in teaching Physics, wherein the students are provided by written guides or procedures on the conduct various activities. The students are directed to the field within Barangay Lawaan Paranas Samar. The students conducted field activity in Physics concepts such as Force, Motion, and Energy with supervision of the researcher. After the lessons and activities, the researcher conducted post-test.

Upon analyses of the quantitative results, interviews were conducted to the participants, once data saturation is reached that was the time the researcher

stopped with the interview. Narrative report was also required for the experiences of the teacher handling the subject and the one who conducted and facilitated the Field-based Laboratory Instruction. A trained teacher from locale of the study.

Statistical Treatment of Data/Data Analyses

The study employed descriptive statistics such as frequency counts, percentages, mean, weighted mean, and standard deviation as to the projection or presentation of results for the pretest and posttest results of the respondents.

A Shapiro Wilk Test was used for normality to assure the appropriateness of the inferential statistics. Since it conforms with the assumptions, paired t-test is then proceeded with p-value at five percent margin of error to decide whether hypothesis of the study be accepted or rejected.

For qualitative data on experiences, thematic analysis was applied to utterances of student-respondents. The process is based on the work of Creswell (2014), it starts with organizing the raw data into proper documents, reading through the complete documents, coding the data, making themes, interrelating themes and interpreting the meaning of themes. For narrative data analysis it is also anchored with the same author. It starts with constructing the narratives, defining significant experiences, exploring categories, themes and experiences, and restructuring the narratives aligned to themes and experiences.

Ethical Consideration

The researcher of this study ensures that the data collected were treated with utmost confidentiality and secure all approval of the involved authorities prior to the conduct of the study. After the data were tallied it was shredded and disposed properly.

The researcher guaranteed that the methodology was subjected for ethical review, and revised accordingly in conformity to the issuance of ethical approval certificate.

CHAPTER IV

PRESENTATION, ANALYSIS, AND INTERPRETATION OF DATA

This chapter shows the tabular and graphic presentation of the results of the study, the corresponding analyses and interpretations.

Development of Field-based Laboratory Teaching Guide in Motion, Force, and Energy

The development of Field-based laboratory Instruction Workbook is anchored from the Lesson Planning Flow Chart model of Foliaki (2011), from Curriculum Guide (CG) its competency (learning objective), preparation of daily lesson log (DLL) thru DepEd Oder 42, s, 2016, expert validation of DLL through master teacher (Sangalang, 2019), incorporate suggestions, printing, and fielding or application of lesson plan.

Figure 2. ***The Conceptual Model of Field-Based Laboratory Workbook Guide***

Daily Lesson Log is a template use by the teacher to log parts of their daily lesson. It covers a day or a week's worth of lessons and contains the following parts, objectives, content, learning resources, procedures, remarks, and reflection. The constructed DLL applied the framework of contextualization, relating the curriculum to a particular setting, situation, or area of application to make the competencies relevant, meaningful, and useful to all learners (DepEd Order No. 32, s. 2015). Its instructional process has a three (3) steps: (1) planning instruction; (2) delivery of instruction; and (3) assessment of learning (Airasian ,1994). This means that teacher must prepare, organize and develop a plan before begins a plan for teaching, implement that plan, and measure how effectively they implemented a plan.

The workbook's format is anchored to the work of Rogayan (2019), it is localized according to the resources available in the locale. It starts with topic title, then learning competencies from K to 12 curriculum guide, then introductory statement explaining concepts used in the presentation of lesson, the contextualized activity, learning outcomes, and learning tasks oriented with Field-based Laboratory Instructions. The Field-based Laboratory Workbook contains separate objectives, materials, procedures, analysis, presentation, vocabulary enhancement, and assessment. The workbook is checked and validated by experts through a Master Teacher, Thesis Adviser, and an Expert from Samar State University.

Students' Performances Before and After Exposure to Field Based Laboratory Instruction

Table 1 provides data of the students' performance before and after exposure to Field Based Laboratory Instruction (FBLI).

From the table, the performance of students before exposure to FBLI has a mean equivalent performance of 69.30, an indication that they did not meet expectations as to topics force, motion, and energy. However, upon utilization of FBLI there is an increase in the mean performance of students, from not meeting expectations to fairly satisfactory. Results implied that there is a shift in the students' performance with the use of FBLI. A fairly satisfactory performance specifies that the students met the competencies as basis forgiving remarks as passed (DO 8, s. 2015). The intervention thru FBLI provides minimal improvement on students' performance thus it needs consistent utilization and evaluation.

Table 1

Students' Performances Before and After Exposure to Field Based Instruction

Equivalent Performance and Description	Pretest		Posttest	
	f	%	f	%
90-100 (Outstanding)	-	-	-	-
85-89 (Very Satisfactory)	-	-	-	-
80-84 (Satisfactory)	-	-	1	2.94
75-79 (Fairly Satisfactory)	-	-	18	52.94
below 75 (Did Not Meet Expectations)	34	100	15	44.12
Mean Performances	**69.30 (Did Not Meet Expectations)**		**75.02 (Fairly Satisfactory)**	

**Equivalent Performance and Description is based on DepEd Order No. 8, s. 2015*

Effectiveness of Field-Based Laboratory Instruction

The test validation is undergone before proceeding to statistical treatment of data, Shapiro Wilk Test value resulted to 0.1974 with skewness of 0.2029 which is potentially symmetrical. The data showed no outliers and assumed that After Exposure Minus Before Exposure to FBLI is normally distributed or more accurately or cannot reject the normality assumption. With this, data can proceed to paired t-test calculation.

It can be gleaned in Table 2 the statistical results on the validation of the null hypothesis (Ho) there is no significant increase in the performance of students before and after exposure to FBLI.

Table 2

Statistical Results on Validation of Hypothesis

Category	Mean	SD	Absolute Mean Difference	t-critical	t-stat (p-value)	Decision
Pretest	69.30	2.24	5.72	2.03	9.78 ($2.79\ e^{-11}$)	Reject Ho/ Significant
Posttest	75.02	1.97				

If t-critical is ≥ t-stat reject Ho, Significant; If t-critical is ≤ t-stat accept Ho, Not Significant
Level of significance=0.05: if p≤0.05 Reject Ho, Significant; if p≥0.05 Accept Ho, Not Significant

From the table, since t-stat (9.78) is higher than the critical t-value (2.03), hypothesis is rejected. It is supported by the p-value ($2.79\ e^{-11}$) which is much lower than the level of significance at 0.05 which reinforces claim that there is a significant increase in the performance after exposure to FBLI as reflected in their mean equivalent performances (from 69.30 to 75.02). The statistical results implied that the difference between the average equivalent performance after, minus before exposure

to FBLI (5.73) is big enough to be statistically significant. Thus, FBLI is an effective tool to help improve students' performance in Force, Motion, and Energy. It is supported by some of the published literature that FBLI is intriguing and influential because it helps learners understand concepts and connect with the instructional framework, and unique learning setting (Kinslow, Sadler, & Nguyen, 2018). FBLI also enhances learning activities accessibility and an avenue to produce more meaningful instructional workshops (Feig, Atchison, Stokes, & Gilley, 2019). It is a recommendation that science teachers need to utilize more often FBLI to support new learning experiences of students.

Students' Experiences in Using Field-Based Laboratory Instruction

There are three themes that emerged in the utterances of the student-participants with the use of Field-Based Laboratory Involvement (FBLI). These themes are follow:

Theme 1: Learned from the conducted FBLI performances

One of their experiences using FBLI is they learned from the conducted performances, as presented in the following utterances of the participants.

> "*I've learned sir because during the discussion I volunteer to perform a hands-on example and I can able to answer the guide questions easily because I am involved in performing the activity too.*" (Participant 1)

> "*I'm excited to listen to the discussion and I've learned a lot because my group mates show how to perform the activity.*" (Participant 2)

> "*It's a new kind of teaching for me, it's fun and the environment is with us during the learnings of the topic and I was able to understand the topic easily because we are the one performing the activity, there is retention on the discussion.*" (Participant 8)

"My classmates are encouraged to go to school because the teaching is fun an it's easy to learn because we are the one performing the activity." (Participant 10)

"I really enjoyed the Field base laboratory instruction because my friends are also with me in the field, were not inside the classroom to learned, it's a new experience and we are only the class section who are in the field to study." (Participants12)

"I experience to learned outside the classroom and I've learned through that kind of teaching because I enjoyed in performing the activities." (Participants 13)

"*It is easy to understand the topic because of the demonstration and we are involved in performing the activity."* (Participants 14)

According to them, they learned from the conducted FBLI performances because it is hands-on (Participant 1), a new kind of teaching and it is fun (Participants 8 &10), it is a new experience to learn outside the classroom (Participants 12 &13), and easy to understand the topic (Participant 14). Students are hands-on because they experienced real life setting, instructional activities develop understanding through innovative way of teaching (Maxwell, Hilaski, & Whelan-Kim, 2018). Thus, it is suggested that Science Teachers should prepare activities align to Field-Based Laboratory.

Theme 2: Field-Based Laboratory Instruction is Good and Enjoyable

Participants' experiences using FBLI is found to be good and enjoyable, as presented in the following utterances:

"Field-based instruction is good sir because it is a different way of teaching because when we are in the classroom, I'm not used to listen but when we are in the field, I'm excited to listen to the discussion and I've learned a lot because my group mates show how to perform the activity." (Participant 2)

"Field-based instruction sir is good; I don't get bored compared when we are inside the classroom." (Participant 3)

"Field-based instruction is good because there are a lot of challenges just like biking a certain slant area to show conservation of mechanical energy." (Participant 4)

"We're able to finish performing the activity in a short period of time and I really enjoy sir when we are in the field." (Participant 5)

"I enjoy sir because in our activity we are using materials that are natural and present in the environment." (Participant 6)

"I enjoy the activity sir just like the topic regarding the causes of changes in momentum just like the impulse, the title of that activity sir is "Catch Me When I Fall." (Participant 7)

"I enjoy the Field-based instruction sir because the teaching in our school is inside the classroom. Field-based instruction sir, we're able to visit the entire locality of our barangay in performing the activity." (Participant 9)

"My classmates are encouraged to go to school because they enjoyed the way it was taught, it's easy to learn because we are the one performing the activity." (Participant 10)

"I enjoy field-based instruction because my friends are there also and everyone is cooperating with the instruction of our group leader and I am also excited because we will be in the field for our next meeting." (Participant 11)

"I really enjoyed the Field base laboratory instruction because my friends are also with us in the field, were not in the classroom to discuss the topic but we are in the field, it's a new experience. (Participants 12)
"Field-based laboratory instruction is exciting because of the activities and I experience to learned outside the classroom through that kind of teaching, because I enjoyed performing the activities." (Participant 13)

"We enjoyed the teaching it's fun and exciting and it's easy to learn the topic because of the demonstration and we are involved in performing the activity." (Participant 14)

According to them, FLBI is good and enjoyable because it is a different way of teaching and they don't get bored (Participants 2 & 3) although there are a lot of challenges (Participant 4), the activities are finished in a certain time (Participant 5). The materials used are present in the environment (Participant 6), and it is easy to learn and everyone is cooperating (Participants 10 & 12) because it is exciting and

fun (Participants 13 & 14). Field work is essential and enjoyable learning method as it develops skills, building group identity, team spirit and relationship and it also provides a deeper learning experience (Smith, 2020). Thus, it is recommended that science teachers must design activities that are suited to the learners need for them to enjoy teaching-learning process.

Theme 3: Involvement in FBLI is Exciting

From the participants' experience, involvement in FBLI is exciting. These are supported by their utterances presented below:

> *"I can able to answer the guide questions easily because I am involved in performing the activity too."* (Participant 1)

> *"I'm excited to listen to the discussion and I've learned a lot because my group mates show how to perform the activity."* (Participant 2)
> *"I'm excited sir for the next discussion on which place were going to visit and use to perform the activity, just like how we investigate the uniform accelerated motion on horizontal dimension in a certain slant area at the concrete river side to perform the activity."* (Participant 6)

> *"My classmates are encouraged to go to school because the teaching is fun an it's easy to learn because we are involved, we are the one performing the activity."* (Participant 10)

> *"I enjoy the field-based instruction because my friends are there also and everyone is cooperating with the instruction of our group leader and I am also excited because we will be in the field for our next meeting*." (Participant 11)

> *"It's a new experience and we are only the class section who are in the field to learn. I'm also excited about the activities and to be in school always.* (Participant 12)

> *"We enjoyed the teaching it's fun and exciting and it's easy to learn the topic because of the demonstration and we are involved in performing the activity"* (Participant 14)

Involvement FBLI is exciting because they are the ones who perform activities (Participants 1, 6, & 10) and it is done in various places or fields (Participants 6 & 11). Outdoor instruction makes students more open to learning and excited about

natural science (Technical University of Munich, 2018) and it makes students more engaged and interested (Kuo, 2019). Thus, exposing students to FBLI will boost their interest in science and will make them inspired in attending classes.

Field-Based Laboratory Instruction is an activity oriented learning (from Theme 1), and student-centered (from Theme 3) because it is suited to learner's needs and enjoyable (from Themes 2 & 3).

Teacher's Experiences in Using Field-Based Laboratory Instruction

Presented in this portion is the self-narrative of the teacher who conducted the Field-Based Laboratory Instruction (FBLI). In his narration, most of his experiences are on the burden encountered using FBLI. In his first narration:

> *"Field-based instruction is a time-consuming way of teaching; one hour isn't enough to finish the lesson. Teacher must plan ahead of time to ensure smoothness of the delivery of the lesson. The instructional materials, daily lesson log (DLL), activity sheets and have an advance visit to the venue/place to be used in the delivery of the lesson to be familiar with and to ensure the safety of the students are those things that must be emphasis prior to the conduct of field-based instruction."*

In the afore-cited context, it is evident that the teacher is having difficulty on the lesson preparations especially as to the learning materials. Another thing to consider in using FBLI is the security of students during the conduct of activities. Field experiences require time, effort and an advance planning on both sides and it requires teacher to undergo extensive training before exposing into it but (Long, 2017). Thus, it is recommended that teacher must require more studies and initiatives that explore professional development that will enhance teacher's confidence and expertise in handle field teaching.

Another experiences shared by the teacher is on,

> *"Field based laboratory instruction increased motivation and participation among the students it helps students develop their personal, social and scientific skills such as observation, measuring, inferring, predicting and experimenting. Challenges aroused on the conduct of field-based laboratory instruction such as, unpredicted weather that interrupts the delivery of the lesson, students are not comfortable in performing the activity during rainy day and it can be the reason to change and adjust the field setting arrangement just like bringing the discussion to covered court just carried out the activity"*

In the above cited text, it shows that the teacher has found a strategy that will encourage student's attendance and improve their performance in school. On the other hand, unpredictable weather aroused on the conduct of FBLI that caused interruption on the delivery of the lesson. Students that are involve in learning experience outside the classroom shows higher level of motivation, recall the course material clearly and improve academic performance in the class (Mcdaniel, 2020) but weather condition disturb human outdoor activity and this include extremely low or high temperature, rain wind or excessive heat and it is the responsibility of the facilitator in outdoor education to be prepared for such condition (Torkos, 2019). Thus, FBLI must be executed in a comfortable manner to make sure that students will benefit on this matter and to have a continues improvement in learning scientific. Another experiences shared by the teacher is,

> *"Teacher must orient students prior to the conduct of field-based instruction to ensure everyone is cooperating. This teaching strategy is new to the students, misbehavior is being observe during the conduct of the FBLI. Orientation is also necessary to avoid the unnecessary things that may cause injury to the students"*

It was exposed in the above cited narrative that the classroom management must be strengthen on the conduct of FBLI and make sure that the safety of the students must be prioritized in conducting a field-based laboratory instruction, students must be aware of the do's and don'ts in the field to make sure the hundred

percent achievement of the objectives. It is not surprising that classroom management is an issue in outdoor activity, this is unusual and innovative for most teacher and therefor distracting to the parts of the students because this is unfamiliar to them so they are subject to misbehavior (Ayotte-Beaudet, Potvin, Lapierre, & Glackin, 2017). The safety of the students must consider in taking FBLI one of the most important steps in minimizing risk will be to undertake a site assessment of the outdoor learning area before taking students to this area to ensure the site is clear of hazards (WorkCoverQueensland,2016).

CHAPTER V

SUMMARY OF FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

This chapter provides the summary of findings and the conclusions and recommendations drawn from significant results and interview results of the study.

Summary of Findings

1. Fifteen worksheets aligned to Field-based Laboratory Instruction were developed and packaged to a workbook for the topics Forces, Motion, and Energy. It is developed in a contextualized manner following the competencies stated at the Curriculum Guide and specify in the Daily Lesson Logs as teaching guide.

2. The performance of students before exposure to FBI has a mean equivalent performance of 69.30, an indication that they did not meet expectations as to topics force, motion, and energy. However, upon utilization of FBI there is an increase in the mean performance of students, from not meeting expectations to fairly satisfactory. Results implied that there is a shift in the students' performance with the use of FBI.

3. The statistical results on validation of hypothesis provide a t-stat (9.78) higher than the critical t-value (2.03), hypothesis is rejected. It is supported by the p-value ($2.79\ e^{-11}$) which is much lower than the level of significance at 0.05 which reinforces claim that there is a significant increase in the performance after exposure to FBI as reflected in their mean equivalent performances (from 69.30 to 75.02). The statistical results implied that the difference between the average equivalent

performance after, minus before exposure to FBI (5.73) is big enough to be statistically significant.

4. According to the student-participants they learned from the conducted FBLI performances because it is hands-on (participant 1), a new kind of teaching and it is fun (participants 8 and 10).

5. Another experience the student-participants have noted is that, FLBI is good and enjoyable because it is a different way of teaching and they don't get bored (Participants 2 & 3) although there are a lot of challenges (Participant 4), the activities are finished in a certain time (Participant 5). The materials used are present in the environment (Participant 6), and it is easy to learn and everyone is cooperating (Participants 10 & 12) because it is exciting and fun (Participants 13 & 14).

6. Lastly, student-participants found involvement FBLI is exciting because they are the ones who perform activities (Participants 1, 6, & 10) and it is done in various places or fields (Participants 6 & 11).

7. It is evident that the teacher is having difficulty on the lesson preparations especially as to the learning materials. Another thing to consider in using FBLI is the security of students during the conduct of activities.

8. It shows that the teacher has found a strategy that will encourage student's attendance and improve their performance in school. On the other hand, unpredictable weather aroused on the conduct of FBLI that caused interruption on the delivery of the lesson.

Conclusions

1. The developed workbook oriented with Field-based Laboratory Instructions contained significant components such as explanation of concepts, presentation of lesson, contextualized activity, learning outcomes, and learning tasks, it is successfully piloted to the respondents of the study.

2. The use of Field-Based Laboratory Instruction improves students' performance on the topics force, motion, and energy, from not meeting expectations to fairly satisfactory.

3. Field-based Laboratory Instruction with the aid of the developed workbook is an effective tool to help improve students' performance in Force, Motion, and Energy.

4. Field-Based Laboratory Instruction provides learning thru conducting actual or concrete activities. It is suited to junior high school learners because they found it good and enjoyable. Further, getting involve in the activities align to FBLI makes students excited to learn new things in a unique way.

5. A well planned Field-based laboratory instruction delivers the lesson correctly, however, preparation of instructional materials and classroom management up to the precautionary measure are also things for considerations.

Recommendations

1. It is suggested that Science Teachers should prepare activities align to Field-Based Laboratory Instruction and design activities that are contextualized and suited to the learners need for them to enjoy teaching-learning process.

2. Expose students to Field-based Laboratory since the study had proven that it can enhance students' science interest and learning.

3. It is recommended to use the output of the study when teaching Forces, Motion, and Energy to validate if it would also improve students' performance from other classes and locales.

CHAPTER VI

FIELD-BASED WORKBOOK ON FORCES, MOTION AND ENERGY

This chapter presents the developed workbook of the study, it is discussed in this section the format and the corresponding laboratory activity.

Overview

In this portion, it describes the background of the chapter prior to specific topics in order to guide the readers with the content of the worksheet. It is also placed in this section the competencies to be attained by the students.

Introductory Statement

The introductory statements are simple introduction for the specific learning topic, it is composed of some examples, analogies, and the like so that students would be guided with the presentation and discussion in every worksheet. There are some illustrations that would deepen the understanding of the students on the various concepts they would encounter as they complete the activity.

Learning Outcomes

So for the learning outcomes, it is based on the learning competencies in the Curriculum Guide. It is subdivided with the three domains of learning as to knowledge, skills, and attitudes that would be developed by the learner at the end of each lesson.

Learning Tasks

For the learning task, this is now where the Field-Based Laboratory Instruction activities are presented with specific activity objectives, materials, procedure, analysis, presentation.

Vocabulary Enhancement

This is where the used terminologies and concepts are defined, meaning it would be the expected words that should be learned by the students.

Key Concepts

It is the generalization of the topic discussed and is presented based on the learning competencies.

Suggested Readings

It is the section where references are presented so that students could easily revisit the necessary materials that would enhance their understanding of the topic.

WORKBOOK

FORCES, MOTION AND ENERGY

9

SCIENCE

Workbook on

Forces, Motion and Energy

MARK GIL L. EMPIENGCO
Author

Subject Area and Grade Level: **Science 9**
QUARTER 4

Hello students! This Workbook is intended for your use in school and even at home. This aims to help you gain knowledge and understanding with the concept of force, Motion, and Energy. This material provides you a very informative concepts of force, Motion, and Energy taking into consideration your learning difficulties in understanding the topic. The examples given are easy to comprehend and enough exercises are provided to sustain your interest and concretize your knowledge. The questions and problems in this material will help you understand the main ideas in each concept.

We look forward that this workbook will help you for a better understanding in the concepts of force, Motion, and Energy. Good luck and have fun!

The Author

Overview

At this level, you are already equipped with some basic ideas in physics from previous learning in Grades 7 and 8. You were able to describe motion and the forces that affect it and explained why objects move the way they do. Heat and temperature are exciting topics that you also explored. As a student, you acquired basic concepts on how heat is transferred. You also gained a greater appreciation of the natural phenomena of light and sound through the concept of waves, and an understanding of the laws of optics. From these concepts that you have learned, you were able to understand your environment and the different changes happening to it.

Now, you are going to do Physics more mathematically. This will allow you to unlock more ideas about your physical environment. At the same time, this will improve the mathematical skills you gained in your environment. At the same time, this will improve the mathematical skills you gained in your previous grade level, by finding new ways of applying math. Worksheets will be presented to you for deeper understanding on forces, motion, and energy.

In Forces and Motion, you will learn how to describe uniform motion mathematically. With forces and motion, you will be able to apply Newton's Law of Motion to practical problems in free-fall, projectile motion, and understand the concepts of impulse and momentum. With these, you will find out how ideas in Physics can help you play better in your sports.

In Work, Power, and Energy, you will tackle work, power, and energy and explain how they are related to one another. You will learn how conservation of energy can be used to describe the motion of a man-made objects and the rush of water in the dam.

In Heat, Work, and Energy, you will encounter topics in heat and work and how these two relate with each other. With the basic concepts on heat and work, you will understand how energy is transformed. You will understand how heat is converted to work, and work to heat.

In Electricity and Magnetism, you will learn how electrical energy is generated and transmitted. You will further develop your understanding of the transmission of electricity from power stations to your homes. From these connects, you will be able to gain further insights on the transmission of energy that takes place in a simple generator.

TABLE OF CONTENT

QUARTER 4 FORCES, MOTION AND ENERGY

FORCES AND MOTION

Overview

In your previous Grade level, the effects of forces on motion and applied the concepts in real life situation. You did a various experiments and activities on Newton's Three laws of motion and gained insights on the relationship of mass, Forces, and acceleration. From the law of inertia, you were able to gain an understanding of the behavior of the bodies in motion. The law of acceleration was thoroughly discussed where you related forces and acceleration you also appreciated the Law of interaction through simple activities in daily life.

You also quantify non- uniform motion. In these worksheets, you will mathematically describe the horizontal and vertical dimensions of Uniformly Accelerated Motion (UAM). You will use basic trigonometric functions in solving problems dealing with two-dimensional motion as in projectile motion and adapt techniques in playing your favorite sport. You will also discuss impulse and Momentum and understand how these concepts can be applied in real life situation.

At the end of Worksheets, you will be able to:

1. Describe the horizontal and vertical motions of a projectile
2. Investigate the relationship between the angle of release and the height and range of the projectile
3. Relate impulse and momentum to collision of objects (e.g., vehicular collision);
4. Infer that the total momentum before and after collision is equal;
5. Examine effects and predicts cause of collision-related damages/injuries;

Science 9
Learning Area

Name of Learner: _____Grade Level: _____Section: _____
School: _____Date: _____

Uniform Acceleration Motion: Horizontal Dimension

Title

INTRODUCTORY STATEMENT:

You learn in your lower grade level that the pull of gravity acts on all objects. That is the reason why when you throw something up it will always go down – simply the law of gravitation. These objects always fall on a constant acceleration which has a magnitude of 9.8 m/s^2.

How would you describe a motion of a stream of water flowing in a river? maybe these explain the reason.

a. A stream of water that flows along the surface of the ulot river

The stream of water that flows along the surface of the ulot river is moving in one dimension – *the horizontal direction*. This motion referred to as motion in one direction.

If a body maintain a constant change in its velocity in a given time interval along a straight line, then then body is said to have a **uniform accelerated motion**.

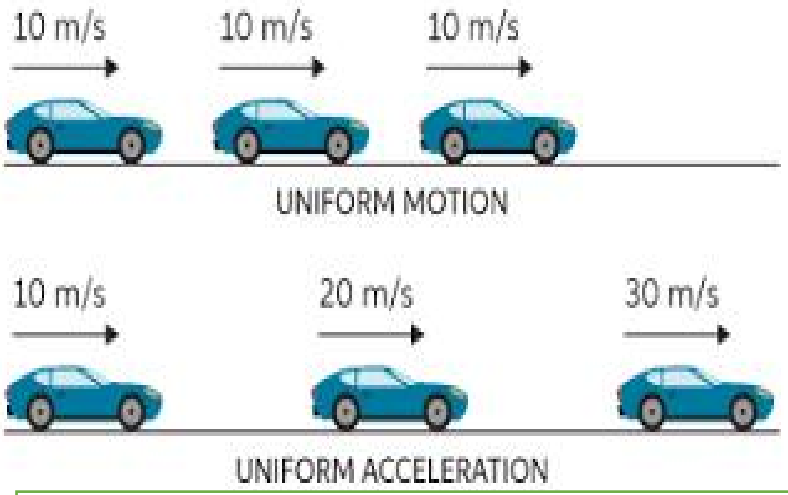


Figure 1. Uniform motion vs. Uniform Acceleration

Consider a student riding a bicycle on a runway. Positions taken at equal time intervals are indicated in the figure below.

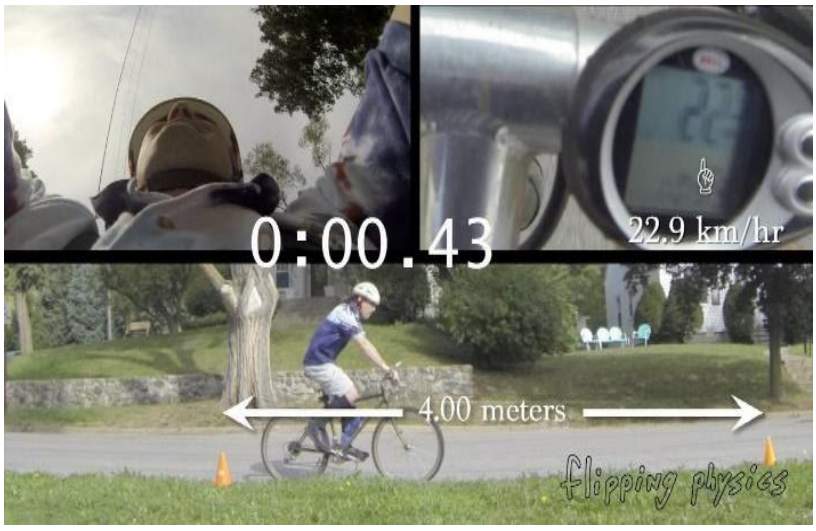


Figure 1. Student about to start biking

The change in position for each time interval is increasing as shown in figure 1, thus it is moving faster and faster. This means that the bicycle is accelerating. Try the next activity to further understand acceleration.

Try this example: **A bike race!**

You are cruising along a bike race, going a steady 10 meters per second **(10 m/s).**

Acceleration: Now you start cycling faster! You increase to 14 m/s over the next 2 seconds (Still heading in the same direction):

Your velocity **increase by 4 m/s**, over a time period of 2 seconds, so:

$$\text{Acceleration} = \frac{\text{Change in Velocity (m/s)}}{\text{Time (s)}}$$

Your speed changes by **2meters per second squared.**

LEARNING OUTCOMES

Describe the horizontal and vertical motions of a projectile; S9FE-Iva-34

Learning Objectives

Knowledge: Describe horizontal motions of a projectile
Skills: Solve problem related to Uniformly Accelerated Motion
Attitudes: Apply horizontal motions of a projectile

LEARNING TASKS:

Part I. **Direction:** To understand and describe the horizontal motions of a projectile, perform the group activity that follows. Cooperation from the members of each group is a must.

Remember:

- Student 1 holds the timing device and accurately starts and stops the timing device (stopwatch or cellphone with stopwatch application).
- Students 2 records the time in the table provided for the activity.
- Students 3, 4, and 5 releases the tin can in each marked position.

Activity 1: Roll, Roll, and Away

I. OBJECTIVES:

- Calculate the acceleration of the can rolling down an inclined plane, given a distance vs. time and distance vs. time2 graph of its motion; and
- Describe the motion of an object given a distance vs. time or a distance vs. time2 graph.

II. Materials

Slant/Incline Surface (Located at the river side of Purok 4, Lawaan I Paranas, Samar)
timing device (stopwatch)
Baseball ball or Tennis ball
improvised clinometer
meter stick
chalk or marking pen
scientific calculator
graphing paper

III. Procedure

1. Find a slanting or incline area in your place. Mark the slanting area for every 1m, 2m, 3m, 4m and 5m using a meter stick starting from the lowest end.
2. Once you have located your area determine the angle of elevation by using the improvised clinometer of the top of the 5m.
3. Roll the baseball ball from each labelled point starting with the 1m mark. Start the timer as the baseball ball is released, and stop the timer when the baseball ball has reached the bottom of the inclined area.
4. Ask your partner to record the time (t) taken by the baseball ball to travel each distance (d) down the inclined area. Perform three trials from each mark. Use the table below for your data.

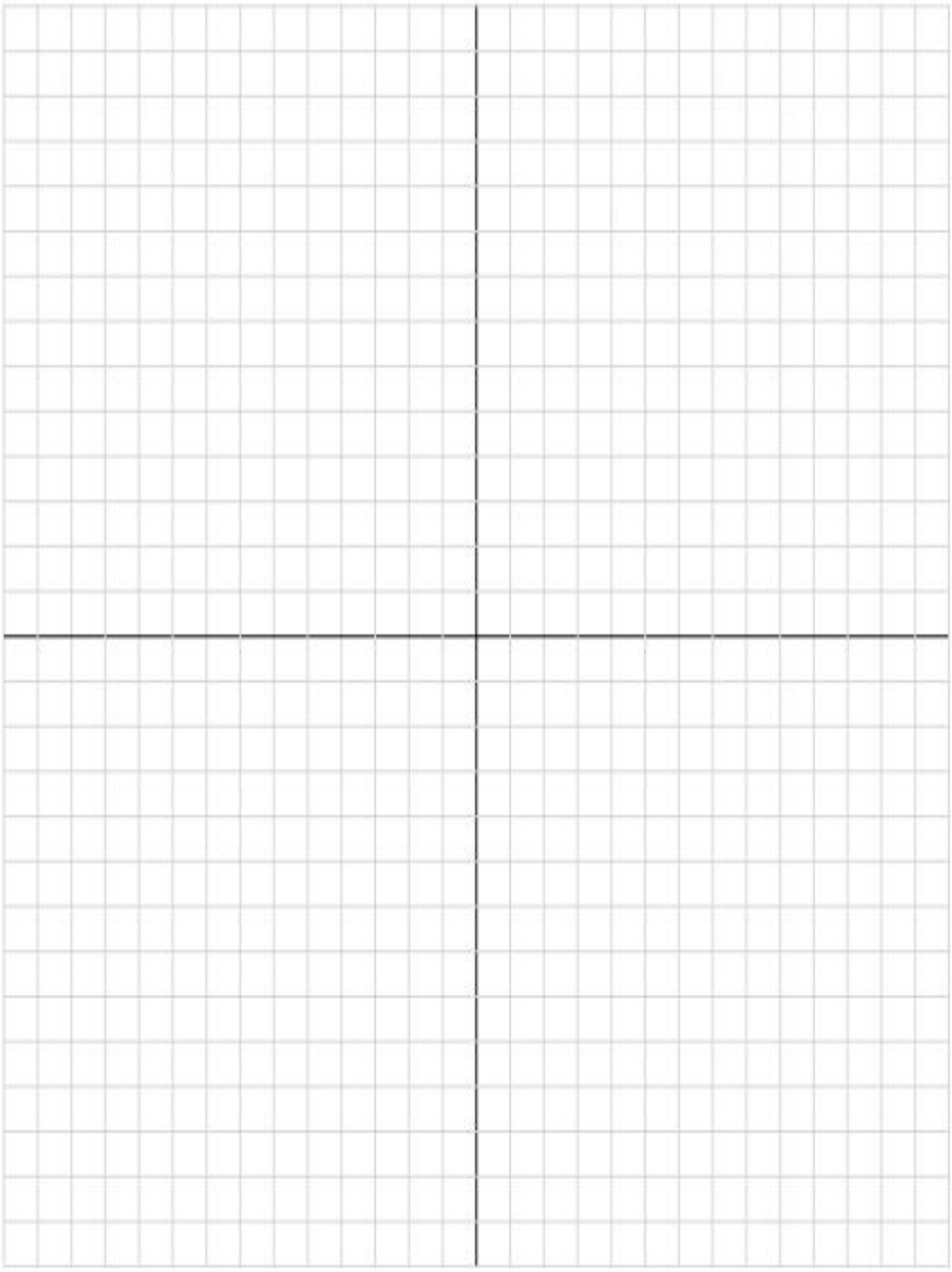
5. graph d vs. t and then d vs. t2.

TABLE 1. Data on the Motion of a Rolling Baseball ball

Distance, d(m)	**Time, t (s)**				time2, t2 (s2)
	Trial 1	Trial 2	Trial 3	Average	
1					
2					
3					
4					
5					

Angle of inclination: _____

Direction: Graph your data on d vs. t and then d vs. t2 on the graphing sheets provided.



IV. Analysis

1. How will you describe the graphs of?

A. distance vs. time?

_____
_____
_____
_____

B. distance vs. time2,

_____
_____
_____
_____

2. What is the relationship between distance and time of travel of the rolling baseball ball?

_____
_____
_____
_____

3. What is the slope of d-t2 graph? What quantity does the slope of d-t2 graph represent? (Refer to the unit of the slope)

_____
_____
_____
_____

4. What do the graphs of distance vs. time and distance vs. time2 suggest?

_____
_____
_____
_____

V. Presentation

The leader or the members of the group will report their output to the class.

SCORING RUBRICS

Criteria	5 points	3 points	1 point
Teamwork	All of the group members actively participated	Some of the group members actively participated	Some of the group members participated
Quality of work	The output was neatly done without errors and mistakes	The output was neatly done but with minimal errors and mistakes	The output was unpleasant with errors and mistakes
Time	Finished the task before the given time.	Finished the task on time.	Needs more time to finished the given task

POINTS EARNED	DESCRIPTIVE RATING
12-15	Very good
8-11	Good
4-7	Fair
1-3	Needs improvement

You have learned about displacements, velocities and acceleration when were in Grades 7 and 8. Now you will use those basic equations to derive formulae used in uniformly Accelerated Motion (UAM). Using the following equations on velocity, average velocity, and acceleration, you can derive other equations.

Equation A $$v = \frac{d}{t}$$

Equation B $$v = \frac{v_f + v_i}{2}$$

Equation c $$a = \frac{v_f + v_i}{t}$$

Where: v=velocity

v_f =final velocity

v_i =initial velocity

v_{ave} =average velocity

d =displacement

t =time

a =acceleration

To find out how displacement changes with time when an object is uniformly accelerated, rearrange equation A to arrive at d=vt. Since the velocity of the object changes when it is uniformly accelerating, we use the average velocity to determine displacement, so substituting v by vave in equation B, you will get;

d=vt

Equation d $$d = (\frac{v_f + v_i}{2})t$$

Rearrange equation C to arrive at vf=vi+*at* and substituting the vf in equation D, you

$$d = (\frac{v_f+v_i}{2})t$$

$$d = \{\frac{(v_f+at)+v_i}{2})t$$

Combining v_i, you will arrive at

$$d = \left(\frac{2v_i+at}{2}\right)t$$

Distributing t will give you

$$d = \frac{2v_i+at^2}{2}$$

Simplifying further will provide you

Equation d

$$d = v_i t + \frac{at^2}{2}$$

will get

This shows that the displacement of the body is directly proportional to the square of time. This confirms that for equal interval of time, displacement increases quadratically.

To find out how final velocity depends on the displacement, substitute v and t from equations B and C to d=vt and you will find

$$d = vt$$

$$d = \left(\frac{v_f+V_I}{2}\right)\left(\frac{v_f+V_I}{a}\right)$$

Recall from your algebra class that (a+b) (a-b) = $a^2 - b^2$

$$d = (\frac{v_f2-v_i2}{2a})$$

Simplifying, you will get

Equation f

$$2ad = v_f2 - v_i2$$

$$v_f2 = v_i2 + 2ad$$

To apply these derived equations, study the following problems.

Part II. **Direction:** Let the students answer the following word problems related to horizontal motion of a projectile.

1. An airplane from rest accelerates on a runway at 5.50 ms2 for 20.25 s until it finally takes off the ground. What is the distance covered before take-off?

_____
_____
_____
_____
_____
_____
_____

2. A train accelerate to a speed of 20 m/s over a distance of 150 m. Determine the acceleration (assume uniform) of the train.

_____
_____
_____
_____
_____
_____
_____

VOCABULARY

Motion- is the change of position of an object with respect to time (e.g., A book falling off a table, water flowing from the tap, rattling windows, etc. all exhibit motion)

Acceleration- is defined to be the rate of change of the velocity.

Uniform Acceleration- Refers to an acceleration of an object, which remains constant irrespective of time.in simpler terms, a number equal to the acceleration in such a motion does not change as a function of time.

Uniform motion- is defined as the motion of an object in which the object travels in a straight line and its velocity remains constant along that line as it

covers equal distances in equal intervals of time, irrespective of the duration of the time.

Key Concept

- Uniformly Accelerated Motion (UAM) is motion of an object where the acceleration is constant. In other words, the acceleration remains uniform; the acceleration is equal to a number and that number does not change as a function of time. UAM can be describe either horizontal or vertical motion to analyze how projectiles.
- Uniform horizontal motion, is define as straight-line horizontal motion which covers equal distances in equal times.
- The following formula is needed to understand the concept of Uniform Accelerated Motion (UAM)

Equation A $v = \frac{d}{t}$

Equation B $v = \frac{v_f + v_i}{2}$

Equation C $a = \frac{v_f + v_i}{t}$

Equation D $d = (\frac{v_f + v_i}{2})t$

Equation E $d = v_i t + \frac{at^2}{2}$

Equation F $v_f 2 = v_i 2 + 2ad$

TEST YOUR SELF!

Test I: Word Problem
Direction: Answer the word problem (5 points each)

1. A jeepney from rest accelerates uniformly over a time of 3.25 seconds and covers a distance of 15m. Determine the acceleration of the jeepney?

_____
_____
_____
_____
_____
_____

2. A motorcycle accelerates to a speed of 20 m/s over a distance of 150 m. Determine the acceleration (assume uniform) of the motorcycle.

_____
_____
_____
_____
_____
_____
_____
_____
_____

SUGGESTED READINGS

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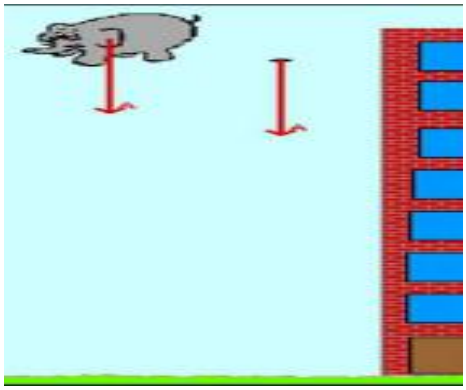
SCIENCE 9
Learning Area
Name of Learner: _____Grade Level:_____Section: _____
School: _____Date: _____

Uniform Accelerated Motion: Vertical Dimension

Title

INTRODUCTORY STATEMENT:



Galileo conducted an experiment from the top of the tower of Pisa. He dropped two cannon balls of different weights from the top of Leaning Tower of Piza. The two cannon balls reached the ground at the same time. He proved that when objects of different weight are drop at the same height and time, they take the same amount of time to fall to the ground (ignoring air

You learned in your grade 8 that the pull of gravity acts on all objects. So, on Earth, when you throw something up, it will go down. Things thrown upward always fall at a constant acceleration which has a magnitude of 9.8 m/s2. This means that the velocity of an object in free fall changes by 9.8 m/s every second fall.

Consider a stone dropped from a cliff as shown in figure 2. For equal time interval, the distance travelled increases quadratically.

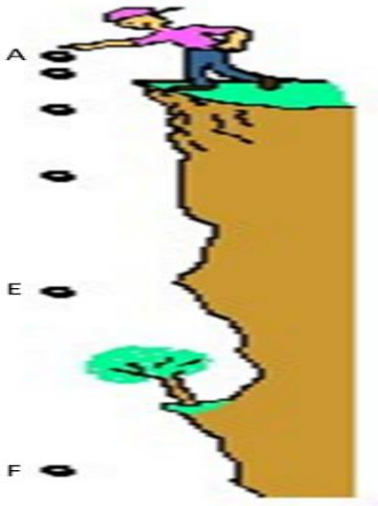


Figure 2. Motion of the stone dropped from a hill

Analyze another example of a free-fall is a body thrown upward. Considered figure 3 on the right where a ball is thrown upward. As the ball goes up, it decelerates with a magnitude of 9.8m/s2 until it stops momentarily and changes direction. That means, it reaches its maximum height before it starts to fall. Using equation F, you will also find that when the ball falls back to the point where it was thrown, its speed will be equal to the speed at which it was thrown. Note that the, magnitude of the two velocities are equal, but hey have opposite directions-velocity is upward when it was thrown, but downward when it returns

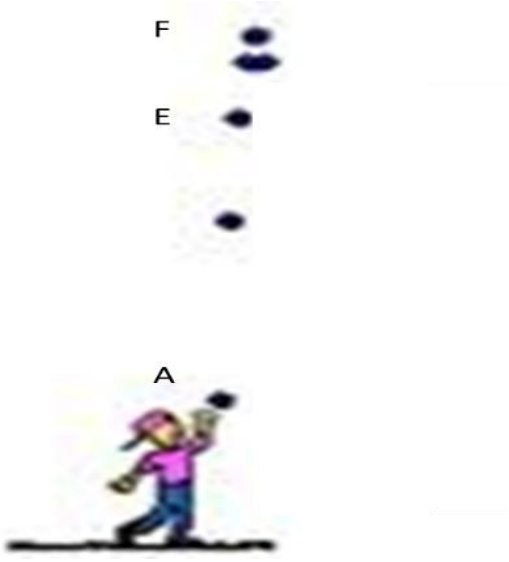


Figure 3. Motion of the stone thrown vertically upward

LEARNING OUTCOMES

Describe the horizontal and vertical motions of a projectile; S9FE-Iva-34

Learning Objectives:

Knowledge: Describe vertical motions of a projectile
Skills: Solve vertical motions of a projectile.
Attitudes: Apply vertical motions of a projectile in daily life situation

LEARNING TASKS:

Part I. **Direction:** To understand and describe the vertical motions of a projectile, perform the group activity that follows. Cooperation from the members of each group is a must.

Activity 2: Drop Me!

I. OBJECTIVES:

- Record the time for the ball to reach the ground.
- Calculate the height of a building.

II. Materials

stopwatch/cellphone
Ball (e.g., baseball ball, ect.)
long string

III. Procedure:

1. Look for a tall building in you place. Drop a tennis ball from the tall building.
2. Using a stopwatch, ask your classmate to record the time it takes the ball to reach the ground. Record your data.
3. Calculate the height covered by the ball using the formula
   $h = \frac{1}{2} a_g t^2$ since $v_i = 0$

TABLE 2. Data on the Time and Height of the Building

Trial	Time, t (s)	Height, h (m)
1		
2		
3		
Average		

4. Using the data from the table, calculate the final velocity of the ball using the formula vf=at

since vi=0. Try calculating the final velocity using the formula $v_f = \sqrt{2a_g h}$ and compare your answers.

IV. Analysis

5. What is the velocity of the ball just before it hits the ground?

_____
_____
_____
_____

5. Using a very long string, get the actual height of the building.

6. How will you compare the actual height of the building from the result of the experiment?

_____
_____
_____
_____

7. What is the percentage of error?

(Note: Use the formula in finding the percentage of error.)

Percentage Error=Actual Value-Experimental ValueActual Value x 100%

_____
_____
_____
_____
_____

IV. Presentation

A representative from the group will report the out to the class.

SCORING RUBRICS

Criteria	5 points	3 points	1 point
Teamwork	All of the group members actively participated	Some of the group members actively participated	Some of the group members participated
Quality of work	The output was neatly done without errors and mistakes	The output was neatly done but with minimal errors and mistakes	The output was unpleasant with errors and mistakes
Time	Finished the task before the given time.	Finished the task on time.	Needs more time to finished the given task

POINTS EARNED	DESCRIPTIVE RATING
12-15	Very good
8-11	Good
4-7	Fair
1-3	Needs improvement

Using the formula:

$v_f = v_i + a_g t$	$v_f^2 = v_i^2 + 2ah$
Where: v_i = initial velocity v_f = final velocity a = acceleration t = time	Where: v_i = initial velocity v_f = final velocity a = acceleration h = height

Part II. **Direction:** Answer the word problem related to vertical motions of a projectile. Write your answer on the space provided

1. Zed is playing with a ball on top of a building but the ball fell and hits the ground after 2.6 seconds, what is the final velocity of the ball just before it hits the ground and how high is the building?

_____
_____
_____
_____
_____

VOCABULARY

Free Fall - Is any motion of a body where its weight is the only force acting upon it. When a falling object is free from all forces. No friction or air resistance

Velocity- Quantity that designates how fast and in what direction a point is moving

Magnitude- Defines the size of an entity, or its speed when moving, in comparison to motion.

Law of acceleration- According to Newton s Second Law of Motion, also known as the Law of Force and Acceleration, a force upon an object causes it to accelerate according to the formula *net force = mass x acceleration*. So, the acceleration of the object is directly proportional to the force and inversely proportional to the mass.

Key Concept

Uniformly Accelerated Motion (UAM) is motion of an object where the acceleration is constant. In other words, the acceleration remains uniform; the acceleration is equal to a number and that number does not change as a function of time. UAM can be describe either horizontal or vertical motion to analyze how projectiles.

- Naturally accelerated vertical motion, is the motion of a vertically falling body. The following formula is needed to understand the concept of Uniform Accelerated Motion (UAM)

Equation A

Equation B

Equation C

Equation D

Equation E

Equation F

TEST YOUR SELF!

Direction: Encircle the letter that corresponds to the correct answer.

1. If a free-falling ball is equipped with a speedometer, by how much would its speed-reading increase for every second?
   a. 0 m/s
   b. 9.8 m/s
   c. 10 m/s
   d.20 m/s
2. Which statement best describes what happens to the VERTICAL velocity of a projectile?
   a. it accelerates downwards
   b. it accelerates upwards
   c. it remains constant
3. A baseball ball is hit vertically upward by a player. What is its acceleration after 1 second?
   a. o
   b. 1 m/s* 2
   c. 9.8 m/s *2
   d. -9,8 m/s *2

4. A volleyball ball is tossed vertically upward, with an initial velocity of 5 m/s and caught back at the same level as when it was thrown. What is the velocity of the ball at that point?

a. 0m/s
b. -5m/s
c. -9.8 m/s
d.-9.8 m/s *2

5. a basketball ball is thrown vertically upward. What is its instantaneous speed at its maximum height?

a. 0
b.5 m/s
c.9.8 m/s
d. 9.8 m/s*2

SUGGESTED READINGS

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SCIENCE 9
Learning Area

Name of Learner: _____Grade Level: _____ Section: _____
School: _____Date: _____

Motion in Two Dimension

Title

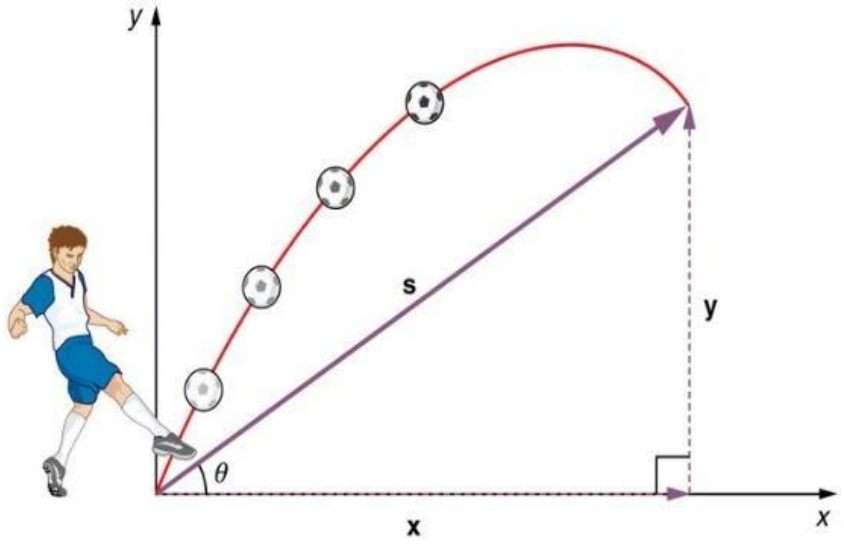
INTRODUCTORY STATEMENT:

Last time you were asked what is the difference of a flowing water on a stream and the flow of water from a hose of a person who is watering a plant. And maybe these explain the reason.

a. A stream of water that flows along the surface of the ulot river
b. flow of water from a hose of a person who is watering a plant

1. The stream of water that flows along the surface of the ulot river is moving in one dimension – *the horizontal direction*. This motion referred to as motion in one direction.
2. The flow of water from a hose of a person who is watering a plant is moving in two perpendicular directions – *the horizontal and the vertical direction.* This motion is considered as motion in two dimensions.

Have you noticed the curved path they make in the mid-air? This curve is what naturally happens when an object, called a **projectile**, moves in **two dimensions**- having both horizontal and vertical motion components, acted by gravity only. In physics, this is called **projectile motion.**



Projectile Motion: Throwing a rock of kicking a ball generally produces a projectile pattern of motion that has both a vertical and a

Projectile motion is the motion of an object thrown, or projected, into the air, subject only to the force of gravity. The object is called a projectile, and its path is called its trajectory. The motion of falling objects is a simple one-dimensional type of projectile motion in which there is no horizontal movement. In two-dimensional projectile motion, such as that of a football or other thrown object, there is both a vertical and a horizontal component to the motion.

LEARNING OUTCOMES

Describe the horizontal and vertical motions of a projectile; S9FE-Iva-34

Investigate the relationship between the projectile of release and the height of range of the projectile S9FE-Iva-35

***Learning Objectives*:**

Knowledge: Investigate the relationships between the projection angle, the height, the range, and the time of travel of a projectile.
Skills: Demonstrate the relationships between the projection angle, the height, the range, and the time of travel of a projectile
Attitudes: Recognize the importance of projectile motion in sports.

LEARNING TASKS:

Part I. **Direction:** To understand and describe the horizontal and vertical motions of a projectile, perform the group activity that follows. Cooperation from the members of each group is a must.

Activity 3: Curve Me on an Incline

I. OBJECTIVES:

- Capture a full trajectory of projectile motion on an inclined surface.
- Investigate the relationships between the projection angle, the height, the range, and the time of travel of a projectile.

II. Materials

Projectiles : marbles or jackstone, soda/water plastic bottle cap, powder (e.g., face powder or flour on low container to coat marbles)

Projectile launcher :retractable pen preferably HBW Matrix pen, sticky tape, pair of scissors, and 2popsicle sticks

Inclined surface : 1/8 illustration board (10"x15") alone or on cookie baking sheet or cookie baking sheet (13"x17") alone, held or propped on books (1" thick) for 200-400 inclined depending on the retractable pen's launching ability.

table top
protractor
pencil
tissue paper
ruler or tape measure

III. Procedure:
Day One Activity

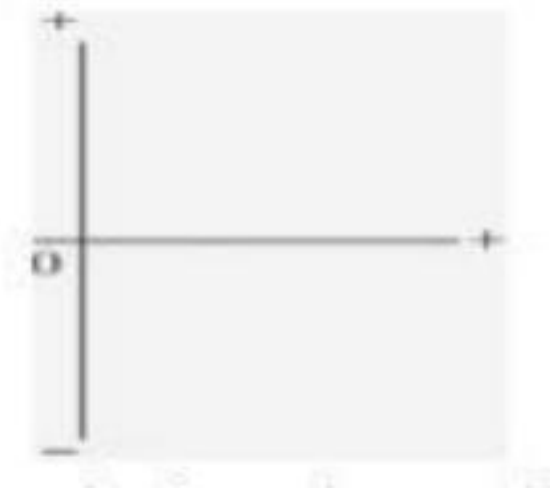
Review of Pre-requisite concepts

I. Linear horizontal motion

Use the pen to move the marble horizontally along the table top. (See that the depressed end of the pen will hit the object about the center.) Observe the motion. Sketch and label the velocity=time and the acceleration=time graphs on the axes below.

Graph 1. Velocity – time graph for objects rolling horizontally

II

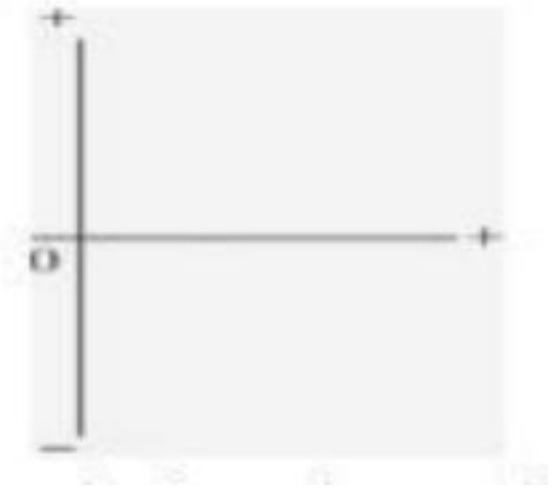


Graph 2. Acceleration – time graph for objects rolling down an incline

Linear motion down an incline

Hold an illustration board and release a marble. Sketch and label the velocity - time and the acceleration-time graphs on the axes below.

Graph 3. Velocity – time graph for objects rolling straight down an incline



Graph 4. Acceleration – time graph for objects rolling straight down an incline

Activity Proper

III. Two-dimensional motion along an incline

Tracing the trajectory

1. Tape the popsicle sticks together. Using tape, attach these firmly to one side of the retractable pen to serve as the launching pad. Push the top end and position the object to launch (marble or bottle cap). Refer to figure 4 below.

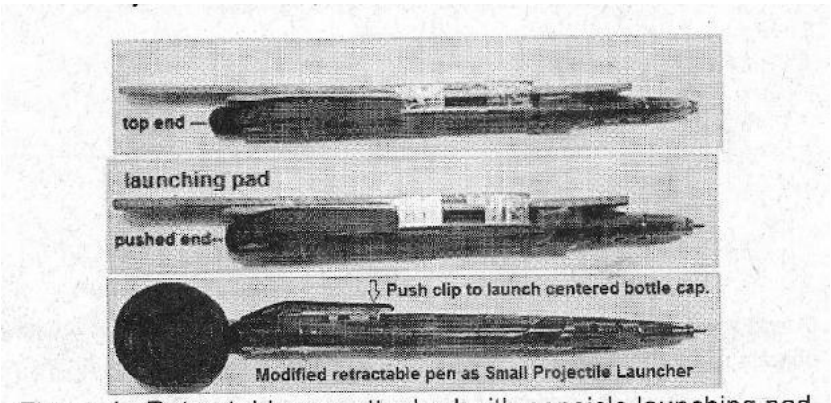


Figure 4. Retractable pen attached with popsicle launching pad

2. Using a protractor and pencil, mark the bottom left of the illustration board left

of the illustration board or cookie baking sheet with selected angles at 15- or 20-degree intervals. Tape the illustration board at the top right of the cookie sheet.

On the board select and draw fixed origins at points A and B. The left and bottom ends of the board or cookie baking sheet may serve as the y-axis and x-axis respectively.

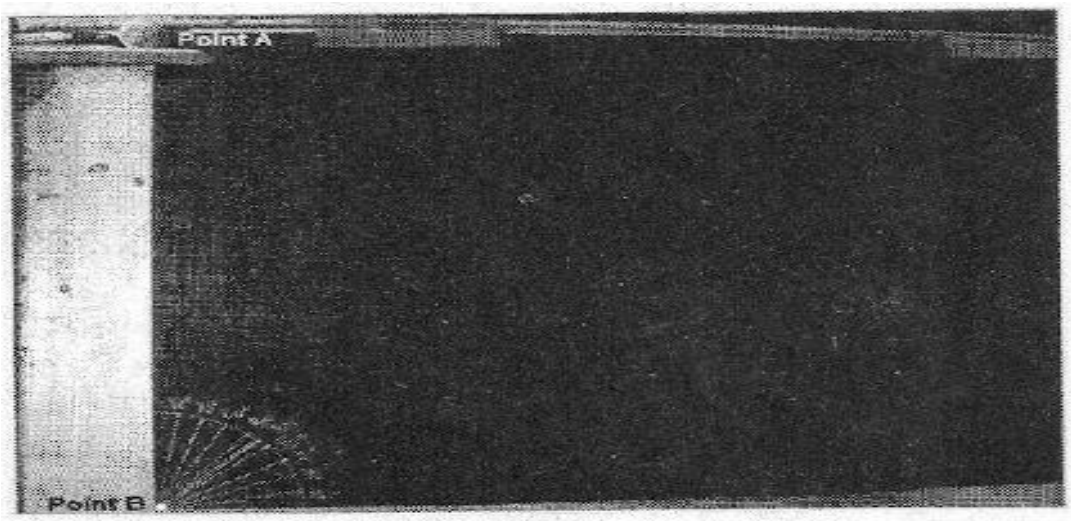


Fig. 5a. The modified retractable pen mounted with a powder-coated marble at point A ready for horizontal projection along the labelled incline illustration boards.

To complete the set-up, elevate one end of the board or cookie sheet using books with an angle of inclination of about 200-400. Use another book to hold the inclined surface in place as shown in fig. 5b.

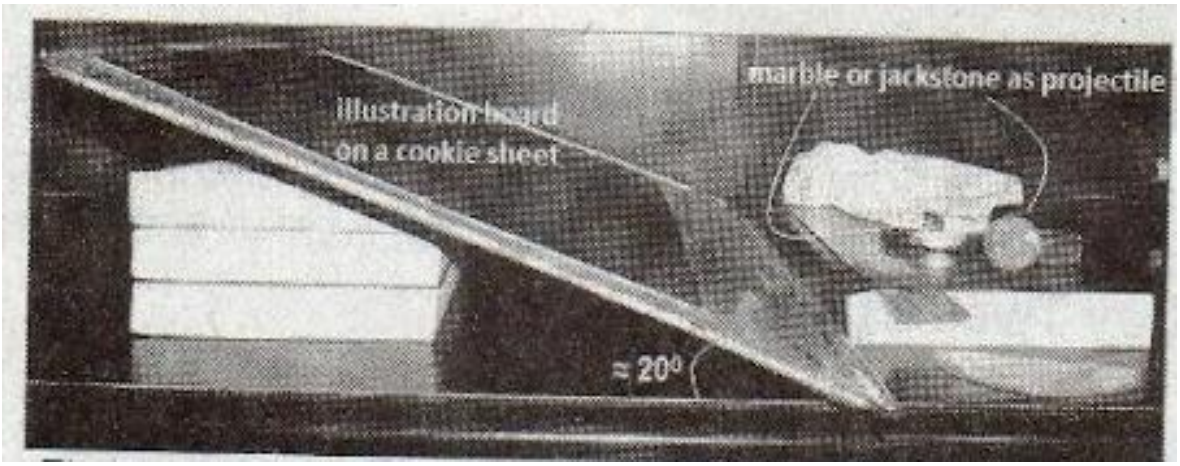


Fig. 5b. The incline illustration board-cookie baking sheet propped between books for the marble projectile.

3. Push the top end of the modified retractable pen and firmly hold it horizontally

at point A. Then carefully place the powder-coated marble on its launching pad. Launched the marble by pushing the clip of the modified retractable pen.

4. Trace the powder-marked trajectory with a pencil. Dust off the powder. Label; this as 'horizontally-launched for later analysis.

5. At point B, repeat steps 3 and 4 but this time, carefully launching the marble at

selected angles (e.g., 150,300,450,600 and 750) and marking the pencil traced trajectories as launched at _____angle.

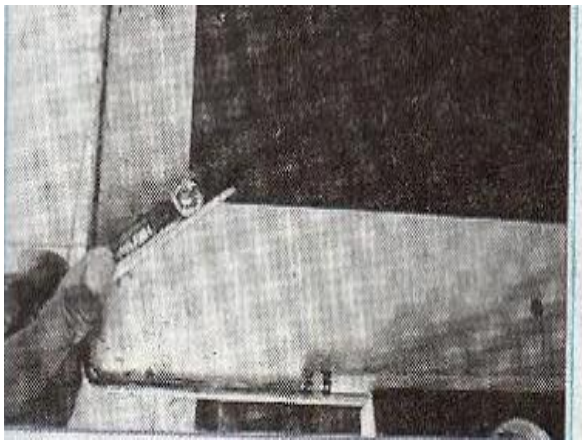


Fig. 5c. Marble projectile at point B ready for launching at an angle up the inclined board.

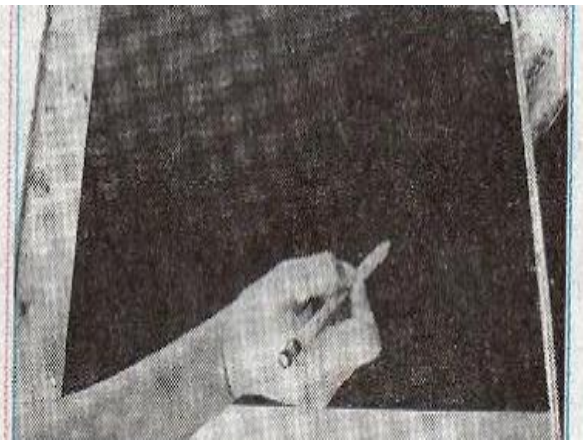


Fig. 5d. Tracing with pencil the powder-marked trajectory of the marble launched at an angle.

Note: The actual projections may not exactly the initial angles that your group selected. At least try to have projection angles close to the angle intervals selected.

Guide Questions:

10. Describe the trajectory for horizontally-fired projectiles along an incline. Sketch the trajectory.

11. Describe the shape of the trajectory for projectiles fired at angles along an incline. Sketch the trajectory.

12. Compare the locations of the trajectory peaks in terms of maximum height, hmax reached.

13. Compare the horizontal distance, x (range) reached when they return to the elevation from which they were projected.

14. Among the trajectories of projectile fired at angles, for the same launching velocity, which covered the greatest range (horizontal distance in the x-axis)

15. Among the trajectories
of projectiles fired at angles, for the same launching speed, which recorded the highest peak?

16. Which pairs of trajectories have ranges that are almost equal?

_____
_____
_____
_____

What will happen to the horizontal distances of the trajectory if the board is inclined 900 and is now totally vertical? On the next activity…

Day Two Activity

IV. Two-dimensional motion on air

Launching Bottle Caps Horizontally

6. Use the modified retractable pen to launch a bottle cap horizontally five to ten times from heights, h of 0.5m, 1.0m, 1.5m, and 2.0 m

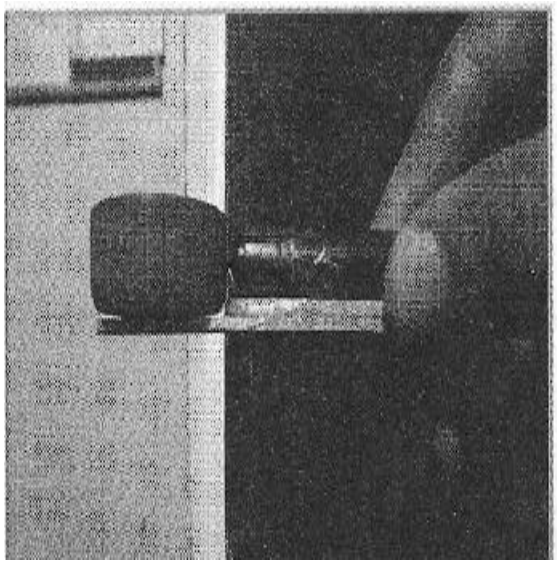


Fig. 5e. Preparing to horizontally launch through air a plastic bottle cap from a height.

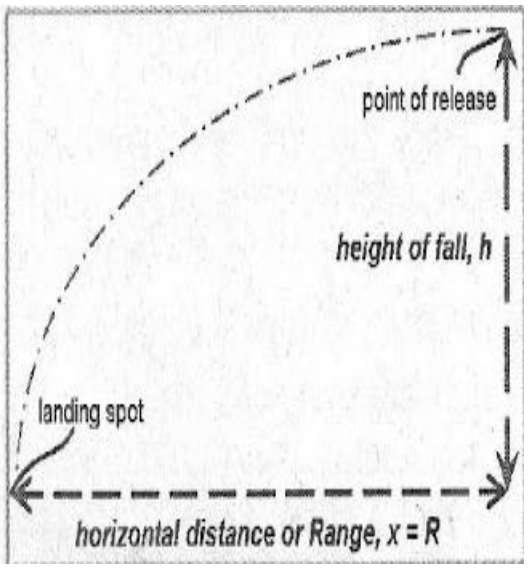


Fig. 5f. Displacement of horizontally launched plastic bottle cap from a height.

Note: Measure and record the projectiles horizontal distance from this spot to the point on the floor that is exactly below the release location of the bottle cap. Record

this as the range.

17. Repeat steps 6 and complete Tables. 6a and 6b below

Safety checked: Ensure that the trajectories are free from obstructions and the person assigned to launch the plastic cap is tall enough for the 2.0m release height. If standing on a table or a chair, assign another member to hold the table/chair in place.

Table 6a. Range of horizontally-launched bottle cap from different heights.

Height of fall, h(m)	**Range, R (m)**					**Average Range, R (m)**
	Trial 1	**Trial 2**	**Trial 3**	**Trial 4**	**Trial 5**	
0.00						
-0.50						
-1.00						
-1.50						
-2.00						

Guide Question:

1. At which height of fall is the average range the longest? Shortest?

_____

_____

_____

Table 6b. Calculated time of fall of horizontally-launched plastic bottle cap

Calculated Time of Fall, $t_{calc^2}(s^2)$ $t_{calc} = \sqrt{\frac{2h}{g}}$	Square of Calculated Time of Fall, $t_{calc^2}(s^2)$	Average Range, R (m)	Height of Fall, h(m)
			0.00
			-0.50
			-1.00
			-1.50
			-2.00

2. At what height of fall is the calculated time of fall the longest? Shortest?

_____
_____
_____
_____

Part II. Direction: Write at least 5 sports involving projectile motion

1. _____
2. _____
3. _____
4. _____
5. _____

VOCABULARY

Projectile motion- is the motion of an object thrown or projected into the air, subject to only the acceleration of gravity. The object is called a projectile, and its path is called its trajectory

Projection angle- The angle at which the object is launched dictates the range, height, and time of flight the object will experience while in projectile motion. shows different paths for the same object being launched at the same initial velocity and different launch angles

Linear motion- Is the motion that is natural to an object: moving in a straight line. According to Newton s First Law of Motion, an object not affected by any force will

continue indefinitely in a straight line. If a projectile is thrown vertically, it will travel in linear motion and will begin to fall when the force of gravity equals the force of the throw.

Trajectory- The path of a body as it travels through space

Key Concept

All projectiles, regardless of their path, will always follow these principles;

- Projectiles always maintain a constant horizontal velocity (neglecting air resistance)
- Projectiles always experience a constant acceleration along the axis the constant net force is directed. There is a constant vertical acceleration of 9.8 m/s *2, downward (neglecting air resistance) for projectiles on air. For projectiles on inclined surface, the constant "vertical" acceleration will be smaller than 9.8 m/s *2 down the tilt which is equal to .
- The horizontal and vertical motions are completely independent of each other. Therefore, the velocity of a projectile can be separated into the horizontal and vertical components.

For a projectile (neglecting air resistance) that begins and ends at the same height, the time it takes to rise to its highest point equals the time it takes to fall from the highest point back to its original height of release.

TEST YOUR SELF!

Direction: Encircle the letter that corresponds to the correct answer

1. A volleyball is tossed vertically upward, with an initial velocity of 5 m/s and caught back at the same level as when it was thrown. What is the velocity of the ball at that point?

a. 0 c. 9.8 m/s^2

b. -5 m/s d. -9.8 m/s^2

2. A sepak takraw ball is hit vertically upward by a player. What is its acceleration after 1 second?

a. 0 c. 9.8 m/s^2

a. 1 m/s^2 d. -9.8 m/s^2

3. A ball is hit at an angle of 30 degrees. At what point in its trajectory does this projectile have the least speed?

a. Just after it was launched
b. At the highest point in its flight
c. Just before it hits the ground
d. halfway between the ground and the highest point

4. A ball is hit at an angle of 30 degrees. At what point in its trajectory does this projectile have the least speed?

a. Just after it was launched
b. At the highest point in its flight
c. Just before it hits the ground
d. halfway between the ground and the highest point

5. At what angle should a water hose be aimed in order for the water to land with the greatest horizontal range?

a. 0 degree
b. 30 degrees
c. 45 degrees
d. 60 degrees

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SCIENCE 9
Learning Area
Name of Learner: _____Grade Level: _____Section: _____
School: _____Date: _____

Momentum

Title

INTRODUCTORY STATEMENT:

What makes things move? Why do some objects move continuously while some moving objects stop suddenly? These might be some of the questions you had in mind but were not really answered in last year of your science class.

Unbalanced forces cause stationary object to move. According to Newton's Second Law of Motion, the greater the force applied, the larger the acceleration of an object. it also stated that with the same force, heavier objects have smaller acceleration, thus, Net force=mass x acceleration or Fnet=ma.

What affects motion? Consider a cargo truck with a mass of 10,000 kilograms traveling at a velocity of 40 kilometers per hour and a small car with a mass of 2000 kilogram traveling at the same velocity as shown below. If the two vehicles suddenly lose their breaks and crash against the brick wall, which do you think would be more damaging? On what factor would the impact of collision depend if their velocities are the same?

Figure 12. A truck and a car hitting a wall

If you suggested that it would be the mass of the truck, then you are correct. Although the two vehicles have the same velocities but different masses, the impact of the truck's collision with the truck's collision with the brick wall is far damaging compared with the impact of the car's collision with the brick wall.

In the same manner with the two toy cars, which do you think of the two will be more difficult to stop? Is it the lighter one or the heavier one? The heavier one is more difficult to stop because it possesses a greater inertia in motion which depends on an object's mass and velocity. An object's momentum is also known as inertia in motion. For objects moving at the same velocity, a more massive or heavier object has a greater inertia in motion therefore a greater momentum. Momentum depends on two factors – **mass** and **velocity**. Two cars of the same mass but different velocities will also have different momenta (momentum).

Operationally, momentum is defined as the product of mass and velocity of an object. In equation, p = mv.

Where;
p= is the momentum
m= is the mass
v= is the velocity

Example: What is the momentum of a car that weighs 115 kg and travels at 1.3 m/s?

Equation: p=mv
Given: m= 115 kg
v= 1.3 m/s

Find: p (momentum)

Solution: p=mv

= (115 kg) (1.3 m/s)

p= 149.5 kg-m/s

The momentum of the car is 149.5 kg-m/s

LEARNING OUTCOMES

Relate impulse and momentum to collision of objects (e.g., vehicular collision: (S9FE-IVb36)
Infer that the total momentum before and after collision is equal; (S9FE-IVb37)

Learning Objectives:

Knowledge: Define momentum operationally
Skills: Solve problems involving momentum
Attitudes: Show diligence and accuracy in solving problems

LEARNING TASKS:

Part I. **Direction:** To define momentum operationally, perform the group activity that follows. Cooperation from the members of each group is a must.

Activity 4: Investigating Momentum

I. OBJECTIVES:

- Identify the factors that affect momentum.

II. Materials

- Slant/Incline Surface (Located at the river side of Purok 4, Lawaan I Paranas, Samar),
- Block of wood or Empty box of carton,
- masking tape,
- improvised clinometer,
- meter stick,
- basketball ball (heavy ball), volleyball ball (light Ball)

III. Procedure:

1. Look for an incline surface in your place. Measure it angle by using an improvised clinometer.
2. Using masking tape and marker, label distances of every 1m starting from the lower portion of the inclined surface up to 4m.
3. Place the Block of wood/Empty box of carton about 50 cm from the foot of the incline surface. Label this as the Block of wood or empty box of carton initial position.
4. Measure how far the Block of wood or empty box of carton moved. Record this as the stopping distance.

TABLE 8. Stopping Distance of the Balls

Initial Distance (cm)	Stopping Distance (cm) of Light Ball	Stopping Distance (cm) of Heavy ball
20		
40		
60		
80		

5. Repeat steps 3 and 4 while varying only the initial position/distance for 40 cm. 60 cm, and 80 cm.

6. Do steps 3 to 5, this time using the heavy ball. Record your data in the table similar to table 8.

IV. Analysis

32. How will you compare their stopping distance?

_____
_____
_____
_____
_____
_____

33. Did the two balls immediately stop as they hit the block of wood or the small box of cartoon? Describe the stopping distances of the two balls as their point of release increases.

_____
_____
_____
_____
_____

34. What do you think happens to the velocity of the two balls as the point of release increase?

_____
_____
_____
_____
_____

35. If momentum is a measure of how difficult it is to stop a moving object, which of the two balls had greater momentum for the same point of release?

_____
_____
_____
_____
_____

36. How will it be possible for the two bodies of different masses to have equal momentum?

_____
_____
_____
_____
_____

What affects Momentum?

Consider the two identical cars on the left. Car 1 is traveling at 80km/h while car 2 is traveling at 30 km/h. which of the two cars would be more difficult to stop? Which of the two cars has more momentum? Car 1, being faster, is more difficult to stop. It has more momentum.

Figure 14. Two identical cars of different velocities

Which of the two cars was more difficult to stop- the lighter one or the heavier one?

Figure 14. Two unidentical cars with different mass

The heavier one is more difficult to stop. This is because it possesses a greater inertia in motion which depends on an objects mass and velocity. Do you still remember Newtons First Law of Motion? It is also known as the law of Inertia. An object's momentum is also known as inertia in motion. For objects moving at the same velocity, a more massive object has a greater inertia in motion therefore a greater momentum. Momentum depends on two factors-mass and velocity. Two cars of the same mass but different velocities will also have different momenta.

Part II. **Direction-** Given the following data, solve for the missing information using the formula p=mv.

Object	**Mass (kg)**	**Velocity (m/s)**	**Momentum (kg.m/s)**
Bird	0.03	18	
Basketball player	100		500
Bullet		600	2.400
Baseball	0.14	30	
Frog		12	10.80

Remember this:

Equation to use	If you are looking for…	If you know
P=mv	Momentum	Mass and speed
$m\frac{p}{v}$	Mass	Momentum and velocity
$v\frac{p}{m}$	velocity	Momentum and mass

VOCABULARY

Momentum- Is a measurement of mass in motion: how much mass is in how much motion. It is usually given the symbol *p* by definition $p= m.v$

Impulse- Is a term that quantifies the overall effect of a force acting over time. It is conventionally given the symbol (j) and express in newtons seconds.

Velocity- Quantity that designates how fast and in what direction a point is moving

Distance- Is a scalar quantity that refers to "how much ground an object has covered" during its motion.

Mass- Quantitative measure of inertia, a fundamental property of all matter. It is, in effect, the resistance that a body of matter offers to a change in its speed or position upon the application of a force. The greater the mass of a body, the smaller the change produced by an applied force.

Key Concept

- Momentum is defined as inertia in motion. **Momentum** can be defined as "mass in motion." All objects have mass; so if an object is moving, then it has **momentum** - it has its mass in motion.
- An object's momentum is also known as inertia in motion. For objects moving at the same velocity, a more massive objects have greater inertia in motion therefore a greater momentum. Momentum depends on two factors- mass and velocity.
- Operationally, momentum is defined as the product of mass and the velocity of an object. In equation, p=mv

Where p= is the momentum

m= is the mass

V=is the velocity

TEST YOUR SELF!

Test I. Explanation & Fill in the blank
Direction: From the concepts that you have learned, answer the checkup questions.

1. Which has more momentum, a huge truck that is not moving or a small toy cart that is moving?

_____
_____
_____
_____
_____

2. A moving car has momentum. If it moves twice as fast, its momentum would be _____ as much two cars, one twice as heavy as the other, moves down a hill at the same time. The heavier car would have a _____ _____ momentum.

Test II. WORD PROBLEM

Direction: Calculate the momentum of the given objects.

1. A basketball ball having 2kg mass and 6m/s velocity moves to the east

_____
_____
_____
_____
_____
_____

2. A car having 15m/s velocity and 1500kg mass moves to the north

_____
_____
_____
_____
_____
_____

Test III. Multiple Choice

Direction: Encircle the letter that corresponds to the correct answer

1. A moderate force will break an egg. However, an egg dropped on the road usually breaks, while one dropped on the grass usually doesn't break. This is because for the egg dropped on the grass.
   a. The change in momentum is greater
   b. The change in momentum is less
   c. The time interval for stopping is greater
   d. the time interval for stopping is greater
2. a 500kg car is traveling at 5 m/s. what is its momentum?
   a. 2500 kg.m/s
   b. 2000 kg.m/s
   c. 100 kg.m/s
   D. 10 kg.m/s

3. Which of the following object has the greatest momentum?
   a. 2 kg ball rolling at 2m/s
   b. 3 kg ball rolling at 1 m/s
   c. 3 kg ball placed on the cabinet
   d. 1 kg ball rolling at 5 m/s

4. which has more momentum, a heavy truck moving at 30 km/h or a light truck moving at 30 km/h
   a. heavy truck
   b. light truck
   c. Both have the same momentum
   d. cannot be determined

5. Calculate the momentum of a child having mass 25kg and velocity 2m/s moves to the west
   a. 20 m/s
   b. 27 m/s
   c. 23 m/s
   d. 50 m/s

SUGGESTED READINGS

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SCIENCE 9
Learning Area

Name of Learner:_____Grade Level:_____ Section: _____
School: _____Date: _____

Impulse
Title

INTRODUCTORY STATEMENT:

What causes changes in momentum?

Changes in momentum happen every time. A fast-moving car that suddenly stops might have damaging effects not only the vehicle itself but also the person riding it. Various devices have been installed in vehicles in order to ensure the safety of the passengers. The use of seatbelts is even required by law in order to lessen injuries from the car crashes. Inflatable airbags are also installed in most cars aimed to increase the time of impact between the driver or passenger and the crashing vehicle in the event of an accident. Can you think of some other safety devices installed in vehicles?

Figure 15. Seatbelt and airbags

What factors may contribute to the changes in momentum? Find out in the next activity.

LEARNING OUTCOMES

Relate impulse and momentum to collision of objects (e.g., vehicular collision); (S9FE-IVb36)

Infer that the total momentum before and after collision is equal; (S9FE-IVb37)

Learning Objectives:

Knowledge: Define impulse operationally

Skills: Perform activities involving impulse

Attitudes: Show diligence and accuracy in solving problems

LEARNING TASKS:

Part I. **Direction:** Perform the activity that follows to identify what are the factors that contributes to the changes in momentum Cooperation from the members of each group is a must.

Activity 5: Catch Me when I Fall!

I. OBJECTIVES:

- Identify the factors that affect the force of impact on moving objects.

II. Materials

- Open area (LNHS field)
- PE Uniform
- clear plastic cellophane (1 for each pair of students)
- ¼ letter of water

III. Procedure:

1. Look for an open space in your school (LNHS Open field) where you can perform this activity;
2. Pour a ¼ water into a clear cellophane and tie the plastic bag securely this is needed to prevent the water contents from splattering in case.
3. Find a pair in performing the activity.
4. Each pair must be 3 meters away from each other. The objective of the game is to have the water inside the plastic cellophane to travel back and forth from each pair of students without breaking the cellophane. The players are only allowed to throw the cellophane with water tin a curved path.

5. The pair who fails to catch the cellophane with water inside, and/or break it, is considered out of the game. The game proceeds up to the playing of the last pair.
6. The teacher may want to increase the distance by 1 meter between the pair of students for every successful throw in order to make the game more interesting and challenging.
7. The pair who is able to catch and throw the number cellophane with water without breaking them would be declared as the winning pair.

IV. Analysis

Q37. Was your hand able to protect the cellophane with water from breaking? Why? /Why not?

_____
_____
_____
_____
_____

Q38. Why would the cellophane having water break immediately when it hits the ground?

_____
_____
_____
_____
_____
_____

Q39. How was the impact force lessened by the use of your hand?

_____
_____
_____
_____
_____

Q40. Discuss how the hardness or softness of the landing surface is related to the time required to stop the clear plastic cellophane with water.

_____
_____
_____
_____
_____

IV. Presentation

A representative from the group will present the out to the class.

SCORING RUBRICS

Criteria	5 points	3 points	1 point
Teamwork	All of the group members actively participated	Some of the group members actively participated	Some of the group members participated
Quality of work	The output was neatly done without errors and mistakes	The output was neatly done but with minimal errors and mistakes	The output was unpleasant with errors and mistakes
Time	Finished the task before the given time.	Finished the task on time.	Needs more time to finished the given task

POINTS EARNED	DESCRIPTIVE RATING
12-15	Very good
8-11	Good
4-7	Fair
1-3	Needs improvement

Practice Task:

Direction: Let the students analyze the following word problems related to impulse.

Think about this!

1. Tiger woods hits a 0.02 kg golf ball, giving it a speed of 25 m/s. What impulse does he impart to the ball?
Find: I
Given:
M=0.02 kg
V= 25 m/s – 0= 25m/s

Solution:

Since the golf ball is initially at rest, the initial velocity is equal to zero.

Thus, I= p =m v
= (0.02kg) (25m/s)
= 0.50 kg – m/s

Part II. **Direction**: Use impulse = Force x time to solve the following problems. Shiow your solution below

Try this!

1. A football player kicks a ball with a force of 50N. Find the impulse on the ball if his foot stays in contact with the football for 0.01s.

_____
_____
_____
_____
_____
_____
_____
_____

VOCABULARY

Impulse- Is a term that quantifies the overall effect of a force acting over time. It is conventionally given the symbol (J) and expressed in Newton-seconds.

Momentum - Is a measurement of mass in motion: how much mass is in how much motion. It is usually given the symbol (p)

Force - Is a push or pull upon an object resulting from the object's *interaction* with another object. Whenever there is an *interaction* between two objects, there is a force upon each of the objects. When the *interaction* ceases, the two objects no longer experience the force. Forces only exist as a result of an interaction.

Key Concept

- As the force acts upon the object for a given amount of time, the object's velocity is changed; and hence, the object's momentum is changed.
- An object with momentum can be stopped if a force is applied *against* it for a given amount of time.
- A force acting for a given amount of time will change an object's momentum

TEST YOUR SELF!

Direction: Encircle the letter that corresponds to the correct answer

1. A moderate force will break an egg. However, an egg dropped on the road usually breaks, while one dropped on the grass usually doesn't break. This is because for the egg dropped on the grass.
   a. The change in momentum is greater
   b. The change in momentum is less
   c. The time interval for stopping is greater
   d. the time interval for stopping is greater

2. The impulse experienced by a body in is equal to the change in its _____
   a. velocity
   b. kinetic energy
   c. momentum
   d. potential energy
3. Which of the following object has the greatest momentum?
   a. 2 kg ball rolling at 2m/s
   b. 3 kg ball rolling at 1 m/s
   c. 3 kg ball placed on the cabinet
   d. 1 kg ball rolling at 5 m/s
4. A 500 kg car is travelling at 5 m/s> what is its momentum?
   a. 2500 kg.m/s
   b. 2000 kg.m/s
   c. 100 kg.m/s
   d. 10 kg.m/s

Test II. Direction: answer the following questions! (2 points each)

1. What happens when a van crashes into a car?

   _____

   _____

   _____

2. What safety measures are provided on road crossings so that accidents may be avoided.

_____
_____
_____

3. A speeding bicycle bumps to a heavy loaded jeep parked at the side of the road. which of the two vehicles will have a greater damage? Why?

_____
_____
_____
_____

SUGGESTED READINGS

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SCIENCE 9
Learning Area

Name of Learner: _____Grade Level: _____ Section: _____
School: _____Date: _____

Conservation of Momentum

Title

INTRODUCTORY STATEMENT:

In your Grade 8, you have learned that an external force is required to make an object accelerate. Similarly, if we want to change the momentum of an object, an external force is required. There will be no change in momentum if there is no external force.

Think about this picture!

How is momentum transferred on the photo presented below?

Let's take this situation as an example.

A person steps off a boat. As the person moves to the left, the boat moves back to the right. Action. Reaction. Are there equal and opposite forces acting on the person and the boat? Yes. As the person steps off eventually the boat moves to the right while the man moves to the opposite direction, away from each other. Newton's third law teel us that the force that the man exerts on the boat and the force that makes the man move to other direction are equal magnitude but off opposite directions. The man and the boat make up a system- a collection of objects that affects one another (figure 19), no net/unbalance external force acts on the man-boat system, thus, the total momentum of the system does not change (figure 19).

Remember that momentum, like velocity and force, is a vector quantity. The momentum gained by the man is of equal magnitude but opposite direction to the momentum gained by the boat, in this system, no momentum is gained or lost. We say that momentum is conserved.

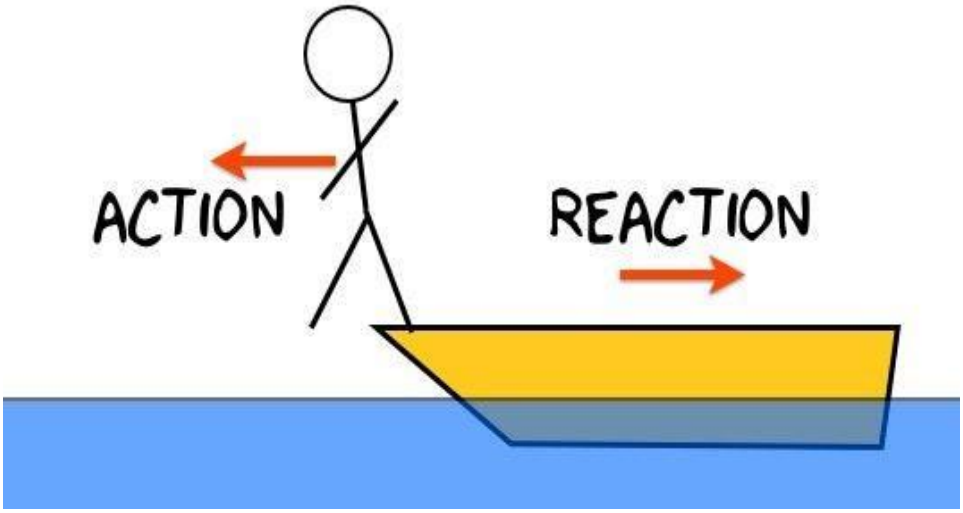

Figure 19. in this example, the total momentum of the man-boat system before a person steps off on a boat is zero. After a person steps off on a boat the total momentum of a man-boat system still zero because the momentum of a person is of equal magnitude but opposite direction to the momentum of the boat. Note that the momentum of the boat alone is not the same before and after the persons step off; and the momentum of the person alone is not the same before and after the person step off.

Explain how momentum is conserved in the following activity

LEARNING OUTCOMES

1. Relate impulse and momentum to collision of objects (e.g., vehicular collision); (S9FE-IVb36)
2. Infer that the total momentum before and after collision is equal; (S9FE-IVb37)

Learning Objectives:

Knowledge: Define Law of Conservation of Momentum
Skills: Explain the law of conservation of momentum
Attitudes: Show camaraderie in performing the activity

LEARNING TASKS:

Part I. **Direction:** To relate impulse and momentum to collision of object and to infer that the total momentum before and after collision is equal, perform the group activity that follows. Cooperation from the members of each group is a must.

Activity 6: Balloon Rocket

I. OBJECTIVES:

- Describe how the balloon rocket works and how conservation of momentum explains rocket motion.

II. Materials

- Open area (LNHS field)
- Balloon (long shape)
- String/nylon (at least 2m)
- tape
- paper clip
- straw
- pinch of starch

III. Procedure:

1. Insert the string into the straw before stretching it over two posts. Two standing students will serve as a post. Make sure that the string is taut.
2. Put a pinch of starch inside the balloon before inflating it. twist the opened end and temporarily secure it with a paper clip.
3. Tape the straw to the balloon such that it is aligned with the balloon opening (see photo below).

4. Position the balloon at the middle of the string.

5. Release the air from the balloon by removing the paper clip and observe carefully.

6. Draw diagram showing the momentum vectors of your balloon rocket and the air.

IV. Analysis

Q41. What can you say about the initial momentum of the system before releasing the air from the balloon?

Q42. What did you observe after releasing the air from the balloon?

Q43. What is the direction of the balloon compared to the direction of air coming out from the balloon?

Q44. How do their momenta compare after releasing the air?

Q45. From your answer in Q4, how does the velocity of the air that is pushed out of the rocket compare to the velocity of the balloon rocket?

IV. Presentation

The leader will choose a member to report the output in the class.

SCORING RUBRICS

Criteria	5 points	3 points	1 point
Teamwork	All of the group members actively participated	Some of the group members actively participated	Some of the group members participated
Quality of work	The output was neatly done without errors and mistakes	The output was neatly done but with minimal errors and mistakes	The output was unpleasant with errors and mistakes
Time	Finished the task before the given time.	Finished the task on time.	Needs more time to finished the given task

POINTS EARNED	DESCRIPTIVE RATING
12-15	Very good
8-11	Good
4-7	Fair
1-3	Needs improvement

Part II. **Direction**: Let the students demonstrate and describe the following activity that shows conservation of momentum

- Let students show and explain how the momentum was conserved when a baseball ball line up on top of the basketball ball and release at 1-meter height above the ground.

- Cite some applications of conservation of momentum in our daily undertakings.

VOCABULARY

External forces- Are forces resulting from the interaction between human body and its environment.

System- A collection of objects that affects one another

Balanced forces - Cause no change in the speed of an object

Unbalanced forces - Not equal, and they always cause the motion of an object to change the speed and/or direction that it is moving.

Vector Quantities- Refer to the physical quantities characterized by the presence of both magnitude as well as direction. For example, displacement, force, torque, momentum, acceleration, velocity, etc.

Newton's third law of Motion- States that for a force applied by an object A on object B, object B exerts back an equal force in magnitude, but opposite in direction.

Law of Conservation of Momentum- For two or more bodies in an isolated system acting upon each other, their total momentum remains constant unless an external force is applied. Therefore, momentum can neither be created nor destroyed.

Collision- Is an encounter between two objects resulting in exchange of impulse and momentum

Elastic collision – one in which the total kinetic energy of the system does not change and colliding objects bounces off after collision.

Inelastic collision – one in which the total kinetic energy of the system changes (i.e., cob=verted to some other form of energy). Objects that stick together after collision is said to be perfectly inelastic.

Key Concept!

- Momentum is a vector quantity. It must have both magnitude (numerical value) and direction. The direction of the momentum vector quantities, momentum vectors can be added. For situations in which the two vectors are in opposite directions, one vector is considered negative and the other is positive.
- Collision is an encounter between two objects resulting in exchange of impulse and momentum. Because the time of impact is usually small the impulse provided by external forces like friction during this time is negligible. If we take the colliding bodies as one system, the momentum of the system is therefore approximately conserved.
- In an isolated system, the total momentum of the system before the collision is equal to the total momentum of the system after the collision.
- **Total momentum before collision = total momentum after collision**

TEST YOUR SELF!

Direction: Encircle the letter that corresponds to the correct answer

1. Which is a necessary condition for the total momentum of a system to be conserved?
   a. kinetic energy must not change.
   b. No external force is present.
   c. An object must be at rest
   d. Only the force of gravity acts on the system.

2. the law of _____ of momentum states that the momentum is neither created nor destroyed.
   a. Preservation
   b. Conservation
   c. Reservation
   d. Protection

3. when the baseball bat hits the ball, the change in momentum of the bat is _____ to the change in momentum of the ball.
   a, greater than
   b. less than
   c. equal to
   d. neither

4. which has greater momentum? A bus parked at the same station or a bicycle in motion?
   a. bus
   b. Bicycle
   c. Both
   d. Neither

5. A force applied for a longer time increases the change in
   a. Momentum
   b. Gravity
   c. Forces
   d. Mass

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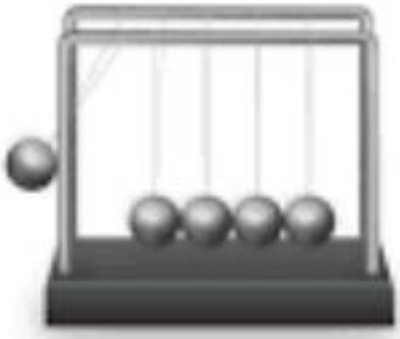
SCIENCE 9
Learning Area

Name of Learner: _____Grade Level: _____ Section: _____
School: _____Date: _____

Conservation of Momentum in different types of collision
Title

INTRODUCTORY STATEMENT:

Is collision present on the picture presented? Why?



Hit the line-up of seven coins with two coins and describe how the momentum transferred on the even coins?

1. 

2. 

Momentum conservation applies to a single object, but it's a lot more interesting to look at a situation with at least two interacting objects. If two objects (a car and a truck, for example) collide, momentum will always be conserved. There are three different kinds of collisions, however, elastic, inelastic, and completely inelastic. Just to restate, momentum is conserved in all three kinds of collisions. What distinguishes the collisions is what happens to the kinetic energy.

LEARNING OUTCOMES

Examine effects and predicts causes of collision-related damages/injuries; S9FE-IVc-38

Learning Objectives:

Knowledge: Describe different type of collision
Skills: Solve problems involving different types of collisions
Attitude: Show diligence and accuracy in solving problems

LEARNING TASKS:

Part I. **Direction:** Let the students describe the types of collision by performing the group activity that follows. Cooperation from the members of each group is a must.

Activity 7: Bouncing Balls

I. OBJECTIVES:

- Describe the types of collision

II. Materials

- Open area (LNHS field)
- 3 different balls (suggestions: ping-pong ball, tennis ball, racquetball, golf ball, baseball, super ball, clay, billiards ball)
- 3 different bouncing surfaces (suggestions: tile floor, linoleum floor, carpeted floor, wooden block, cinder block)
- kilogram or gram scale
- meter stick
- 3 copies of the Bouncing Balls Worksheet (one per student)

III. Procedure:

Before the Activity

- Gather materials.
- Make enough copies of the Bouncing Balls Worksheet so that each student has one.

With the Students

1. Determine the mass in kilograms of each ball and record it on the data sheet.
2. Drop each ball from a distance of 1 meter onto the surface and record how high it bounces in meters (example: 0.46 meters).
3. Note whether the ball and surface showed more of an elastic or inelastic collision.

- If the ball bounces up more than .5 meters, then it is more elastic.
- If it bounces up less than .5 meters, then it is more inelastic.

1. Repeat steps 1, 2 and 3 for the two other surfaces.
2. Calculate the velocity using the formula $V = d/t$ for each ball right before it bounces (question 2) and right after it bounces (question 3).
3. Calculate the momentum using the formula p=mv for each ball right before it bounces (question 4) and right after (question 5).
4. Calculate the percentage of momentum lost for each case (question 6).
5. Answer the Further Learning questions on the worksheet based on your answers. (Note: Have students' complete question 11 as a group.)
6. Once the class is finished with the Bouncing Balls Worksheet, discuss which balls had the best elastic collisions on each surface. Also, if time permits go over some of the Further Learning questions as a class.

IV. Analysis

1. Based from then activity which balls had the best elastic collisions on each surface?

_____
_____
_____
_____

2. How do you distinguish between elastic and inelastic collision?

_____
_____
_____
_____

IV. Presentation

The leader will choose a member to report the output in the class.

SCORING RUBRICS

Criteria	5 points	3 points	1 point
Teamwork	All of the group members actively participated	Some of the group members actively participated	Some of the group members participated
Quality of work	The output was neatly done without errors and mistakes	The output was neatly done but with minimal errors and mistakes	The output was unpleasant with errors and mistakes
Time	Finished the task before the given time.	Finished the task on time.	Needs more time to finished the given task

POINTS EARNED	DESCRIPTIVE RATING
12-15	Very good
8-11	Good
4-7	Fair

ATTACHMENT 2

Bouncing Balls Worksheet

DataBall Types:

Ball 1:_____

Ball 2:_____

Ball 3:_____

Surface Types:

Surface 1:_____

Surface 2:_____

Surface 3:_____

1. Based on the **Height** of the bounce for each ball, is the collision more elastic or inelastic? Fill in the table accordingly.

Case	Ball	Surface	Mass of Ball (kg)	Bounce Height (m)	Elastic or Inelastic

Calculations and Results

1. Calculate the velocity of each ball right before it hits the surface (Starting Velocity). Why do you only have to perform this calculation once?

2. Calculate the velocity of each ball right after it hits the surface (Ending Velocity).

3. Calculate the momentum of each ball before it hits the surface (Starting Momentum).

4. Calculate the momentum of each ball after it hits the surface (Ending Momentum).

5. Calculate the change in momentum and the percentage of momentum that was lost for each case.

_____

_____

Fill in the Table below with your answers:

Case	Starting Velocity (m/s)	Ending Velocity (m/s)	Starting Momentum (kg*m)/s	Ending Momentum (kg*m)/s	Change in Momentum (kg*m)/s	Percent of Momentum Lost

Part II. **Direction**: Let the students answer the following word problems related to conservation of momentum. Answer the questions on the space provided.

A. Based from the concepts learned about collision, cite at least 5 common activities in our daily undertakings that shows elastic and inelastic collision

1._____
2._____
3._____
4._____
5._____

B. Word problem

Direction: Answer the word problem on the space provided. Show your solution below

1.) A motor cycle rider moving at a rate of 10 m/s collided with another rider moving at 15 m/s. if both riders have a mass of 80 kg, what is their velocity during the collision?

_____
_____
_____
_____
_____
_____
_____
_____
_____

VOCABULARY

Collision- Is an encounter between two objects resulting in exchange of impulse and momentum

Elastic collision – one in which the total kinetic energy of the system does not change and colliding objects bounces off after collision.

Inelastic collision – one in which the total kinetic energy of the system changes (i.e., cob=verted to some other form of energy). Objects that stick together after collision is said to be perfectly inelastic.

Key Concept

- An elastic collision follows the Law of Conservation of Momentum, which states "the total amount of momentum before a collision is equal to the total amount of momentum after a collision." In addition, the total kinetic energy of the system (all the objects that collide) is conserved during an elastic collision.
- In an inelastic collision, the total momentum of the system is conserved, but the total kinetic energy of the system is not conserved. Instead, the kinetic energy is transferred to another kind of energy such as heat or internal energy

TEST YOUR SELF!

Direction: Encircle the letter that corresponds to the correct answer

For numbers 1 and 2: Two 0.5 kg balls approach each other with the same speed of 1.0 m/s.

1. What is the total momentum of the system before collision
   a. O
   b. 0.50 kg m/s
   c. 1.0 kg m/s
   d. -1.0 kg m/s

2 Consider a karate expert. During a talent show, she executes a swift blow to a cement block and breaks it with her bare hand. During the collision between her hand and the block, the _____.
   a. time of impact on both the block and the expert's hand is the same
   b. force on both the block and the expert's hand has the same magnitude
   c. impulse on both the block and the expert's hand has the same magnitude
   d. all of the above.
   e. none of the above.

3. Two billiards ball approach each other at equal speed. if they collide in a perfectly elastic collision, what would be their velocities after collision?
   a. zero
   b. same in magnitude and direction
   c. same in magnitude but opposite in direction
   d. different in magnitude and opposite in direction

4 Cars are equipped with padded dashboards. In collisions, the padded dashboards would be safer than non-padded ones because they ____. List all that apply.
   a. increases the impact time
   b. decreases an occupant's impulse
   c. decreases the impact force

d. none of the above

5. A passenger bus of mass 200kg moving with a constant velocity of 5 m/s. collide and moved another passenger bus of mass 2500 kg which is at rest. Calculate the velocity with which the buses move off after the collision.

a. 2.2 m/s
b. 12.5 m/s
c. 5 m/s
d. 3.5 m/s

SUGGESTED READINGS

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WORK, POWER and ENERGY

Overview

In these worksheets, you studied about objects moving in two dimensions. These moving objects possess momentum and experience impulses during interactions with other objects, not only that, these objects also possess energy. On their own or during interactions, there are energy transfer and/or transformation.

The transformation of energy especially mechanical energy and its conservation will be studied conceptually and mathematically as applied in many natural events as well as in the working principles of man- made structures such as rides and electronic power plants.

At the end of this worksheets, you are expected to

1. Explain energy transformation in various activities, archery, amusement ride);
2. Perform activities to demonstrate conservation of mechanical energy;
3. Infer that the total mechanical energy remains the same during any process;

SCIENCE 9
Learning Area

Name of Learner: _____Grade Level: _____ Section: _____
School: _____Date: _____

WORK, POWER, and ENERGY

Title

INTRODUCTORY STATEMENT:

In module 1, you studied about objects moving in two dimensions. These moving objects possess momentum and experience impulse during interactions with other objects. Not only that, these objects also possess energy. On their own or during interactions, there are energy transfer and /or transformations.

In this module, the transformations of energy especially mechanical energy and its conservation will be studied conceptually and mathematically as applied in many natural events as well as in the working principles of man-made structures such as rides and electric power plans.

Mechanical Energy Rules! (of forms and transformations…)

Energy is the name of the game. Everything exists or cease to exist because of its presence or absence. It is stored in different forms and can transfer and/or transform. It can be transferred without being transformed. It can also be transformed without being transformed. Or it can also be transformed during transfers.

Table 2. Mechanical Potential and kinetic Energy equations

A. Potential Energy 	$PE_{grav} = mgh$ $PE_{elas} = \frac{1}{2}kx^2$	where: PE_{grav} = **gravitational potential energy** m = mass of object g = acceleration due to gravity h = height or elevation difference where: PE_{elas} = **elastic potential energy** k = spring constant x = compression or extension length
B. Kinetic Energy 	$KE = \frac{1}{2}mv^2$	Where: KE = **kinetic energy** m = mass of object v = velocity of object

Try this!

Look around into an open area, find at least three different objects that are using different types of energy, and let them write down their findings and share it to the class

LEARNING OUTCOMES

Explain energy transformation in various activities/events (e.g., waterfall, archery, amusement rides); S9FE-IVc-39

Learning Objectives

Knowledge: Identify the different forms of mechanical energy
Skills: determine the energy transformation takes place in the different activates
Attitude: show active participation through sharing of ideas

LEARNING TASKS:

Part I. **Direction:** Identify the transfer and transformation of the different energy forms present, using the toys and objects present in the field by performing the group activity that follows. Cooperation from the members of each group is a must.

Activity 8: Little shop of Things

I. OBJECTIVES:

At the end of the activity, you should be able to:

- Identify the energy forms present in the operation of simple toy and objects, and
- Describe the energy transformation in the toys and objects present in the field.

II. Materials

- Open area
- yoyo
- Dam/River
- Bicycle

III. Procedure:

1. Operate each toy and objects to move and observe closely what causes it to start and moving.

2. For each toy and objects, identify all forms of energy involved in the process.
3. Trace the energy transformations by sketching and labeling the toy while in motion.
4. From the open area, choose two objects of interest to you (Ex. students running the bike, A man playing basketball). Do steps 1 to 3.
5. For each toy or object, answer the following questions.

IV. Analysis

A. Yoyo

1. What does the yoyo do?

_____
_____
_____
_____

2. What energy changes take place as the yoyo operate??

_____
_____
_____
_____

3. What form does the stored energy start out?

_____
_____
_____
_____

4. What form does the stored energy turn into?

_____
_____
_____
_____

5. What form is the output energy when it stops?

_____
_____
_____
_____

6. What made the yoyo move in a certain displacement and what made yoyo come to a stop after being displaced?

B. Students running a bicycle

1. What does the bicycle do?

2. What energy changes take place as bicycle operates??

3. What form does the stored energy start out?

4. What form does the stored energy turn into?

5. What form is the output energy when it stops?

6. What made the bicycle move a certain displacement and what made bicycle come to a stop after being displaced?

_____
_____
_____
_____

IV. Presentation

The leader will choose a member to report the output to the class

SCORING RUBRICS

Criteria	5 points	3 points	1 point
Teamwork	All of the group members actively participated	Some of the group members actively participated	Some of the group members participated
Quality of work	The output was neatly done without errors and mistakes	The output was neatly done but with minimal errors and mistakes	The output was unpleasant with errors and mistakes
Time	Finished the task before the given time.	Finished the task on time.	Needs more time to finished the given task

POINTS EARNED	DESCRIPTIVE RATING
12-15	Very good
8-11	Good
4-7	Fair
1-3	Needs improvement

Part II. **Direction**: Study the energy transformations on the following situations. State the sequence of its energy transformation and write it on the space provided.

1. Go outside the classroom and observe plants receiving sunrays.

_____
_____
_____
_____
_____

2. Students running a bicycle.

_____
_____
_____
_____

3. River

_____
_____
_____
_____

VOCABULARY

Kinetic Energy - Is a property of a moving object or particle and depends not only on its motion but also on its mass

Potential Energy - Energy that is stored – or conserved - in an object or substance. This stored energy is based on the position, arrangement or state of the object or substance. You can think of it as energy that has the 'potential' to do work

Mechanical Energy - The sum of the potential and kinetic energies in a system.

Conservation of Mechanical Energy - states that the total mechanical energy in a system (i.e., the sum of the potential plus kinetic energies) remains constant as long as the only forces acting are conservative forces

Key Concept

Energy transformation is when **energy** changes from one form to another – like in a hydroelectric dam that transforms the kinetic **energy** of water into electrical **energy**. While **energy** can be transferred or **transformed**, the total amount of **energy** does not change – this is called **energy** conservation.

TEST YOUR SELF!

Direction: Encircle the letter that corresponds to the correct answer

1. What is the energy of a motorcycle going fast midway down a hill?
    a. entirely kinetic
    b. entirely potential
    c. entirely gravitational
    d. both kinetic and potential
2. Which events is explained in the sequence of energy changes shown in the diagram below?

    a. blue spotlight is on
    b. a runner doing stretches
    c. an electric fan rotates
    d. the battery-powered toy car runs forward
3. In the Agus VI Hydroelectric Power (HEP) Plant, which energy transformation takes place?
    a. Electrical energy—mechanical energy – electrical energy
    b. gravitational potential energy—kinetic energy- electrical energy
    c. heat – mechanical energy --- electrical energy
    d. nuclear energy---heat—electrical energy
4. Which events does not describe potential energy being changed into kinetic energy?
    a. A cart rolls down a hill
    b. A rubber foam is being compressed
    c. A students lets go a stretched slinky
    d. A twig falls from a branch
5. Which among the objects is considered as having potential energy?
    a. ambulance siren
    b. candle flame
    c. hot milk
    d. milk

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SCIENCE 9
Learning Area

Name of Learner: _____Grade Level: _____ Section: _____
School: _____Date: _____

Conservation of Mechanical Energy

Title

INTRODUCTORY STATEMENT:

A person dropped an egg on the floor. Why did the egg break? What caused the object to move in the first place? We can understand why it broke by understanding mechanical energy.

A person riding a bicycle in the curve surface. How will you describe the energy transformation in the demonstration? Can we measure the amount of energy being transformed in the biker from one kind to another?

LEARNING OUTCOMES

Perform activities to demonstrate conservation of mechanical energy; S9FE-IVd-40
Infer that the total mechanical energy remains the same during any process; S9FE-IVe-41

Learning objectives:

Knowledge: Identify the positions where kinetic energy or potential energy is at maximum or minimum; and
Skills: Solve word problems related to mechanical energy.
Attitude: Infer that the total mechanical energy remains the same during any process

LEARNING TASKS:

Part I. **Direction:** To understand the concept of conservation of mechanical energy they will, perform the group activity to analyze the energy of a swinging ball. Cooperation from the members of each group is a must.

Activity 9: Bashing Ball

I. OBJECTIVES:

At the end of the activity, you should be able to:

- Identify the positions where kinetic energy or potential energy is at maximum or minimum; and
- Explain the result of the demonstration using conservation of energy.

II. Materials

- 1 kl of sand inside the plastic cellophane
- rope
- sturdy twig
- net bag

CAUTION

- Danger of being hit on the face if done with extra movement or push
  - Ensure that the task volunteer will not lean forward before and during the 'giant pendulum'
  - Ensure that no additional push is added to the bowling ball during release
- Danger of having the 'giant pendulum 'drop on or roll over the toes
  - Secure tightly and properly (a) the rope to the overhead suspension on the sturdy twig, and (b) the swinging weight to the rope
- Wait for the teacher to demonstrate first how to properly and safely conduct the activity before taking the challenge yourself -assistance is needed from someone to hold the giant pendulum' nest to the teacher's or volunteer's nose and just release it without pulling or pushing.
- REFRAIN from pushing others or jumping in anticipation of or as reaction to the activity result.
- REFRAIN also from cutting across the swinging weight's path to avoid being hit. Other observers may also be viewing the demonstration from the sides.

III. Procedure:

1. Request a custodian or a maintenance personnel to hang securely a 1 kl of sand weight on a sturdy twig with the use of a net bag and a durable, non-slip rope. The hanging weight should be 1 meter or a little bit farther from the ground.
2. The task volunteer Teacher first and later a student or two) stands straight on one end of the swinging path.

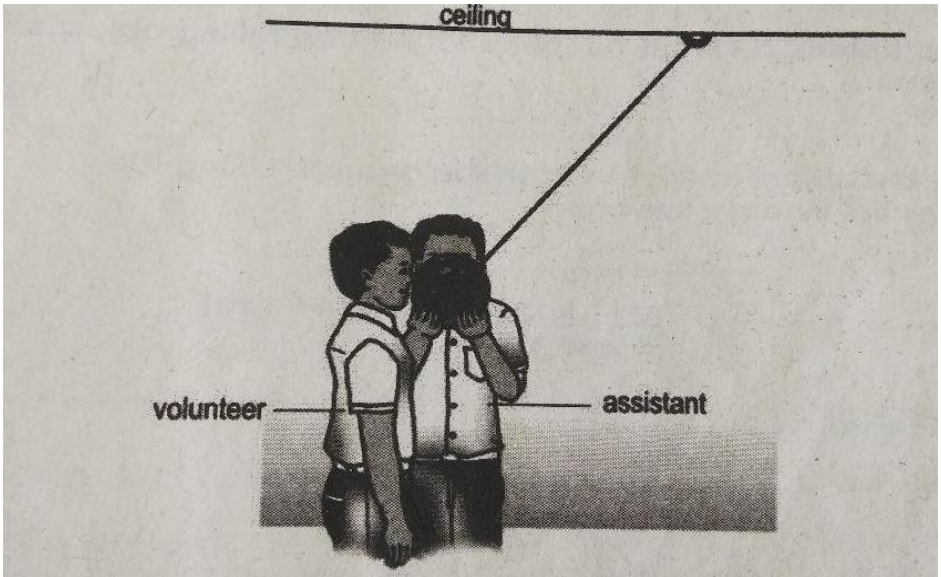


Figure 13. Giant Pendulum Challenge

3. Another student who is strong enough should be assigned to hold steadily the hanging weight for the volunteer and bring it close to the tip of the volunteer's nose with the rope still taut.

4. With the volunteer remaining still and without extra head movement, the assistance gives a signal and releases his hold on the 'giant pendulum' without pulling or pushing. The teacher can be the assistance for student's task volunteers in the next rounds of demonstration.

5. The other students are to predict and observe what happens when the 1 kl sand swings back and returns to the release point.

IV. Analysis

1. Did the 1kl of sand reach the tip of the nose of the student volunteer? Did it rise higher or lower than its original height?

_____
_____
_____
_____

2. At what location(s) along the path of the bowling ball is the balls kinetic energy the greatest? Why?

_____
_____
_____
_____

3. at what location(s) along the path of the bowling ball is the balls gravitational potential energy the greatest? Why?

_____
_____
_____
_____

IV. Presentation

The leader will choose a member to report the output in the class.

SCORING RUBRICS

Criteria	5 points	3 points	1 point
Teamwork	All of the group members actively participated	Some of the group members actively participated	Some of the group members participated
Quality of work	The output was neatly done without errors and mistakes	The output was neatly done but with minimal errors and mistakes	The output was unpleasant with errors and mistakes
Time	Finished the task before the given time.	Finished the task on time.	Needs more time to finished the given task

POINTS EARNED	DESCRIPTIVE RATING
12-15	Very good
8-11	Good
4-7	Fair
1-3	Needs improvement

Part II. **Direction**: Let the students answer the word problem and fill up the table 4. (Summary of the mechanical Energy of a Free Falling Body) to analyze that the total mechanical energy remains the same during any process.

1. Consider a 1 kg stone dropped on top of a hill and reached the ground after 3s. From your concept on free fall, the height of the hill can be computed using the formula h=12agt2 and vf=agt since vi=0. Determine what happens to the free object's kinetic energy and potential energy.

_____
_____
_____
_____
_____

Table 4. (Summary of the Mechanical energy of a Free-Falling Body.

Time, t (s)	Height, h (m)	Velocity, v (m/s)	Potential Energy, PE (J)	Kinetic Energy, KE (J)	Total Mechanical Energy, MET=PE+KE (J)
0	**44.1**	**0**	**432.18**	**0**	**432.18**
1	**39.2**	**9.8**	**384.16**	**48.02**	**432.18s**
2					
3					

VOCABULARY

Acceleration: The rate of change of velocity with respect to time. The measure of how fast the velocity of an object increases or decreases.

Energy: The capacity to do work. There are different types of energy including mechanical, heat, electrical, magnetic, chemical, nuclear, sound, or radiant. The energy dealt with in this lesson and associated activity will be primarily mechanical energy since it is the energy of motion.

Force: Anything that tends to change the state of rest or motion of an object. Force is represented by two quantities; its magnitude and direction in space. The magnitude of a force is represented by quantities such as pounds, tons, or Newtons. Direction in space refers literally to the direction a force is applied. This means that force is a vector and requires two (2) pieces of information to define it completely. When a number of forces act simultaneously on an object, the object moves as if acted on by a single force with a magnitude and direction that are the sum of the applied forces.

Impact: The striking of one object against another; collision.

kinetic energy: The energy possessed by an object because of its motion.

Mass: A measure of how much matter an object contains, or the total number of particles in an object. Mass is not weight. Weight is the force caused on a mass by gravity. Therefore, your mass would not change on different planets, but your weight would. For instance, you would weigh about 1/6th of your body weight now if you were on the moon.

Potential energy: The energy of a particle or system of particles resulting from position, or condition. Gravitational potential energy is based on how high off of the ground an object is while other forms of potential energy can include a spring, a battery, or fuel.

Vector: A quantity that has both magnitude and direction. Examples of vector quantities include velocity, weight and force. Alternatively, speed and mass are NOT vector quantities and can be represented by their magnitude.

Velocity: A vector quantity whose magnitude is a object's speed and whose direction is in the object's direction of motion. Velocity is different from speed because velocity describes a direction as well.

Key Concept

The Law of Conservation of energy states that the energy can neither be created nor destroyed; it is merely converted from one form to another. In terms of mechanical energy, the sum of the potential and kinetic energies of an object remains constant.

…

For a free-falling body released from rest, the vertical distance traveled from the top is

The velocity at any point is given by; , where t=time

Elapsed from released.

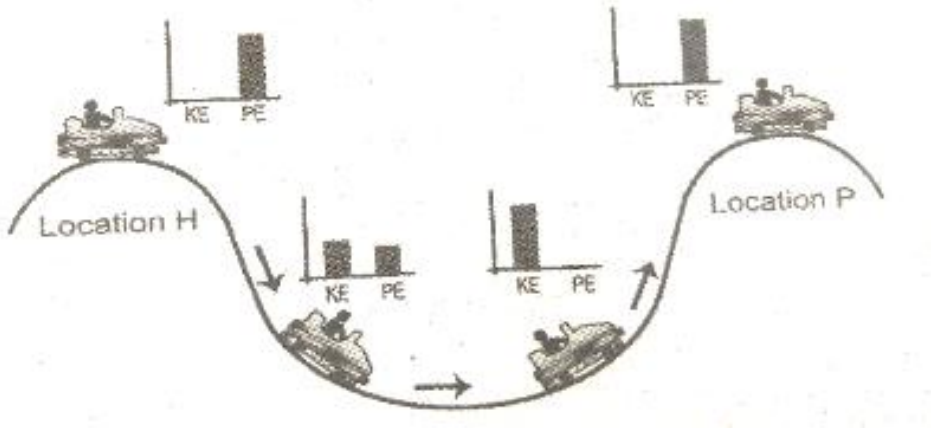
TEST YOUR SELF!

Test I Direction: Encircle the letter that corresponds to the correct answer

1. Which of the following happens to a coconut that falls freely?
   a. Loses potential energy and gains kinetic energy
   b. Loses both potential energy and kinetic energy
   c. Gains potential energy an loses kinetic energy
   d. Gains both potential energy and kinetic energy
2. A torchlight fell from a watch tower. The potential energy of the torchlight at the highest point compared to its kinetic energy at the lost point is _____
   a. lesser
   b. equal
   c. greater
   d. not related

3. At the position H the car is stationary, as the car begins to move down the hill, the potential energy begins to be converted to kinetic energy. The car gathered speed until it reaches back on top of the other side of the hill and converts the gained kinetic energy back to potential energy.

This illustrates about _____



a. Conservation of mechanical energy
b. gravitational potential energy
c. electrical energy
d. radiant energy

4. The total mechanical energy of a yoyo_____
a. is equally divided between kinetic energy and potential energy
b. at any one instant, is either all kinetic energy or all potential energy
c. can never be negative
d. is constant, if only conservative forces act

5. Which of the following situation show work is done.
a. Farmers planting rice
b. a boy sitting a concrete wall
c. a waiter holding a tray
d. none of the above

6. The total mechanical of the object bat the highest point compared with the total mechanical energy at the lowest point is _____
a. greater
b. lower
c. same
d. zero

7. The mechanical energy of a free-falling body is _____
a. wasted
b. conserved
c. equal
d. lesser

Test II. Word problem (2 points)
Direction: Show your solution on the following word problem write your answer on the space provided

1. A 2-kg toy car moves along a frictionless surface with a uniform speed of 6 m/s. What is its kinetic energy?

a. 3.6 j
b. 36 j
c. 366 j
d. 3660 j

_____
_____
_____
_____
_____

2. Consider a 3 kg stone on top of a building and reached the ground after 9s. What is the total mechanical energy of the stone?

_____
_____
_____
_____
_____

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HEAT, WORK, ENERGY

Overview

Have you tried to heat a pot of tap water on a hot burner of the stove? It is observed that the water temperature increases. In this situation, heat flows hot burner to the cold water. When two objects at different temperatures are put in the contact, heat spontaneously flows from an object of high temperatures to the object of low temperatures. The natural flow of heat is always in the direction tending to equalize the temperature. If the two objects are kept in contact long enough for their temperatures to become equal, the two bodies are said to be in thermal equilibrium, and there is no further heat flow between them. Let us take for example, when you have a fever. You will use thermometer in your armpit to monitor your temperature. Heat is flowing from your armpit to the thermometer when the temperature reading stops increasing. The thermometer is then in equilibrium with your armpit and they are at the same temperature.

At the end of this worksheet, you were be able to

1. Construct a model to demonstrate that heat can do work;
2. Infer that heat transfer can be used to do work, and that work involves the release of heat;
3. Explain why machines are never 100-percent efficient;
4. Explain how heat transfer energy transformation make heat engines like geothermal plants work; and

SCIENCE 9
Learning Area

Name of Learner: _____ Grade Level: _____ Section: _____
School: _____Date: _____

HEAT, and WORK

Title

INTRODUCTORY STATEMENT:

In this worksheet focuses on heat and work. It aims to explain how heat can be turned into work and how doing work releases heat. It discusses the spontaneous processes where heat flows from an object of higher temperature to an object of lower temperature. Further, how heat engine's function, cars engine specifically is given emphasis. It tackles also how heat pumps operates. Efficiency of heat engines is discussed through some worded problems and its effects to the environment. Thermal pollution is explained as a result of rise in temperature of bodies of water that is detrimental to aquatic animals and is caused by the disposal of heated industrial water wastes. Being aware of the disadvantages of less efficient heat engines, we could design ways and means to lessen its effects.

In Grade 7, you learned that heat is related to temperature, heat transfer may change one's temperature or one's phase. This change in temperature, either a decrease or an increase, means that there is an energy transfer in the form of heat. On the other hand, phase change means that there is a change in body's internal energy.

Conservation of Energy and Thermodynamics

The concept of the conservation of energy states that: *Energy cannot be created or destroyed.* The first law of thermodynamics is actually based on this concept. It states that: *The change in internal energy of a system equals the difference between the heat taken in by the system and the work done by the system.* **Internal energy** of a substance is the sum of molecular kinetic energy (due to the random motion of the molecules), the molecular potential energy (due to forces that act between the atoms of a molecule and between the molecules), and other kinds of molecular energy. The first law of thermodynamics is just another version of the conservation of energy. It simply states that part of the heat transferred to an object is used by the object to do work. The remaining heat changes the internal energy of the object.

When heat flows in instances where the work done is negligible, the internal energy of the hot substance decreases and the internal energy of the cold substance increases. While heat may originate in the internal energy supply of a substance, *it is not correct to say that a substance contains heat.* The substance has internal energy, not heat. The word "heat" is used only when referring to the energy actually in transit from hot to cold.

The law is expressed as

$$\Delta U = Q - W$$

Where:

Q = the amount of heat flowing into a system during a given process
W = the net work done by the system
ΔU = the change in the system's internal energy

This is derived from the conservation of energy given as out how heat is related to work? Or how heat is related to work?

$$Q = W + \Delta U$$

We will use *Joule (J)* as our SI unit for energy.

The first law tells us that a system's internal energy can be changed by transferring energy by either work, heat or a combination of the two.

LEARNING OUTCOMES

Construct a model to demonstrate that heat can do work; S9FE-IVe-42

Learning task:

Knowledge: Describe how the model produce heat and can-do work
Skills: Construct a model that demonstrate heat can do work.
Attitude: Appreciate the importance of heat.

LEARNING TASKS:

Part I. **Direction:** To demonstrate how heat causes the internal energy of water increase, perform the group activity that follows. Cooperation from the members of each group is a must.

Activity 10: Heat and Internal Energy

I. OBJECTIVES:

At the end of the activity, you should be able to:

- the learners will demonstrate how heat causes the internal energy of the water increase.

II. Materials

- pot
- thermometer
- 500 ml of water
- stove

III. Procedure:

1. Put 500 mL of water into a pot.
2. Place the pot of water into a stove. Measure the temperature of water.
3. Let it boil. Measure its temperature before boiling, while boiling, and after boiling.

Temperature before boiling 0C	Temperature while boiling 0C	Temperature after boiling 0C

IV. Analysis

1. Compare the temperature of water before it is boiled, while it is boiling, and after it has boiled.

_____
_____
_____
_____

2. What does the increase in temperature indicate?

_____
_____
_____
_____

IV. Presentation

The leader will choose a

SCORING RUBRICS

Criteria	5 points	3 points	1 point
Teamwork	All of the group members actively participated	Some of the group members actively participated	Some of the group members participated
Quality of work	The output was neatly done without errors and mistakes	The output was neatly done but with minimal errors and mistakes	The output was unpleasant with errors and mistakes
Time	Finished the task before the given time.	Finished the task on time.	Needs more time to finished the given task

POINTS EARNED	DESCRIPTIVE RATING
12-15	Very good
8-11	Good
4-7	Fair
1-3	Needs improvement

Sample problems:

1. If 200 J of energy is added to a system that does 150 J of external work. By how much is the thermal energy of the system raised?

Given: Q = 200 J

W = 150 J

Find: U = ?

Solution:

U = Q- W

= 200 J – 150 J

= 50 J

2. If 500 cal of heat are added to a gas, and the gas expands doing 500 J of work on its surroundings, what is the change I he internal energy of the gas?

Given: Q = 500 cal or 2,093 J (remember that 1 cal = 4.186 J)

W = 500 J

Find: U = ?

Solution:

U = Q-W

= 2,093 J – 500 J

= 1,593 J

Let us find out how heat is converted into work and how heat causes an increase of a system's internal energy.

Part II. Direction: Let the students answer the following problem.

1. How does heat transfer in a Balloon over heated Flask takes place? (Let students manipulate the materials to justify heat can do work)

_____
_____
_____
_____
_____
_____

Direction: Answer the sample problem no. 2. Show your solution on the space provided.

2. If 150 J of energy ins added to a system when no external work has been done, by how much will the thermal energy of the system be raised?

_____
_____
_____
_____
_____
_____

VOCABULARY

Heat- Is the form of energy that is transferred between systems or objects with different temperatures (flowing from the high-temperature system to the low-temperature system).

Work - In physics, measure of energy transfer that occurs when an object is moved over a distance by an external force at least part of which is applied in the direction of the displacement

Internal energy- is defined as the energy associated with the random, disordered motion of molecules. It is separated in scale from the macroscopic ordered energy associated with moving objects; it refers to the invisible microscopic energy on the atomic and molecular scale.
The First Law of Thermodynamics- States that heat is a form of energy, and thermodynamic processes are therefore subject to the principle of conservation of energy. This means that heat energy cannot be created or destroyed. It can, however, be transferred from one location to another and converted to and from other forms of energy.

Joule – Unit of work or energy in the International System of Units (SI); it is equal to the work done by a force of one newton acting through one meter

Key Concept

- The increase in the internal energy of a system is equal to the amount of heat added to a system minus the work done by the system.
- Adiabatic process is a progress without gain or loss of heat.
- internal/thermal energy is the sum of all kinetic and potential energies of the atoms/molecules in the system

TEST YOUR SELF!

Direction: student will construct a model presented out of the available materials and answer the questions that follows.

1. How does the constructed model produce heat and can-do work?

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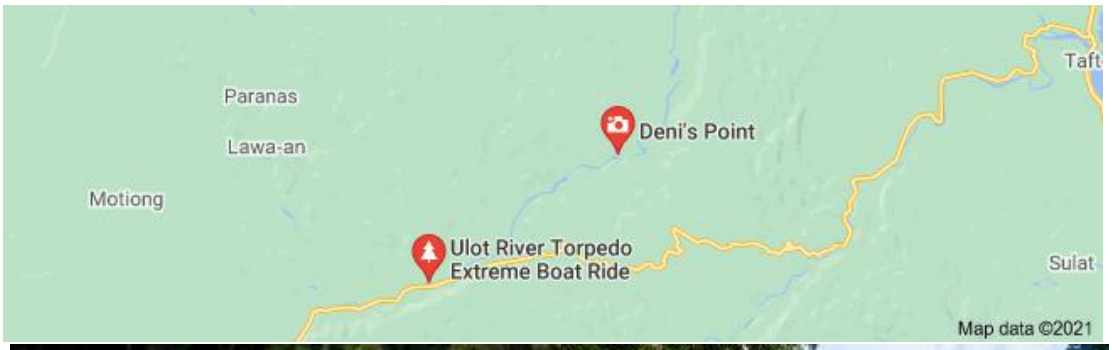
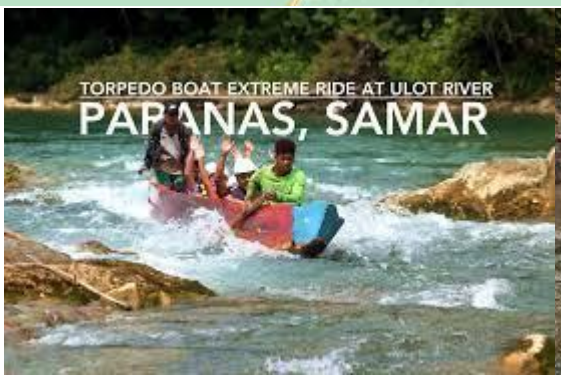
SCIENCE 9
Learning Area

Name of Learner: _____Grade Level: _____ Section: _____
School: _____Date: _____

Heat, work, and Efficiency
Title

INTRODUCTORY STATEMENT:





Observe the motion of the Ulot River, where does the river goes? Is it possible to turn back the water in the river to its original location?
Is it possible to reverse the process?

Heat pump

An object with a high temperature is said to be hot, and the word HOT brings to mind the word HEAT. Heat flows from a hotter object to a cooler object when the two objects are placed in contact.

How can we do the reverse? A **heat pump** is used to reverse the process. It is a device that allows heat to transfer from a cold reservoir to a warmer one, which cannot happen spontaneously, or on its own.

Heat flows normally from higher temperature to lower temperature. It is a natural or **spontaneous process**. It does not require any external energy to occur. When heat flows from lower temperature to higher temperature, it needs mechanical energy to happen. It is called **non-spontaneous process**. In doing so work should be done. Mechanical energy is required for this to happen. The Second law of thermodynamics is applied here. It states that heat will never of itself flow from a cold temperature to a hot temperature object. The work is provided by the motor of the heat pump.

LEARNING OUTCOMES

Infer that heat transfer can be used to do work, and that involves the release of heat S9FE-IVf-43

Learning Objectives:

Knowledge: Differentiate spontaneous and non-spontaneous process.

Skills: List down machines/devices in the community that possesses heat transfer to be use to do work

Attitude: Value the things which has the process of heat transfer.

LEARNING TASKS:

Part I. **Direction:** to distinguish the process as spontaneous or non-spontaneous process, perform the group activity that follows. Cooperation from the members of each group is a must.

Activity 11: Where do I belong

I. OBJECTIVES:

At the end of the activity, you should be able to:

- The Learners should be able to distinguish the process as spontaneous or non-spontaneous process.

II. Materials

- Drying of leaves
- Breakage of an egg
- a piece of a falling rock
- river/water falls
- ball rolling in an incline area

III. Procedure:

1. Study the given example.
2. From the given example above, fill in the table like this

Spontaneous Process	Non-Spontaneous Process	Needs work to reverse the process

IV. Analysis

1. Which of them are spontaneous process?

_____
_____
_____
_____

2. How can we reverse the process for each of the following?

a. drying of leaves to making them fresh again	
b. fixing an eggshell to make it whole again	
c. a piece of a falling rock	
d. ball rolling in an incline area	
e. flowing the water back to the top	

3. What is needed to reverse the process?

_____
_____
_____
_____

IV. Presentation

The leader will choose a member to report the output to the class.

SCORING RUBRICS

Criteria	5 points	3 points	1 point
Teamwork	All of the group members actively participated	Some of the group members actively participated	Some of the group members participated
Quality of work	The output was neatly done without errors and mistakes	The output was neatly done but with minimal errors and mistakes	The output was unpleasant with errors and mistakes
Time	Finished the task before the given time.	Finished the task on time.	Needs more time to finished the given task

POINTS EARNED	DESCRIPTIVE RATING
12-15	Very good
8-11	Good
4-7	Fair
1-3	Needs improvement

Part II. **Direction**: Look around into your surroundings. List at least five examples of spontaneous and nonspontaneous process

1._____

2._____

3._____

4._____

5._____

VOCABULARY

Heat pump- is a device that pulls the energy out of air for the purpose of either heating or cooling a space

Spontaneous process - Is a process that occurs on its own without outside intervention. Outside intervention is something that changes the process after it has started. In this example, the process starts as soon as you let go and leave the glass unsupported in midair. After this point any input from the outside, such as you catching the glass as it falls, is outside intervention.

Non spontaneous process - An endergonic reaction (also called a nonspontaneous reaction or an unfavorable reaction) is a chemical reaction in which the standard change in free energy is positive, and energy is absorbed.

Thermodynamics - is the branch of physics that deals with the relationships between heat and other forms of energy. In particular, it describes how thermal energy is converted to and from other forms of energy and how it affects matter.

Key Concept

- Heat flows normally from higher temperature to lower temperature which is s spontaneous process. It does not require any external energy to occur.
- Non-spontaneous process happens when heat flows from lower temperature to higher temperature, it needs mechanical energy to occur.
- The second law of thermodynamics states that heat will never of itself flow from a cold temperature to a hot temperature object. Hence heat pump is used.
- Heat hump is a device that reverse the direction of the heat flow; from a cold reservoir to a warmer one. Refrigerator and air conditioning unit are example of heat pump.

TEST YOUR SELF!

Direction: Answer the questions that follows.

1. What is the difference between spontaneous and non-spontaneous process?

_____
_____
_____

2. What is the role of mechanical energy in non-spontaneous process?

_____
_____
_____

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SCIENCE 9
Learning Area

Name of Learner: _____Grade Level: _____ Section: _____
School: _____Date: _____

Heat Pump
Title

INTRODUCTORY STATEMENT:

Why does our farmer in Lawaan are using water pumps in their rice field? Where does the water came from? How does the water go to their rice field?

A Water pump used to sustain rice field

A heat pump is a versatile, efficient cooling and heating system. Thanks to a reversing valve, a heat pump can change the flow of refrigerant and either heat or cool a home. Air is blown over an evaporator coil, transferring heat energy from the air to the refrigerant. That heat energy is circulated in the refrigerant to a condenser coil, where it is released as a fan blows air across the coil. Through this process, heat is pumped from one place to another.

LEARNING OUTCOMES

Infer that heat transfer can be used to do work, and that involves the release of heat S9FE-IVf-43

Learning Objectives

Knowledge: Explain how things undergo heat transfer that can be used to do work

Skills: Enumerate devices/machine at home that possess heat transfer to be use to do work.

Attitude: value the importance of heat transfer to individual.

LEARNING TASKS:

Part I. **Direction:** To understand and discuss how heat pumps (refrigerator and air conditioner) work. Perform the group activity that follows. Cooperation from the members of each group is a must.

Activity 12: The Reverse Process

I. OBJECTIVES:

At the end of the activity, you should be able to:

- The Learners should be able to discuss how heat pumps (refrigerator and air conditioning) work.

II. Materials

- air conditioning cycle
- refrigerator
- Figure 2. Refrigeration cooling cycle
- Figure 3. refrigeration Cycle

III. Procedure:

1. Find a place in your community where there is an air condition and a refrigerator with your illustration Study their parts.

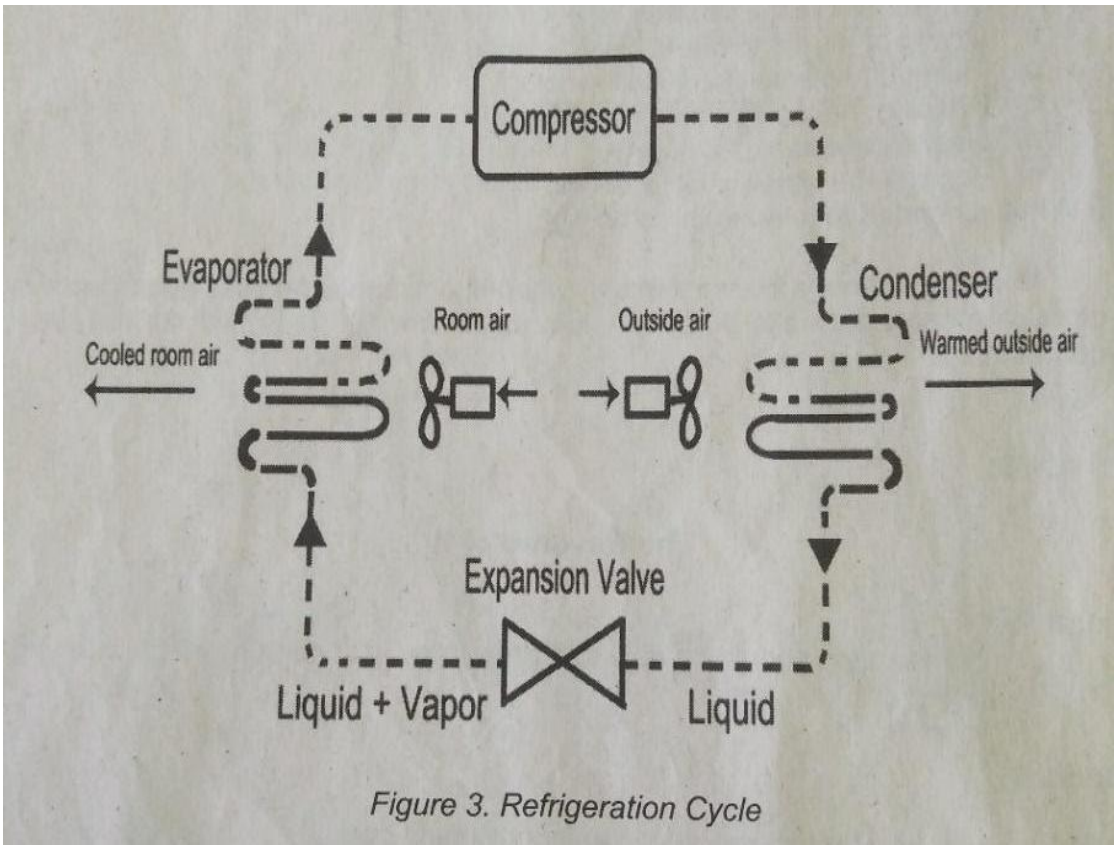


Figure 3. Refrigeration Cycle

IV. Analysis

1. How does a refrigerator work?

_____
_____
_____
_____

2. Describe the compressor. How does it work? What gas is inside the compressor which has low boiling point?

_____
_____
_____
_____

3. What happened to the hot gas produced by compression?

_____
_____
_____
_____

4. How does a condenser function?

5. What happens to the pressure and heat in the evaporator?

6. When does the cycle repeat?

7. Discuss the complete cycle of how refrigerator works.

A. How does the air conditioner work?

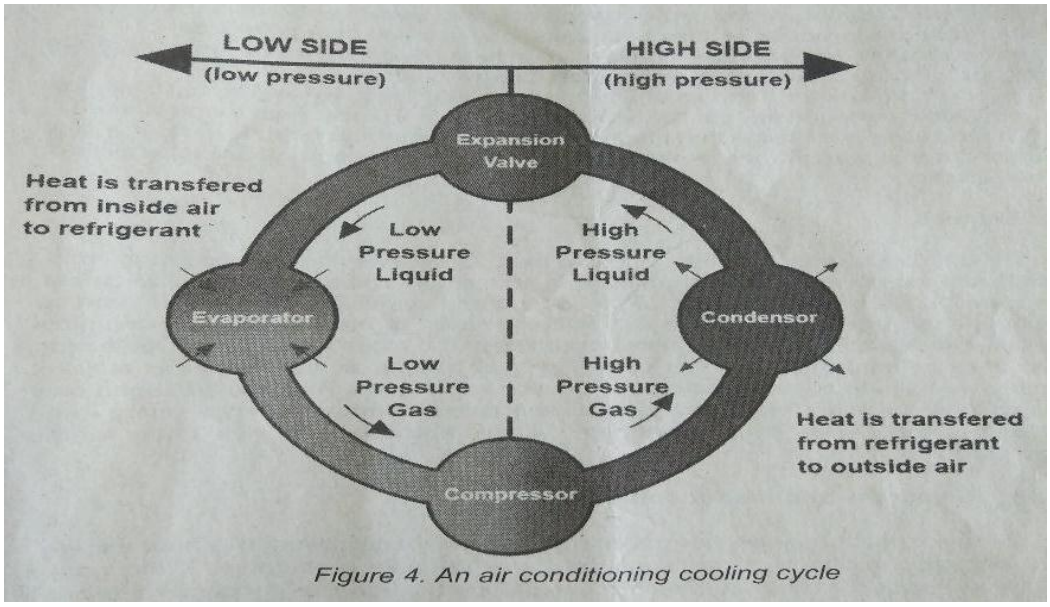


Figure 4. An air conditioning cooling cycle

8. What is the function of an air conditioning unit?

9. How does an air conditioning unit work during summer?

10. What is the function of air conditioning during cold days?

11. What is needed to transfer heat in this device?

IV. Presentation

The leader will choose a member to report their output to the class.

SCORING RUBRICS

Criteria	5 points	3 points	1 point
Teamwork	All of the group members actively participated	Some of the group members actively participated	Some of the group members participated
Quality of work	The output was neatly done without errors and mistakes	The output was neatly done but with minimal errors and mistakes	The output was unpleasant with errors and mistakes
Time	Finished the task before the given time.	Finished the task on time.	Needs more time to finished the given task

POINTS EARNED	DESCRIPTIVE RATING
12-15	Very good
8-11	Good
4-7	Fair
1-3	Needs improvement

Part II**. Direction**: To value the importance of heat transfer to individual. Answer the question that follows. Write your answer on the space provided.

1. How important water pump as a main source of water supply in our school?

_____
_____
_____
_____
_____

VOCABULARY

Mechanical energy - is the energy that is possessed by an object due to its motion or due to its position. Mechanical energy can be either kinetic energy (energy of motion) or potential energy (stored energy of position).

***Heat pump* -** is a device that reverses the direction of the heat flow; from a cold reservoir to a warmer one. Refrigerator and air conditioning unit are examples of heat pump.

Vapor Compression Refrigeration Cycle - Involves four components: compressor, condenser, expansion valve/throttle valve and evaporator. It is a compression process, whose aim is to raise the refrigerant pressure, as it flows from an evaporator. The high-pressure refrigerant flows through a condenser/heat exchanger before attaining the initial low pressure and going back to the evaporator

Key Concept

- heat flows normally from higher temperature to lower temperature which is a **spontaneous process.** It does not require any external energy to occur.
- **Non-spontaneous process** happens when heat flows from lower temperature to higher temperature. it needs mechanical energy to occur.
- *the second law of thermodynamics* states heat will never itself flow from cold temperature to a hot temperature object. Hence, heat pump is used.

TEST YOUR SELF!

Multiple choice
Direction: Encircle the letter that corresponds to the correct answer

1. Mang Fermin, a carpenter, is planning a piece of wood with his planar. After a few minutes, he observed that it is hot. Is there an evidence of heat transfer?
   a. there is no evidence.
   b. Yes, hotness means there is an increase in the temperature
   c. Yes, hotness means there is a decrease in the temperature
   d. No, hotness is not related to a change in temperature
2. How does water from the deep well move upward?
   a. it occurs naturally l
   b. it uses water heat pump.
   c. it is spontaneous process

d. it flows from higher temperature to cooler temperature

3. How can air conditioning unit functions as heater during cold days and cooler during hot days?

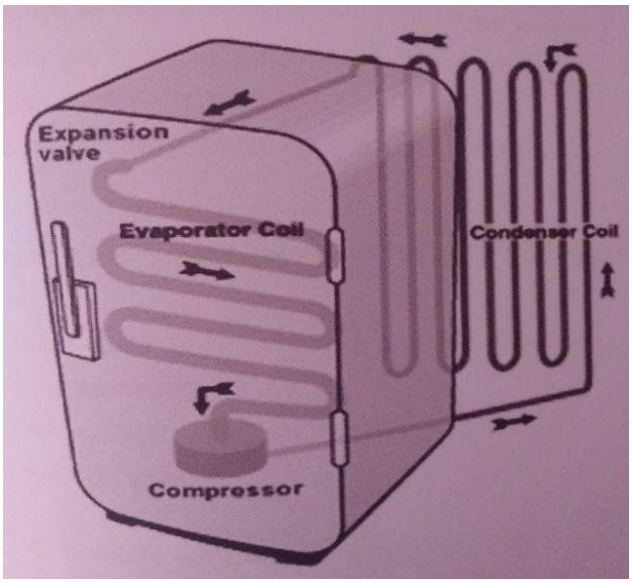
I. It cools the inside of the house and heats the outside
II. It takes heat from the air outside to warm the inside

a. I only b. II only c. I and II only d. None of them

4. What is the function of a heat engine?

a. it converts chemical energy to mechanical energy
b. it converts thermal energy to mechanical energy
c. it converts mechanical energy to chemical energy
d. it converts thermal energy into chemical energy.

5. Use the figure presented below to explain the process of heat transfer in a refrigerator that can be used to do work which involves the release of heat. Write your answer on the box provided.



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SCIENCE 9
Learning Area

Name of Learner: _____Grade Level: _____ Section: _____
School: _____Date: _____

Heat Engine
Title

INTRODUCTORY STATEMENT:

Work can be easily transformed into heat. It is very evident when doing work. All the work we do in overcoming friction is completely changed to heat. Example, eating (which is a method of work due to tearing and chewing food particles) can be completely converted into heat (which is the product of mechanical and chemical combustion and absorption of nutrient occurred in the digestive system). Reversing the process is impossible such as changing heat completely into work. This would happen only by using heat engines. Heat engine is a device that changes thermal energy into mechanical work. How does it happen? What implication will this bring to the environment?

A device that changes thermal energy into mechanical work is heat engine. A heat engine consists of a gas confined by a piston in a chamber. If the gas is heated, it expands, making the piston move. A practical engine is operated through cycles; the piston has to move back and forth. When the gas has heated, the piston moves up. When it is cooled, the piston moves downward, a cycle of heating and cooling will move the piston up and down.

A very important component of heat engines, then, is that two temperatures ar involved. At one cycle, the system is heated, at another, it is cooled.

Three things happen in a full cycle of a heat engine.

1. Heat is added. It is an input heat QH which is a relatively high temperature.
2. Some of the energy from that input heat is used to do work (W)
3. The rest of the heat is removed at a relatively cold temperature QC

LEARNING OUTCOMES

Explain how heat transfer and energy transformation make heat engines like geothermal plants work; and S9FE-IVg-45

Learning Objectives:

Knowledge: Describe the heat and energy transformation in a heat engine.
Skills: Enumerate the process of energy transformation in a heat engine.
Attitude: Appreciate how does heat engine work.

LEARNING TASKS:

Part I. **Direction:** To discuss the four-cycle stroke of a gasoline engine, perform the group activity that follows. Cooperation from the members of each group is a must.

Activity 13: Start the Engine

I. OBJECTIVES:

At the end of the activity, you should be able to:

- Discuss the four-cycle stroke of a gasoline engine.

II. Materials

- Illustration of four-cycle stroke

III. Procedure:

1. Study the illustration.

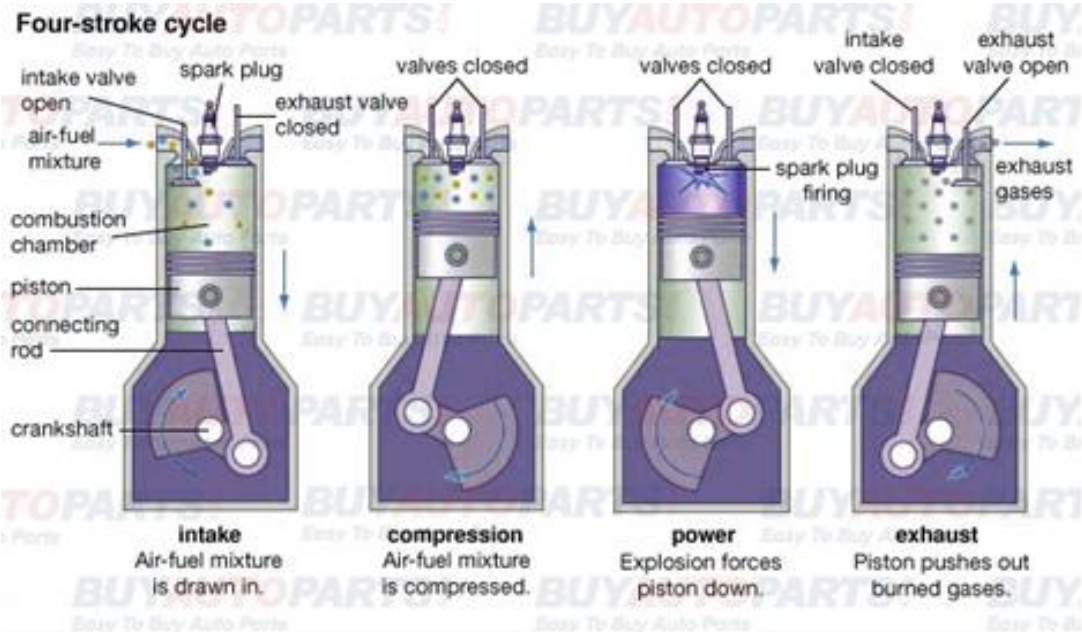

Fig. 5 The four cycle-stroke of gasoline engine

2. Fill in the table.

Cycle stroke	Movement of the piston	What happened to mixture of gases?
Intake		
Compression		

Power		
Exhaust		

IV. Analysis

1. What happens to the gas if it is heated inside the engine's cylinder

2. What happens to the piston and the gases during compression stroke?

3. What is the function of the spark plug? what is its effect to the mixture's temperature?

4. Describe the piston and the gases during power stroke.

5. In exhaust stroke, what happens to the piston and the mixture of gases?

6. What do you think is the effect of this exhaust gas to the environment?

7. Can we consider heat engine 100 % efficient? Why? Why not?

8. As a student, how can you help minimize the effects of thermal pollution?

IV. Presentation

The leader will choose a member to report the output to the class.

SCORING RUBRIC

Criteria	5 points	3 points	1 point
Teamwork	All of the group members actively participated	Some of the group members actively participated	Some of the group members participated
Quality of work	The output was neatly done without errors and mistakes	The output was neatly done but with minimal errors and mistakes	The output was unpleasant with errors and mistakes
Time	Finished the task before the given time.	Finished the task on time.	Needs more time to finished the given task

POINTS EARNED	DESCRIPTIVE RATING
12-15	Very good
8-11	Good
4-7	Fair
1-3	Needs improvement

Part II. **Direction**: Proceed to a mekaniko of a gasoline engine and ask how does a motor cycle changes thermal energy into mechanical work. Write your reflection on the transformation of Heat Energy into Mechanical work on the space provided.

_____

_____

_____

_____

VOCABULARY

Heat engines - are devices that convert heat energy to mechanical energy.

Temperature - The degree of hotness or coldness of a body or environment

Heat- is the form of energy that is transferred between systems or objects with different temperatures (flowing from the high-temperature system to the low-temperature system). Also referred to as heat energy or thermal energy.

Gasoline engine - is a type of heat engine, specifically an internal combustion, that is powered by gasoline. These engines are the most common ways of making motor vehicles move. While turbines can be powered by gasoline, a gasoline engine refers specifically to piston-driven gasoline engines.

Piston -is a moving disk enclosed in a cylinder which is made gas-tight by piston rings. The disk moves inside the cylinder as a liquid or gas inside the cylinder expands and contracts.

KEY CONCEPT

A four-cycle engine works with 4 basic steps to a successful rotation of the crankshaft: the intake, compression, power and exhaust stroke. Each engine cylinder has four openings for the intake, exhaust, spark plug and fuel injection. The piston is driven by the engine's crankshaft whereas the intake and exhaust valves are driven by the camshaft. The crankshaft and camshaft are connected by a timing belt/chain to maintain synchronization between them. The various processes comprising the cycles of a four-stroke engine are explained below:

Intake Stroke: The intake stroke is where the intake valves are open and the air is drawn into the cylinder. The fuel injector sprays the fuel into the cylinder to achieve the perfect air-fuel ratio. The downward movement of the piston causes the air and fuel to be sucked into the cylinder.

Compression Stroke: The next is the compression cycle where both the intake and exhaust valves are closed. The upward movement of the piston causes the air-fuel mixture to be compressed upwards towards the spark plug. The compression makes the air-fuel combination volatile for easier ignition.

Combustion/Power Stroke: During the power/combustion stroke, both the intake and exhaust valves are still closed. The spark plug produces a spark to ignite the compressed air-fuel mixture. The resulting energy of the combustion forcefully pushes the piston downward.

Exhaust Stroke: The last cycle is the exhaust stroke, when the exhaust valves open and the exhaust gases are forced up by the returning piston.

TEST YOUR SELF!

Direction: Encircle the letter that corresponds to the correct answer

1. What is the function of heat engine?

a. It converts chemical energy to mechanical energy
b. It converts thermal energy to mechanical energy
c. It converts mechanical energy to chemical energy
d. It converts thermal energy into chemical energy

2. What is the correct sequence of four-cycle stroke of gasoline engine?

I. Intake
II. Power
III. Exhaust
IV. Compression

a. i,ii,iii,iv
b. i,iv,ii,iii
c. ii,iii,iv,i
d. i, iii,iv,i

3. What causes thermal pollution

a. exhaust of different vehicle
b. exhaust from different industrial engines
c. degradation of water
d. all of them

4. The maximum possible efficiency of a heat engine is determined by

a. its design
b. the amount of heat that flows
c. the maximum and minimum pressure
d. the maximum and minimum temperature

5. The function of a heat engine cycle is to _____ continuously at the expense of _____ to the system.

a) heat input, produce work
b) produce work, heat input
c) can be both of the mentioned
d) none of the mentioned

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SCIENCE 9
Learning Area

Name of Learner: _____Grade Level: _____Section: ____
School: _____Date: _____

Thermal Efficiency

Title

INTRODUCTORY STATEMENT:

It was thought before the full understanding of the second law of thermodynamics that at very low friction, heat engine could convert nearly all the input energy into useful work. It was then that Sadi Carnot carefully studied the and expansion compression cycles.

How well a machine operates is the ratio of the useful work done to the heat provided is the thermal efficiency. Applying Conservation of Energy,

$$Q_H = W + Q_H$$

An important measure of a heat engine is its efficiency: how much of the input energy ends up doing useful work? The efficiency is calculated as a fraction (although it is stated as a percentage.)

$$Efficiency = \frac{Work\ done}{Input\ heat} = \frac{W}{QH}$$

Work is just the input heat minus the exhaust heat, so

$$Efficiency = \frac{QH-QC}{QH} = 1 - \frac{QC}{QH}$$

Where:

QC= energy removed by heat/energy in cold reservoir

QH= energy added by heat/energy in hot reservoir

TC= absolute temperature in cold reservoir

TH= absolute temperature In hot reservoir

Studying our equation, we can only have 100% efficiency if there is no energy transferred away from the engine by heat.

Sample Problem 1.

1. What is the efficiency of a gasoline engine that receives 192.75 J of energy from combustion and loses 125.25 J by heat to exhaust during one cycle?

Given:

$QC=125.25\ J$

$QH=192.75\ J$

Find: efficiency

Solution:

$$\text{Efficiency}= 1-\frac{Q_c}{QH}x100\%$$

$$= 1-\frac{125.25\ J}{195.75J}x100\%$$

$$\text{Efficiency} = 0.36 \text{ or } 36\ \%$$

Try to think!

Observe a running motor cycle. Why do machines are not 100 percent efficient?

LEARNING OUTCOMES

Explain why machines are never 100 %percent efficient; S9FE-IVf-44

Learning Objectives:

Knowledge: Define thermal efficiency of the machine.
Skills: solve word problems related to thermal efficiency
Attitude: Recognize that machines are not 100% efficient.

LEARNING TASKS:

Part I. **Direction:** To verify that machines are not 100% efficient, perform the group activity that follows. Cooperation from the members of each group is a must.

Activity 14: Fill Me In

I. OBJECTIVES:

At the end of the activity, you should be able to:

- Verify that machines are not 100% efficient

II. Materials

- Calculator

III. Procedure:

1. Study the table below

2. Using the equation learned and with the aid of the calculator, solve for the unknown quantity.

3. Supply the table with the final answer obtained from the computation to show the relationship existing among thermal efficiency, temperature/energy in hot reservoir and temperature/energy in cold reservoir.

Temperature/Energy in cold reservoir	Temperature/energy in hot reservoir	Thermal efficiency
250K	500K	
230K	700K	
287.5K	575K	
650J	1054J	
259J	677J	
300C	880C	
560C	920C	
470C	560C	
770C	930C	
650C	850C	

IV. Analysis

1. What are the factors of thermal efficiency? How does each factor affect thermal efficiency?

_____
_____
_____
_____
_____
_____

IV. Presentation

The leader will choose a member to report the output to the class.

SCORING RUBRIC

Criteria	5 points	3 points	1 point
Teamwork	All of the group members actively participated	Some of the group members actively participated	Some of the group members participated
Quality of work	The output was neatly done without errors and mistakes	The output was neatly done but with minimal errors and mistakes	The output was unpleasant with errors and mistakes
Time	Finished the task before the given time.	Finished the task on time.	Needs more time to finished the given task

POINTS EARNED	DESCRIPTIVE RATING
12-15	Very good
8-11	Good
4-7	Fair
1-3	Needs improvement

Part II**. Direction**: answer the questions comprehensively

1. As a concerned citizen in your community, how will avoid, if not lessen the thermal pollution in your environment?

_____
_____
_____
_____

2. What is thermal pollution?

_____
_____
_____
_____

3. Why can machine never work with 100% efficiency?

_____
_____
_____
_____

VOCABULARY

Heat engine is a device that changes thermal energy into mechanical work

Internal combustion engines are engines where combustion takes place inside the engine chamber. examples are gasoline, diesel engine and our human body.

External combustion engines are engines where the fuel combustion takes place outside the engine. Steam, piston engine and the atmosphere are examples of external combustion engine.

Thermal pollution of the air can affect the weather; thermal pollution of water can be harmful to aquatic animals.

Key Concept

The **thermal efficiency** expresses the fraction of heat that becomes useful work. The thermal efficiency can be calculated as a fraction (although it is stated as a percentage).

$$Efficiency = \frac{Work\ done}{Input\ heat} = \frac{W}{QH}$$

Work is just the input heat minus the exhaust heat, so

$$Efficiency = \frac{QH-QC}{QH} = 1 - \frac{QC}{QH}$$

Where:

Qc= energy removed by heat/energy in cold reservoir
QH=energy added by heat/energy in hot reservoir
TC= absolute temperature in cold reservoir
TH=absolute temperature in hot reservoir

Studying the equation, we can only have a 100 % efficiency if there is no energy transferred away from the engine by heat. In reality there is no 100% efficient engine. There will be other losses (to friction, for example) that will reduce the efficiency.

TEST YOUR SELF!

Direction: Encircle the letter that corresponds to the correct answer

1. what are machine?
    a. instruments that assist us to do work easier
    b. Devices that help us do work
    c. Tools that fix the damage
    d. materials that make our work difficult
2. what is the name for a cyclical machine that transforms heat energy into work?
    a. refrigerator
    b. thermal motor
    c. heat engine
    d. carnot cycle
3. Why is heat engine not 100% efficient?
    a. Because all mixture of gasses is converted into work
    b. Because engine needs to be cooled down
    c. All of the gases are used up by the engine.
    d. Some of the gases taken up in the piston
4. the engine with the largest possible efficiency uses a _____
    a. diesel cycle
    b. Joule cycle
    c. carnot cycle
    d. otto cycle

Direction: Answer word problem related to thermal efficiency.

1. Suppose a steam engine receives steam at 600k. The engine uses a part of this thermal energy for work. It exhausts the rest to a condenser at a temperature of 350K. What is the maximum efficiency of this steam engine?

_____
_____
_____
_____
_____

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ELECTRICITY AND MAGNETISM

In your previous Grade level, you learned about the relationship among the three basic electrical quantities – electric current, voltage and resistance. You were tasked to construct simple electric circuits that led to your understanding of Ohm's Law and you were able to apply it to everyday situations. Your teacher also led the class in discussing safety precaution in order to avoid electrical hazards such as short circuits through proper electrical and proper grounding.

In these worksheets, you will discover sources of energy and how electricity is generated from power plants. You will be able to trace the path of electrical energy transmission and distribution from the source, to your homes, and calculated the cost of your energy consumption. This relevant information would help you in understanding your own electrical energy usage and lead you to think on ways on how to conserve electrical energy at home and in school.

At the end of this worksheet, you were be able to

1. Explain how electrical energy is generated, transmitted, and distributed.

SCIENCE 9
Learning Area

Name of Learner: _____Grade Level: _____Section: _____
School: _____Date: _____

ELECTRICITY AND MAGNETISM

Title

INTRODUCTORY STATEMENT:

How is electricity produced?

Electricity powers all our gadgets and appliances at home. Have you ever wondered how electricity reaches us from the electric power plant? What processes does electricity have to go through in order to reach us at home?

Various sources of energy are utilized to provide electricity to power households. For example, the tremendous energy produced by falling water is used by water turbines to rotate large generators at a hydroelectric power plant.

Other sources of energy at power plants include steam from burning fossil fuels, nuclear reactions, winds and ocean tides. Each source provides energy of motion to turbines then to the generators, producing electrical energy. Power plants, include in general uses generators to convert kinetic energy into electrical energy.

EDC increase capacity 60 MW...
dumaguete.com

Indonesia Ranks Third in Utili...
en.netralnews.com

From the power plant, electricity is then made to travel along cables and wires called transmission line. Transmission lines are commonly put up between transmission substations which are regulated by the National power Corporation. Transmission lines may either be constructed overhead on towers or they may be underground. They are operated bat high voltages, send out large amounts of electrical power and extends over considerable distances.

The distribution system connects the transmission system to the customers household. SAMELCO is in charge of the electrical energy distribution in Samar. The distribution substations further step down the voltage to 2,400 – 19, 920 volts. A step-down transformer further reduces the voltage to 220v, the standard AC voltage in the Philippines. This voltage powers most of the electrical appliances we have at home.

Can you identify the different stages of power generation, transmission, and distribution?

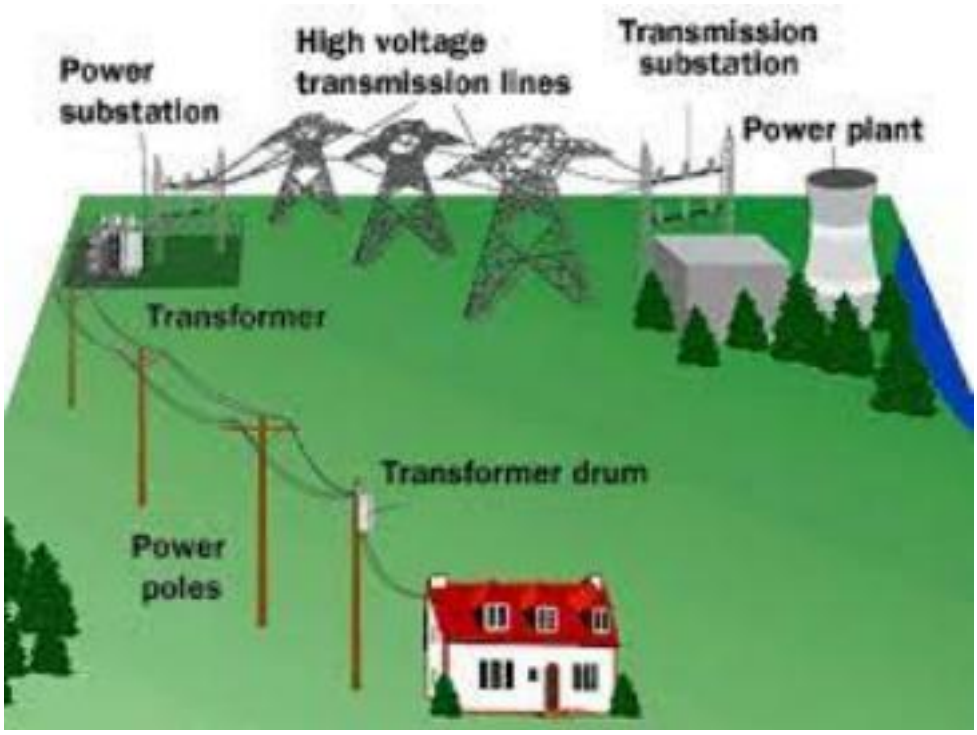


Figure 1. Different stages of power generation, transmission, and distribution

How does a generator convert mechanical energy into electrical energy?

Figure 2. A Simple Generator

Basic components of a generator

Fuel System – Fuel tank usually has sufficient capacity to keep the generator operational for 6 – 8 hours on an average. In the case of small generator units, the fuel tank is a part of the generator's skid base. For commercial applications, it may be necessary to erect and install an external fuel tank.

Engine- Is the source of the input mechanical energy to the generator. The size of the engine is directly proportional to the maximum power output the generator can supply.

Alternator- Is known as the "Genhead", making up a part of the generator that produces the electrical output from the mechanical input supplied by the engine. It contains an assembly of stationary and moving parts encased in a housing. The components work together to cause relative movement between the magnetic and electric fields, which in turn generates electricity.

Control Panel

This is the user interface of the generator and contains provisions for electrical outlets and controls. The following article provides further details regarding the generator control panel. Different manufacturers have varied features to offer in the control panels of their units. Some of these are mentioned below.

Electric start and shut-down – Auto start control panels automatically start your generator during a power outage, monitor the generator while in operation, and automatically shut down the unit when no longer required.

Engine gauges – Different gauges indicate important parameters such as oil pressure, temperature of coolant, battery voltage, engine rotation speed, and duration of operation. Constant measurement and monitoring of these parameters enables built-in shut down of the generator when any of these cross their respective threshold levels.

Generator gauges – The control panel also has meters for the measurement of output current and voltage, and operating frequency.

Other controls – Phase selector switch, frequency switch, and engine control switch (manual mode, auto mode) among others.

LEARNING OUTCOMES

Explain how electrical energy is generated, transmitted, and distributed. S9FE-IVh-j-46s

Learning Objectives:

Knowledge: Identify the components of a simple generator
Skills: Enumerates the process of generation and distribution of electricity
Attitude: Appreciate the importance of electric generator

LEARNING TASKS:

Part I. **Direction:** Determine how electricity is generated, transmitted and distributed. Perform the group activity that follows. Cooperation from the members of each group is a must.

Reminders!

- Secure a copy of a letter granting permission to visit a house having with a generator.
- Observe proper behavior during observation.

Activity 15: Know Me more!

I. OBJECTIVES:

At the end of the activity, you should be able to:

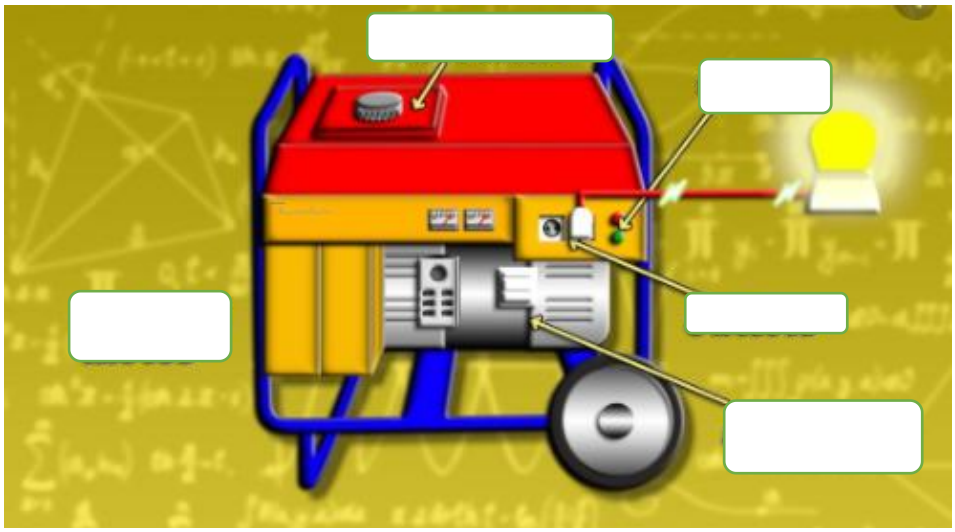
- Discuss how electricity is generated from the simple generator.
- Know the parts and functions of a simple generator by filling up the figure presented.

II. Materials

- Simple Generator
- Worksheets
- Diagram

III. Procedure:

1. Proceed to a house having with generator.
2. Observe how the generator works
3. Ask questions to clarify things pertaining to generator
4. Identify the parts of a generator by supplying the missing information on the figure



IV. Analysis

1. What is the source of mechanical energy for the generator?

_____
_____
_____
_____
_____

2. How do generators produce and transmit electricity?

_____
_____
_____
_____

3. What are the basic components of a generator?

_____
_____
_____

4. Why does the simple generator have a limited time of operation? How does it differ to other types of generators?

_____
_____
_____
_____

IV. Presentation

The leader will choose a member to report the output to the class.

SCORING RUBRIC

Criteria	5 points	3 points	1 point
Teamwork	All of the group members actively participated	Some of the group members actively participated	Some of the group members participated
Quality of work	The output was neatly done without errors and mistakes	The output was neatly done but with minimal errors and mistakes	The output was unpleasant with errors and mistakes
Time	Finished the task before the given time.	Finished the task on time.	Needs more time to finished the given task

POINTS EARNED	DESCRIPTIVE RATING
12-15	Very good
8-11	Good
4-7	Fair
1-3	Needs improvement

Part II. Direction: **Fill in the gaps using the words below.**

A generator is a device that converts kinetic energy to _____ energy. Generators are used by power stations on a large scale to produce mains _____. They produced a voltage by a process called electromagnetic _____.

Induction electricity electrical potential conduction

Part III. **Direction.** Trace the path of electricity from the generating station, transmission station and residential areas; Match the descriptions to the pictures by laying them on top of the table. The first group to finish wins.

Figure 5. Power Transmission Stations

Match the descriptions to the correct illustrations:

A The electric current then runs through the power lines to the substation transformer where voltage is lowered to between 2000 and 13000 volts.

B The steam powers a turbine which spins a huge magnet inside a copper wire. Heat energy converts to mechanical energy which then converts to electrical energy in the generator.

C Steam is generated at the electricity plant by the burning of fossil fuels – or at a nuclear or hydroelectric plant.

D Electricity flows from the power plant through wires to the step up transformer. The transformer raises the voltage so it can travel long distances – its raised as high as 756,000 volts.

E Electricity is then taken through the lines to a pole transformer – or a transformer box if underground – and voltage is lowered again to between 120 and 240 volts.

F From here electricity comes into your home through a service box, where your meter is located to measure how much you use. Wires take electricity around your home powering your lights and all your other appliances

VOCABULARY

Electricity- is the flow of electrical power or charge. It is a secondary energy source which means that we get it from the conversion of other sources of energy, like coal, natural gas, oil, nuclear power and other natural sources, which are called primary sources

Geothermal power plants are used in order to generate electricity by the use of geothermal energy (the Earth's internal thermal energy). They essentially work the same as a coal or nuclear power plant, the main difference being the heat source

Electric generator, also called **dynamo**, any machine that converts mechanical energy to electricity for transmission and distribution over power lines to domestic, commercial, and industrial customers. Generators also produce the electrical power required for automobiles, aircraft, ships, and trains.

Power Plant - Is an industrial facility that generates electricity from primary energy. Most power plants use one or more generators that convert mechanical energy into electrical energy[1] in order to supply power to the electrical grid for society's electrical needs

Transmission line- Is used for the transmission of electrical power from generating substation to the various distribution units. It transmits the wave of voltage and current from one end to another. The transmission line is made up of a conductor having a uniform cross-section along the line

Voltage- Is the pressure from an electrical circuit's power source that pushes charged electrons (current) through a conducting loop, enabling them to do work such as illuminating a light. in brief, voltage = pressure, and it is measured in volts (V)

Transformer - Is defined as a passive electrical device that transfers electrical energy from one circuit to another through the process of electromagnetic induction. It is most commonly used to increase ('step up') or decrease ('step down') voltage levels between circuits.

Key Concept

Electricity is most often generated at a power station by electromechanical generators. Electric generators are devices which convert mechanical energy to electrical energy. This is possible due to the interaction between a changing magnetic field and a conductor inside the generator assembly. A steady, magnet and a conductor at rest cannot produce electric current. Michael Faraday is known for his work on electricity and magnetism in 1821 using an iron ring-coil apparatus. His work paved the way for more advanced discoveries on electromagnetism.

Generators don't actually create electricity. Instead, they convert mechanical or chemical energy into electrical energy. They do this by capturing the power of motion and turning it into electrical energy by forcing electrons from the external source through an electrical circuit

Here's how electricity gets to your house:

- Electricity is made at a generating station by huge generators. Generating stations can use wind, coal, natural gas, or water.
- The current is sent through transformers to increase the voltage to push the power long distances.
- The electrical charge goes through high-voltage transmission lines that stretch across the country.
- It reaches a substation, where the voltage is lowered so it can be sent on smaller power lines.
- It travels through distribution lines to your neighborhood. Smaller transformers reduce the voltage again to make the power safe to use in our homes. These smaller transformers may be mounted on the poles, or sitting on the ground (they're the big green boxes, called pad mount transformers).
- It connects to your house and passes through a meter that measures how much your family uses.
- The electricity goes to the service panel in your basement or garage, where breakers or fuses protect the wires inside your house from being overloaded. (Never touch a service panel! It is only to be operated by your parents or a professional.)
- The electricity travels through wires inside the walls to the outlets and switches all over your house.

TEST YOUR SELF!

Multiple Choice. Direction: Choose the letter of the best answer.

1. What is produce if the magnet and the conductor move relative to each other?
   a. voltage
   b. magnetic field
   c. resistance
   d. current
2. Transformers are used to raise the voltage along substations and lower it for residential consumptions. what kind of transformer are used to raise the voltage?
   a. step-up
   b. step-down
   c. neither of the two
   d. both
3. Shayne turned on a lamp switch in her room. which of the following is the correct path of electrical power that can be traced back to the source?
   a. power plant transmission substations distribution substations residences
   b. transmission substation power plants residence distribution substation
   c. residences distribution substations power plants transmission
   d. distribution substation transmission substation power plants residence
4. When there is a change in the magnetic field in a closed loop of wire,
   a. a voltage is induced in the wire
   b. current is made to flow in the loop of wire
   c. electromagnetic induction occurs
   d. all of these

Direction: Answer the questions comprehensively (2 point each)

1. What are the two important electrical sources of energy?

   _____
   _____
   _____

2. What is being used when a large amount of electricity if needed for long periods?

   _____
   _____
   _____

3. How is the electrical energy generated, transmitted and distributed to the consumer?

   _____
   _____
   _____

SUGGESTED READINGS

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ANSWER KEY

PHYSICS (FORCES, MOTION AND ENERGY) – QUARTER IV
Code; S9FE-Iva-34
Activity 1 -Roll, Roll, and Away! (pp.233)

1. The d vs. graph is a curve line or the vs .t graph is a curved line. The d vs. t2 graph is a straight line inclined to the right.
2. The relationship is quadratic

3. The slope will be solved using the formula (d2-d1)/(t22-t12). The slope of d-t2 graph represents the acceleration. (This can be seen in the unit which is m/s2.)

4. The d-t and d-t2 graphs tell that the baseball ball is accelerating uniformly. It tells that velocity increases over time. It means that for a regular time interval, distance is increasing quadratically.

Application: Word problem

1.

Given:
$v_i = 0$ m/s (assume the train starts from rest)
$v_f = 20$ m/s
$d = 150$ m

Find:
a=?

$v_f^2 = v_i^2 + 2ad$
$(20\ m/s)^2 = (0\ m/s)^2 + 2(a)(150\ m)$
$400\ m^2/s^2 = 0\ m^2/s^2 + (300\ m)a$
$400\ m^2/s^2 = (300\ m)a$
$(400\ m^2/s^2)/(300\ m) = a$
$\boxed{a = 1.3\ m/s}$

2.

Given:
$a = 5.50$ m/s
$t = 20.25$ s
$v_i = 0$ m/s

Find:
d = ?

$d = v_i t + \frac{1}{2} at^2$
$d = (0\ m/s)(20.25\ s) + \frac{1}{2}(5.50\ m/s^2)(20.25\ s)^2$
$\boxed{d = 1130\ m}$

Assessment:

1.Word Problem

Given:

$v_i = 0$ m/s
d = 15 m
t = 3.25 s

Find:

a = ?

$d = v_i t + \frac{1}{2} at^2$
$15\text{ m} = (0\text{ m/s})(3.25\text{ s}) + \frac{1}{2} a(3.25\text{ s})^2$
$15\text{ m} = (5.28\text{s}^2)a$
$a = (15\text{ m})/(5.28\text{ s}^2)$
$a = 2.8\text{ m/s}^2$

2.

Given:
$v_i = 0$ m/s (assume the train starts from rest)
$v_f = 20$ m/s
$d = 150$ m

Find:
a=?

$v_f^2 = v_i^2 + 2ad$
$(20\text{ m/s})^2 = (0\text{ m/s})^2 + 2(a)(150\text{ m})$
$400\text{ m}^2/\text{s}^2 = 0\text{ m}^2/\text{s}^2 + (300\text{ m})a$
$400\text{ m}^2/\text{s}^2 = (300\text{ m})a$
$(400\text{ m}^2/\text{s}^2)/(300\text{ m}) = a$
$a = 1.3\text{ m/s}$

Code; S9FE-Iva-34

Activity 2: Drop me! (LM. pp. 238-239

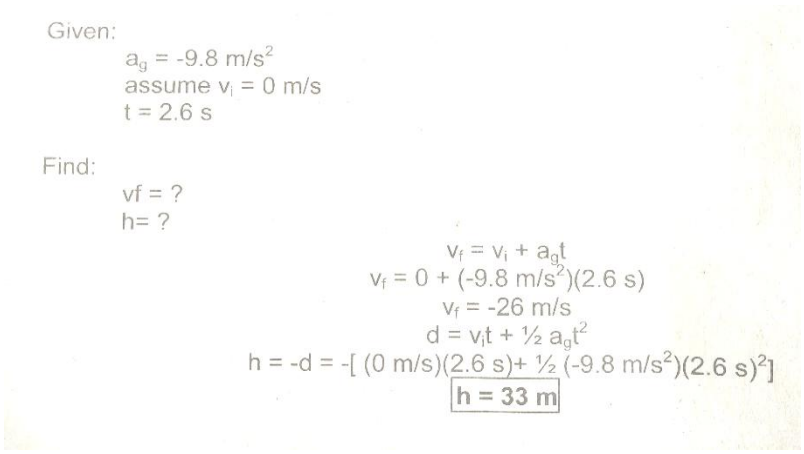
5. Ans: The velocity of the ball just before it hits the grounds will be solved using $vf^2 = 2a_g h$ since $v_1 = 0$ (the valve of h depends on the data on the table)

6. The actual height should be almost the same with the result of our experiment
7. answers may vary

$$Percentage\ Error = \frac{Actual\ Value - Experimental\ Value}{Actual\ Value}\ x\ 100\%$$

Application:

Word Problem



Given:

$a_g = -9.8\ m/s^2$
assume $v_i = 0\ m/s$
$t = 2.6\ s$

Find:

vf = ?
h= ?

$$v_f = v_i + a_g t$$
$$v_f = 0 + (-9.8\ m/s^2)(2.6\ s)$$
$$v_f = -26\ m/s$$
$$d = v_i t + \tfrac{1}{2} a_g t^2$$
$$h = -d = -[\ (0\ m/s)(2.6\ s) + \tfrac{1}{2}\ (-9.8\ m/s^2)(2.6\ s)^2]$$
$$\boxed{h = 33\ m}$$

Assessment

1. b
2. b
3. d
4. b
5. a

Code; S9FE-Iva-35

Activity 4: Curve Me on an Incline (LM. pp. 242-248)

1. The trajectory is a half open-down parabola. Other students may answer curve down or concave down.
2. All the trajectories are full open-down parabolas. In addition, some students may also state something about different maximum height, etc.
3. The trajectory peaks for each projection angle do not have the same location. The peaks are closest to the y-axis origin for shortest range or greatest angle of projection. Each peak is reached just before half the range was travelled. This indicates frictional forces between marble projectile and incline surface resulting to a not so perfect open down parabola.
4. The trajectories have different horizontal distance (range) reached. but some ranges are quite short, some extend beyond the board or cookie sheet.
5. The trajectory fired closest to or at 45 degrees covered the greatest range.
6. The trajectory with the greatest angle launching angle recorded the highest peak.
7. Trajectories at 15 degrees and 75 degrees have almost similar ranges. trajectories bat 30 degrees and 60 degrees also have almost similar but longer ranges than those for 15 degrees and 75 degrees. Some students may note close ranges for pairs of angles that are almost if not complementary angles.

8. The average range is longest for the highest drop at 2 m and shortest at 0.5 m height of fall.
9. The calculated time of fall is the longest for the highest drop at 2 m and shortest at 0.5 m height of fall.

Application
1. Answers may vary

Assessment

1. a
2. d
3. b
4. b
5. c

Code; (S9FE-IVb37)

Activity 6: Investigating Momentum! (LM. pp. 257-258)

1.The stopping distance for the heavy ball is longer than the stopping distance for the small ball.

2. The heavy or big ball had a greater stopping distance. The stopping distance increases as the point of release increases.

Application

1. 10 kg.m/s

2. 2 kg

Assessment

Multiple choice

1. c
2. a
3. d
4. b
5. a

Code: (S9FE-IVb36) (S9FE-IVb37)

Activity 7 Catch me when I fall! (This activity was crafted in the LM. pp. 260-264)

1. Yes. The cellophane with water did not break when I extend the impact of catching it into my hand.
2. By extending the movement of the cellophane impact into the hands it increased the time of action therefore lessening the impact of force on the cellophane with water. This prevented the plastic cellophane with water from breaking

Application: Practice Task

1. Tiger woods hits a 0.02 kg golf ball, giving it a speed of 25 m/s. What impulse does he impart to the ball?
Find: I
Given:
M=0.02 kg
$\triangle$V= 25 m/s – 0= 25m/s

Solution:

Since the golf ball is initially at rest, the initial velocity is equal to zero.

Thus, I=$\triangle$ p =m$\triangle$v
= (0.02kg) (25m/s)
= 0.50 kg – m/s or 0.50 Ns

Assessment:

Test I: Multiple choice

1. C
2. C
3. D
4. A

Test II: Answers may vary

Code: (S9FE-IVb36) (S9FE-IVb37)
Activity 8: Balloon Rocket! (LM. pp. 265-266)

1. Answer: the initial momentum of the system before releasing the air from the balloon is zero
2. Answer: after releasing the air coming out move in opposite directions.
3. Answer: the balloon and the air coming out in opposite directions.
4. Answer: their momenta are the same in magnitude
5. Answer: the velocity of the air is greater than that of the balloon.

Application: answers may vary

Assessment

1. B
2. B
3. C
4. B
5. A

Code: S9FE-IVc-38

activity Bouncy Ball (Please see attached sourcehttps://www.teachengineering.org/activities/view/cub_energy_lesson03_activity3)

Types:

Ball 1: **Tennis Ball**

Ball 2: **Bouncy Ball**

Ball 3: **Wiffle Ball**

Surface Types:

Surface 1: **Tiled Floor**

Surface 2: **Wood table**

Surface 3: **Particle Board**

1. Based on the **Height** of the bounce for each ball, is the collision more elastic or inelastic? Fill in the table accordingly.

Case	Ball	Surface	Mass of Ball (kg)	Bounce Height (m)	Elastic or Inelastic
1	1	1	.0578	.65	Elastic
2	2	1	.0514	.79	Elastic
3	3	1	.0058	.43	Inelastic
4	1	2	.0578	.63	Elastic
5	2	2	.0514	.75	Elastic
6	3	2	.0058	.45	Inelastic
7	1	3	.0578	.61	Elastic
8	2	3	.0514	.76	Elastic
9	3	3	.0058	.44	Inelastic

Calculations and Results

2. Calculate the velocity of each ball right before it hits the surface (Starting Velocity). Why do you only have to perform this calculation once?

Height(d) = 1m Initial velocity (V_i) = 0m/s Acceleration(a) = gravity = 9.81 m/s^2

Final Velocity (V_f) and time (t) are unknown

By using the Kinematic equations:

$$V_f^2 = V_i^2 + 2*a*d$$

$$V_f^2 = (0m/s)^2 + 2*9.81m/s^2*1m$$

$V_f = \sqrt{2*9.81\,m/s^2*1\,m}$

$V_f = 4.43$ m/s

This calculation needs only be performed once because the acceleration of objects is only dependent on the height they are dropped from, the wind resistance, and initial velocity, not the mass of objects. Since we are disregarding wind resistance and all objects are dropped from the same height with no initial velocity, the calculations will be the same.

3. Calculate the velocity of each ball right after it hits the surface (Ending Velocity).

Height(d) = .65m Final velocity (V_f) = 0m/s Acceleration(a) = gravity = 9.81m/s^2

Initial Velocity (V_i) and time (t) are unknown

$V_f^2 = V_i^2 + 2*a*d$

$0 = V_i^2 + 2*9.81m/s^2*0.65m$

$V_i^2 = -2*9.81m/s^2*0.65m$

$V_i = -\sqrt{2*9.81\,m/s^2*0.65\,m}$

$V_i = -3.57$ m/s

By using the same kinematics equation for the rest of the cases, the following velocities were determined:

Surface 2:

$V_i = -3.52$ m/s

Surface 3:

$V_i = -3.46$ m/s

Bouncy Ball:

Surface 1:

$V_i = -3.94$ m/s

Surface 2:

$V_i = -3.84$ m/s

Surface 3:

$V_i = -3.86$ m/s

Wiffle Ball:

Surface 1:

$V_i = -2.90$ m/s

Surface 2:

$V_i = -2.97$ m/s

Surface 3:

$V_i = -2.94$ m/s

4. Calculate the momentum of each ball before it hits the surface (Starting Momentum).

Tennis Ball:

p = m*v where P is momentum, m is mass, and v is the velocity right before the ball hits the surface.

p = 0.0578 kg * 4.43 m/s

p = 0.256 kg * m/s

Bouncy Ball:

p = m*v where P is momentum, m is mass, and v is the velocity right before the ball hits the surface.

p = 0.0514 kg * 4.43 m/s

p = 0.228 kg * m/s

Wiffle Ball:

p = m*v where P is momentum, m is mass, and v is the velocity right before the ball hits the surface.

p = 0.0058 kg * 4.43 m/s

p = 0.0257 kg * m/s

5. Calculate the momentum of each ball after it hits the surface (Ending Momentum).

Tennis Ball:

p is momentum, m is mass, and v is the velocity right after the ball hits the surface

Surface 1:	**Surface 2:**	**Surface 3:**
p = m*v	**p=m*v**	**p=m*v**
p = 0.0578 kg * 3.57 m/s	**p = 0.0578 kg * 3.52 m/s**	**p = 0.0578 kg * 3.46 m/s**
p = 0.206 kg * m/s	**p = 0.203 kg * m/s**	**p = 0.200 kg * m/s**

Bouncy ball:

Surface 1:	**Surface 2:**	**Surface 3:**
p = m*v	**p = m*v**	**p = m*v**
p = 0.0514 kg * 3.94 m/s	**p = 0.0514 kg * 3.84 m/s**	**p = 0.0514 kg * 3.86 m/s**
p = 0.203 kg * m/s	**p = 0.197 kg * m/s**	**p = 0.198 kg * m/s**

Wiffle Ball:

Surface 1:	**Surface 2:**	**Surface 3:**
p = m*v	**p = m*v**	**p = m*v**
p = 0.0058 kg * 2.90 m/s	**p = 0.0058 kg * 2.97 m/s**	**p = 0.0058 kg * 2.94 m/s**
p = 0.0168 kg * m/s	**p = 0.0172 kg * m/s**	**p = 0.0171 kg * m/s**

6. Calculate the change in momentum and the percentage of momentum that was lost for each case.

In each case, we subtract the final momentum from the initial momentum.

For example:

Case 1: 0.256 kg * m/s - 0.206 kg * m/s = 0.05

It is not necessary to have the students show all of their calculations since it is subtraction. However, asking them to show one calculation might be appropriate.

Fill in the Table below with your answers:

Case	Starting Velocity (m/s)	Ending Velocity (m/s)	Starting Momentum (kg*m)/s	Ending Momentum (kg*m)/s	Change in Momentum (kg*m)/s	Percent of Momentum Lost
1	4.43	-3.57	0.256	.206	.050	19.53 %
2	4.43	-3.94	.228	.203	.025	10.96 %
3	4.43	-2.90	.0257	.0168	.0089	34.63 %
4	4.43	-3.52	0.256	.203	.053	20.70 %
5	4.43	-3.84	.228	.197	.031	13.60 %
6	4.43	-2.97	.0257	.0172	.0085	33.07 %
7	4.43	-3.46	0.256	.200	.056	21.88 %
8	4.43	-3.86	.228	.198	.030	13.16 %
9	4.43	-2.94	.0257	.0171	.0086	33.46 %

Application

1. Answers may vary
2. Ans: 0.45 m/s
3. Ans:12.5 m/s

Assessment Multiple Choice

1. A
2. D
3. C
4. a/c
5. a

Code: S9FE-IVc-39

Activity 1: Little Shop of toys! (LM. pp. 283-284)

1. The yoyo can unroll down and roll up. (Some yoyos may also light up or make sounds when in use. Some also use strings that tends to behave elastically.)
2. The elevated yoyos initially have gravitational potential energy. When flicked down, it unrolls changing it gravitational potential energy into linear and rotational kinetic energies until it fully unrolls and stops or sleeps (rotating uniformly at the looped end.) when tugged back by the finger, it rolls up again changing its kinetic energy back into potentials energy.
3. The yoyo started with stored gravitational potential energy
4. The yoyo ended with kinetic energy at the bottom of the drop.
5. When the yoyo stopped, all its potential and kinetic energies are converted into thermal energy.

Application: answers may vary

Assessment Multiple choice

1. D
2. B
3. D
4. B
5. D

Code: S9FE-IVe-41

Activity 3: Bashing Ball! (LM. pp. 294-295)

1. NO. The ball will not reach the tip of the nose of the students and will not exceed its original height.
2. The kinetic energy of the ball is highest at the lowest point in its swing.
3. The gravitational energy of the ball is highest at highest point it its swing.

Application:

Table 4. (Summary of the Mechanical energy of a Free-Falling Body.

Time, t (s)	**Height, h (m)**	**Velocity, v (m/s)**	**Potential Energy, PE (J)**	**Kinetic Energy, KE (J)**	**Total Mechanical Energy,** MET=PE+KE (J)
0	**44.1**	**0**	**432.18**	**0**	**432.18**
1	**39.2**	**9.8**	**384.16**	**48.02**	**432.18s**
2					
3					

Assessment

1. A
2. B
3. A
4. D
5. A
6. C
7. B
8. B
9. -10

Code: S9FE-IVe-42

Activity 1: Heat and Internal Energy (LM. pp. 306-307)

1. **The water's temperature was lower than 100 degree Celsius before boiling, 100 degree Celsius while it was boiling and after boiling.**
2. **It means an increase in internal energy of the water.**

Application 1. If 150 J of energy ins added to a system when no external work has been done, by how much will the thermal energy of the system be raised?

Given: Q =150J

W =0

Find: U

Solution:

U=Q-W

= 150J-0

= 150 J

Assessment: Answers may vary

Code: S9FE-IVf-43

Activity 2: Where Do I Belong (LM. pp. 308-309)

1. **Drying of leaves, spoilage of food, and water falls or some of the examples of spontaneous process.**
2.

a. drying of leaves to making them fresh again	a. by using plant press
b. fixing an eggshell to make it whole again	b. by putting them together using scotch tape
c. a piece of a falling rock	c. gets the rock with your bare hand and return it to its original position
d. ball rolling in an incline area	d. pushes the ball go back to the top
e. flowing the water back to the top	e. by using water pump or motor

3. **An application of work or using motor or a heat pump**

Application: answers may vary

Assessment: answers may vary

Code: S9FE-IVf-43

Activity 3: The Reverse of It (LM. pp. 308-309)

1. Work has to be done by the compressor to "suck" the colder gas from inside the refrigerator out, effectively forcing energy to flow from a chamber of lower temperature to a warmer room outside.
2. A compressor is a motor which compresses a gas known as freon to a pressure of several atmosphere.

Note: Freon is a refrigerant with relatively low boiling point.

3. The hot gas produced by the compressor runs through a condenser.
4. The condenser turned the cooled gas to near room temperature which then condenses into liquid. This cool liquid which has high pressure flows through a narrow tube connected to the evaporator

5. The liquid evaporates when the gas that absorbed heat is produced and goes back to the compressor.
6. The cycle repeats when the gas that absorbed heat is produced and goes back to the compressor
7. The refrigerator cooling cycle follows the following mechanisms;

a. the compressor compresses the freon into a pressure of several atmospheres.

b. the gas is cooled to near room temperature which then condenses into liquid of high pressure.
c. the liquid evaporates due to its low pressure and heat is absorbed from the contents of the refrigerator.
d. the cycle repeats when the gas that absorbed heat is produced and goes back to the compressor.

8. An air conditioning unit is a heat pump used for home heating and cooling.
9. It cools the inside of the house and heats the outside.
10. It takes heat from the air outside to warm the inside.
11. Mechanical energy is needed to transfer heat from a cold object to a warmer one.

Application: answers may vary

Assessment (Multiple choice)

1. A
2. B
3. D
4. A
5. Answers may vary

Code: S9FE-IVg-45

Activity 4 start the engine (L.M page 313-314

1. Ans: The gas expands
2.Ans: The piston moves up. The mixture of gases is compressed into fractional amount.
3. Ans: The spark plug ignites the mixture. This will increase the temperature of the mixture.
4. Ans: The piston moves down. No heat enters or leaves the system.
5. Ans: The piston moves down; the exhaust valve opens and the burned gas expelled out through the exhaust valve.
6. Ans: This gas will constitute to the air pollution. Eventually, it causes thermal pollution.
7.Ans: No, a heat engine could not be 100% efficient because some of the gases are exhausted into the environment.
8. Ans: I will inform the vehicle's operator to always clean their muffler. I will inform the general public regarding the bad effects of this exhaust gases to one's health and to the environment. I will encourage them to use unleaded gasoline. I will advocate to plant trees so that carbon monoxide and halogens will be absorbed by them.

Application: answers may vary

Assessment (Multiple Choice)

1. A
2. D
3. B
4. D
5. B

Code: S9FE-IVf-44

Activity 5: Fill me in (L.M. page 316)

1. The lesser the work output/temperature in the cold reservoir, the greater the efficiency of the heat engine

Application: answers may vary

Assessment:

Test I Multiple choice

1. A
2. C
3. D
4. C

Test II.

5. Word problem

Code: S9FE-IVh-j-46s

Activity 1: Know Me more!

1. Gasoline
2. Generators don't actually *create* electricity. Instead, they *convert* mechanical or chemical energy into electrical energy. They do this by capturing the power of motion and turning it into electrical energy by forcing electrons from the external source through an electrical circuit.
3. Motor engine, fuel tank, alternator, starter, outlet
4. Because it uses gasoline to operate its engine. Compared to larger engines run on diesel, liquid propane, propane gas, or natural gas.

Assessment

Test I. Multiple choice

1. B
2. B
3. B
4. B

Part II

1-3 answers may vary

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APPENDICES

APPENDIX A

PRE/POST- TEST IN SCIENCE – 9

Name: _____Yr. /Sec. _____Rating: _____
Teacher: _____Date: _____Score: _____
Direction: Encircle the letter that corresponds to the correct answer.

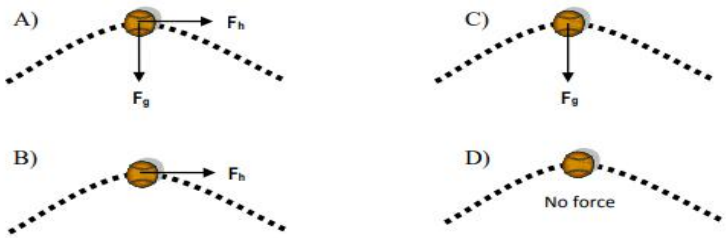
1. Which statement best describes what happens to the HORIZONTAL velocity of a projectile?
   a. it increases (accelerate)
   b. it decreases (decelerate)
   c. it remains constant
   d. none of the above

2. At what angle should a water hose be aimed in order for the water to land with the greatest horizontal range?
   a. O degree
   b. 30 degrees
   c. 45 degrees
   d. none of the above

3. If a free-falling ball is equipped with a speedometer, by how much would its speed-reading increase for every second?
   a. 0 m/s
   b. 9.8 m/s
   c. 10 m/s
   d.20 m/s

4. . Which statement best describes what happens to the VERTICAL velocity of a projectile?
   a. it accelerates downwards
   b. it accelerates upwards
   c. it remains constant
   d. none of the above

5. A fielder throws a softball to a baseman. Which diagram below shows the force(s) acting on the ball while it is on air if Fg represents the force of gravity, and Fh refers to the throwing force?



6. A ball is hit at an angle of 30 degrees. At what point in its trajectory does this projectile have the least speed?
   a. Just after it was launched
   b. At the highest point in its flight
   c. Just before it hits the ground
   d. halfway between the ground and the highest point

7. A ball is hit at an angle of 30 degrees. At what point in its trajectory does this projectile have the least speed?
   a. Just after it was launched
   b. At the highest point in its flight
   c. Just before it hits the ground
   d. halfway between the ground and the highest point

8. At what angle should a water hose be aimed in order for the water to land with the greatest horizontal range?
   a. 0 degree
   b. 30 degrees
   c. 45 degrees
   d. 60 degrees

9. A moderate force will break an egg. However, an egg dropped on the road usually breaks, while one dropped on the grass usually doesn't break. This is because for the egg dropped on the grass.
   a. The change in momentum is greater
   b. The change in momentum is less
   c. The time interval for stopping is greater
   d. the time interval for stopping is greater

10. which has more momentum, a heavy truck moving at 30 km/h or a light truck moving at 30 km/h
   a. heavy truck
   b. light truck
   c. Both have the same momentum
   d. cannot be determined

11. Which of the following object has the greatest momentum?
    a. 2 kg ball rolling at 2m/s
    b. 3 kg ball rolling at 1 m/s
    c. 3 kg ball placed on the cabinet
    d. 1 kg ball rolling at 5 m/s

12. The impulse experienced by a body in is equal to the change in its _____
    a. velocity
    b. kinetic energy
    c. momentum
    d. potential energy

13. Which is a necessary condition for the total momentum of a system to be conserved?
    a. kinetic energy must not change.
    b. No external force is present.
    c. An object must be at rest
    d. Only the force of gravity acts on the system.

14. The law of _____ momentum states that the momentum is neither created nor destroyed.
    a. Preservation
    b. Conservation
    c. Reservation
    d. Protection

15. when the baseball bat hits the ball, the change in momentum of the bat is _____ to the change in momentum of the ball.
    a, greater than
    b. less than
    c. equal to
    d. neither

16. Which has greater momentum? A bus parked at the same station or a bicycle in motion?
    a. bus
    b. Bicycle
    c. Both
    d. Neither

For numbers 17.
Two 0.5 kg balls approach each other with the same speed of 1.0 m/s.

17. What is the total momentum of the system before collision?
    a. O

b. 0.50 kg m/s
c. 1.0 kg m/s
d. -1.0 kg m/s

18. Consider a karate expert. During a talent show, she executes a swift blow to a cement block and breaks it with her bare hand. During the collision between her hand and the block, the _____.
a. time of impact on both the block and the expert's hand is the same
b. force on both the block and the expert's hand have the same magnitude
c. impulse on both the block and the expert's hand have the same magnitude
d. all of the above.

19. Two billiards ball approach each other at equal speed. If they collide in a perfectly elastic collision, what would be their velocities after collision?
a. zero
b. same in magnitude and direction
c. same in magnitude but opposite in direction
d. different in magnitude and opposite in direction

20. Cars are equipped with padded dashboards. In collisions, the padded dashboards would be safer than non-padded ones because they ____. List all that apply.

a. increase the impact time
b. decrease an occupant's impulse
c. decrease the impact force
d. none of the above

21. What is the energy of a motorcycle going fast midway down a hill?
a. entirely kinetic
b. entirely potential
c. entirely gravitational
d. both kinetic and potential

22. Which events is explained in the sequence of energy changes shown in the diagram below?

Chemical Energy ----- Heat ------ Mechanical energy (with wasted heat)

a. blue spotlight is on
b. a runner doing stretches
c. an electric fan rotates
d. the battery-powered toy car runs forward

23. In the Agus VI Hydroelectric Power (HEP) Plant, which energy transformation takes place?
a. Electrical energy—mechanical energy – electrical energy
b. gravitational potential energy—kinetic energy- electrical energy
c. heat – mechanical energy --- electrical energy

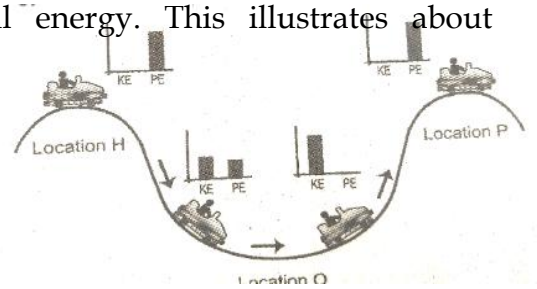
d. nuclear energy---heat—electrical energy

24. Which events does not describe potential energy being changed into kinetic energy?
a. A cart rolls down a hill
b. A rubber foam is being compressed
c. A students lets go a stretched slinky
d. A twig falls from a branch

25. Which of the following happens to a coconut that falls freely?
a. Loses potential energy and gains kinetic energy
b. Loses both potential energy and kinetic energy
c. Gains potential energy an loses kinetic energy
d. Gains both potential energy and kinetic energy

26. A torchlight fell from a watch tower. The potential energy of the torchlight at the highest point compared to its kinetic energy at the lost point is _____
a. lesser
b. equal
c. greater
d. not related

27. At the position H the car is stationary, as the car begins to move down the hill, the potential energy begins to be converted to kinetic energy. The car gathered speed until it reaches back on top of the other side of the hill and converts the gained kinetic energy back to potential energy. This illustrates about _____.



a. Conservation of mechanical energy
b. gravitational potential energy
c. electrical energy
d. radiant energy

28. the total mechanical energy of a yoyo_____
a. is equally divided between kinetic energy and potential energy
b. at any one instant, is either all kinetic energy or all potential energy
c. can never be negative
d. is constant, if only conservative forces act

29. Which of the following situation show work is done.
a. Farmers planting rice
b. a boy sitting a concrete wall
c. a waiter holding a tray
d. none of the above

30. The total mechanical of the object bat the highest point compared with the total
mechanical energy at the lowest point is _____
a. greater
b. lower
c. same
d. zero

31. The mechanical energy of a free-falling body is _____
a. wasted
b. conserved
c. equal
d. lesser

32. A 2-kg toy car moves along a frictionless surface with a uniform speed of 6 m/s. What is its kinetic energy?
a. 3.6 j
b. 36 j
c. 366 j
d. 3660 j

33. Which of the following methods is the least practical when heat is converted into work
a. the bicycle
b. the steam engine
c. burning gases
d. atomic reactor

34. which of the following is not a part of a steam engine?
a. boiler
b. cylinder
c. steam chest
d. commutator

35. what is a refrigerator? it is a device that
a. removes heat from objects
b. primarily keeps the heat from going inside the refrigerator unit
c. uses a non-condensing-type motor
d. has a condenser located inside the refrigerator

36. in what condition does a refrigerator possibly transfer heat from a colder body to another at a higher temperature?
a. the engine ins cooler
b. work is done on the engine
c. the body is first cooled

d. not very efficient

37. Mang Fermin, a carpenter, is planning a piece of wood with his planar. After a few minutes, he observed that it is hot. Is there an evidence of heat transfer?
a. there is no evidence.
b. Yes, hotness means there is an increase in the temperature
c. Yes, hotness means there is a decrease in the temperature
d. No, hotness is not related to a change in temperature

38. How does water from the deep well move upward?
a. it occurs naturally l
b. it uses water heat pump.
c. it is spontaneous process
d. it flows from higher temperature to cooler temperature

39. How can air conditioning unit functions as heater during cold days and cooler during hot days?
I. It cools the inside of the house and heats the outside
II. It takes heat from the air outside to warm the inside
a. I only
b. II only
c. I and II only
d. None of them

40. what is the function of a heat engine?
a. it converts chemical energy to mechanical energy
b. it converts thermal energy to mechanical energy
c. it converts mechanical energy to chemical energy
d. it converts thermal energy into chemical energy

41. Is it possible to change the temperature of a glass of water by stirring the water? even thought the glass is insulated from its surroundings?
a. No, stirring will not affect the temperature of the water.
b. No, insulation prevents the change of temperature of the water
c. yes, stirring the water increases its internal energy causing the increase of its temperature
d. Yes, stirring the water decreases its internal energy causing the decrease of its temperature.

42. What is the correct sequence of four-cycle stroke of gasoline engine?
I. Intake
II. Power
III. Exhaust
IV. Compression
a. i,ii,iii,iv
b. i,iv,ii,iii
c. ii,iii,iv,i
d. i, iii,iv,i

43. What causes thermal pollution
a. exhaust of different vehicle
b. exhaust from different industrial engines
c. degradation of water
d. all of them

44. The maximum possible efficiency of a heat engine is determined by
a. its design
b. the amount of heat that flows
c. the maximum and minimum pressure
d. the maximum and minimum temperature

45. What are machine?
a. instruments that assist us to do work easier
b. Devices that help us do work
c. Tools that fix the damage
d. materials that make our work difficult

46. what is the name for a cyclical machine that transforms heat energy into work?
a. refrigerator
b. thermal motor
c. heat engine
d. carnot cycle

47. Why is heat engine not 100% efficient?
a. Because all mixture of gasses is converted into work
b. Because engine needs to be cooled down
c. All of the gases are used up by the engine.
d. Some of the gases taken up in the piston

48. the engine with the largest possible efficiency uses a _____
a. diesel cycle
b. Joule cycle
c. carnot cycle
d. otto cycle

49. What is produce if the magnet and the conductor move relative to each other?
a. voltage
b. magnetic field
c. resistance
d. Current

50. Transformers are used to raise the voltage along substations and lower it for residential consumptions. what kind of transformer are used to raise the voltage?

a. step-up
b. step-down
c. neither of the two
d. both

51. Shayne turned on a lamp switch in her room. which of the following is the correct path of electrical power that can be traced back to the source?
a. power plant transmission substations distribution substations residences
b. transmission substation power plants residence distribution substation
c. residences distribution substations power plants transmission
d. distribution substation transmission substation power plants residence

52. When there is a change in the magnetic field in a closed loop of wire,
a. a voltage is induced in the wire
b. current is made to flow in the loop of wire
c. electromagnetic induction occurs
d. all of these

APPENDIX B

LETTER TO THE SCHOOL HEAD

January 12, 2020

RONIE C. CALOSA
Teacher In Charge (TIC)
Lawaan NHS

Greetings of peace!

I Mark Gil L. Empiengco, Secondary School Teacher I of Lawaan National High School and currently enrolled in Master of Arts Major in Physics at Samar State University (SSU) Catbalogan City respectfully request from your good office to allow me to conduct a Field-based Laboratory Instruction for my grade 9 Charity Students for all the topics in fourth quarter Science 9 and these will be conducted inside and outside of the school premises.

This Field-based Laboratory Instruction will give the students an avenue to understand comprehensively the topic in force, motion and energy and this provides students opportunity to develop their personal and social skills, become active in decision making and problem-solving skills because of their hands-on involvement during the activity.

The safety and protection of the students and teacher will be emphasized on this intervention and as a researcher I will remain neutral and unbiased and no personal preconceptions interfere with the data collection process.

Hoping for your kind consideration on this matter.

Thank you and God bless.!

(Sgd.) MARK GIL L. EMPIENGCO
MAT -Physics

APPENDIX C

PARENTAL CONSENT FORM

I hereby give consent for my son/daughter _____ to participate in a field-based laboratory Instruction in science 9 fourth quarter activities and this will be conducted inside and outside of the school premises.

For any unnecessary situation may happen during the conduct of the said activity by granting permission for my son/daughter I recognized the potential harm that may exist prior to their participation. Nevertheless, I believe that this chance to learn outweighs these risks.

The personal information of the participants and the existence terms and agreement above shall be kept confidential thru data privacy act of 2012.

Signed:

_____

Parent/Guardian

Date: _____

SAMAR STATE UNIVERSITY
Arteche Blvd., Catbalogan City, Philippines 6700
Office of the Vice President | Research & Extension Services

APPENDIX D

Letter to the Schools Division Superintendent

December 7, 2020

CARMELA R. TAMAYO, Ed.D. CESO VI
Schools Division Superintendent
Samar Division
Arteche Boulevard, Brgy. 7, Catbalogan City

Warm greetings!

I am Mark Gil L. Empiengco, A graduate student of Samar State University taking of Masters of Arts in Teaching major in Physics conducting a study entitled "Field-Based Laboratory Instruction in Teaching Motion, Force and Energy".

With regards to this, I'm requesting from your good office to get the data of the Mean Percentage Score (MPS) of quarterly assessment results for the last three years that is from S.Y. 2019-2020, 2018-2019, 2017-2018 in science subject in the Junior High School of Samar Division. This data will be used solely for the purposes of this study and will be treated with full confidentially.

I hope for your positive response to this request.

Thank you very much and more power.

Respectfully yours,

MARK GIL L. EMPIENGCO
MAT- Physics

Contact details:
markgil.empiengco@deped.gov.ph
09772437050

APPENDIX E

CERTIFICATE OF ETHICS APPROVAL

SAMAR STATE UNIVERSITY
Arteche Blvd., Catbalogan City, Philippines 6700
Office of the University President

We Innovate. We Build. We Serve.

JAS-ANZ

CERTIFICATE OF ETHICS APPROVAL

This is to certify that the Samar State University Institutional Research Ethics Review Committee (IRERC) has reviewed and approved a study entitled:

Title : **FIELD-BASED LABORATORY INSTRUCTION IN TEACHING MOTION, FORCE AND ENERGY**
Name of Researcher/s: **MARK GIL L. EMPIENGCO**
Reference No : **IRERC EA-0028**
Date of Application : **May 30, 2020**

It is hereby mandated that in the implementation of the aforementioned study, the subject researcher shall adhere to International ethical guidelines, national guidelines and all other pertinent requirements prescribed by the SSU-IRERC.

The Researcher can now commence to the data gathering process and the study shall be valid for two (2) years from the date of issuance hereof.

DATE OF ISSUANCE: June 9 , 2020 VALID UNTIL: June 9, 2022

RHEAJANE A. ROSALES, D.M.
Director, IRERC

MARILYN D. CARDOSO, Ph.D.
University President

Telephone No. (055) 251 - 2139 | Fax. (055) 543 - 8394 | Website: www.ssu.edu.ph

APPENDIX F

CERTIFICATE OF VALIDATION

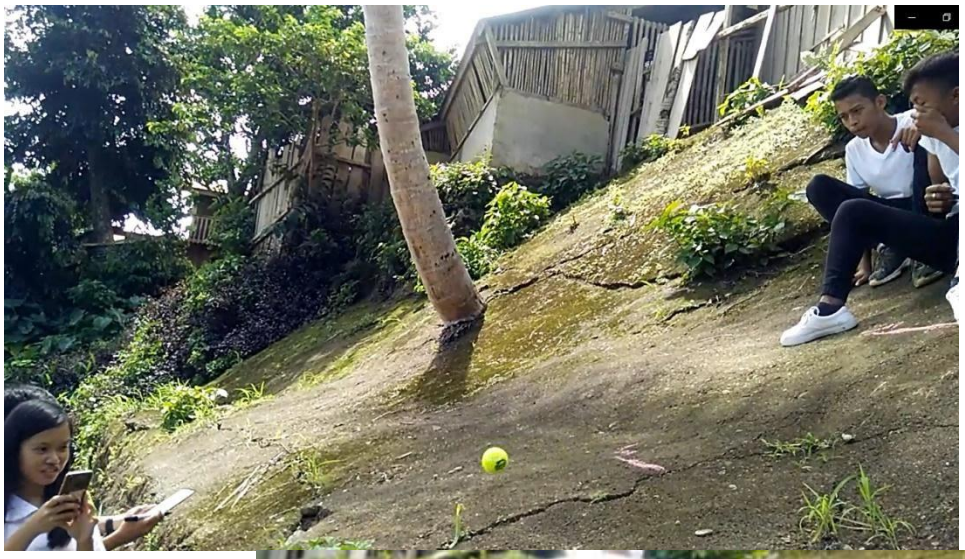
This is to certify that the instrument used in the study of Mr Mark Gil L. Empiengco and the workbook entitled Forces, Motion and Energy have been validated by the undersigned.

ALIDA P. CASILLA
Master Teacher I
Lawaan National High School
Paranas, Samar

APPENDIX G

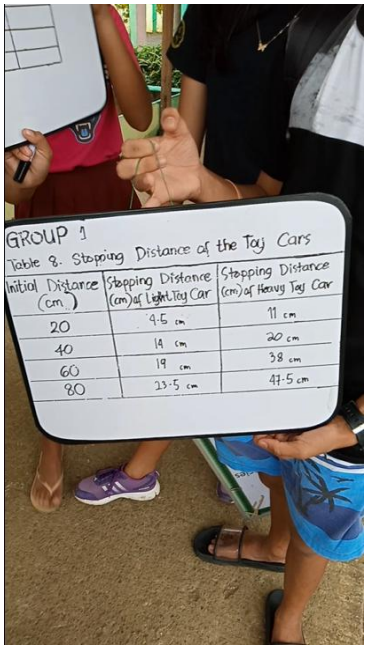
Documentation

Activity 1: Roll, Roll, and Away



Activity 2: Drop Me!

Activity 4: Investigating Momentum



GROUP 1

Table 8. Stopping Distance of the Toy Cars

Initial Distance (cm)	Stopping Distance (cm) of Light Toy Car	Stopping Distance (cm) of Heavy Toy Car
20	9.5 cm	11 cm
40	19 cm	20 cm
60	19 cm	38 cm
80	23.5 cm	47.5 cm

Activity 5: Catch Me when I Fall!

Activity 6: Balloon Rocket

Activity 8: Little shop of Things

Activity 9: Bashing Ball

Activity 10: Heat and Internal Energy

APPENDIX H

Quantitative Raw Data

Respondent	PRE-TEST SCORE	POST TEST SCORE
1	6	21
2	13	20
3	11	18
4	14	21
5	9	21
6	11	21
7	14	19
8	11	17
9	18	22
10	12	17
11	12	15
12	12	19
13	13	18
14	8	15
15	13	19
16	7	21
17	11	16
18	13	25
19	11	17
20	11	15
21	15	20
22	9	18
23	14	26
24	17	21
25	8	19
26	10	19
27	14	23
28	17	20
29	8	21
30	12	21
31	16	21
32	15	19
33	14	21
34	12	18

CURRICULUM VITAE

CURRICULUM VITAE

MARK GIL L. EMPIENGCO
Purok 2 Brgy. Lawaan 1 Paranas, Samar
(+639772437050)
markgil.empiengco@deped.gov.ph

Personal Vitae

Date of Birth	:	September 21, 1992
Place of Birth	:	Brgy. Lawaan I Paranas, Samar
Citizenship	:	Filipino
Marital Status	:	Single

Professional Qualifications

GRADUATE STUDIES

University	:	Samar State University
Address	:	Catbalogan city
Degree	:	Master of Arts in Teaching, Major in Physics
Inclusive year:		Summer 2016- Present

TERTIARY

University	:	Samar State University
Address	:	Catbalogan city
Degree	:	Bachelor of Secondary Education, Major in Physics
Year Graduated:		2015

Eligibilities

Licensure Exam:	Professional teacher
Date of Conferment:	May 22, 2015
License Number:	18- 1156366

Professional Experience

October 10, 2015 - Present:	Secondary School Teacher I

Lawaan National High School
Lawaan I Paranas, Samar

Skills

Computer Literacy

Languages

English, Filipino, and Waray-waray

LIST OF TABLES

Table **Page**

LIST OF FIGURES

Figure **Page**