DEPED - GENERAL SANTOS CITY
SIMPLIFIED SELF-LEARNING MODULE
(S S L M)

GENSAN's ProTUNA
General Santos City's Pro-Active Response in Turbulent, Uncertain, New and Ambiguous Environment

GENERAL PHYSICS 1 - GRADE 12

Name: _____ Date: _____

Grade: _____ Section: _____

Quarter: 1 Week: 6 SSLM No.6 MELC(s):

Relate the gravitational potential energy of a system or object to the configuration of the system. **STEM_GP12WE-Ig-48,**

Relate the elastic potential energy of a system or object to the configuration of the system. **STEM_GP12WE-Ig-49**

Explain the properties and the effects of conservative forces. **STEM_GP12WE-Ig-50**

Use potential energy diagrams to infer force; stable, unstable, and neutral equilibria; and turning points. **STEM_GP12WE-Ig-53**

Solve problems involving work, energy, and power in contexts such as, but not limited to, bungee jumping, design of roller-coasters, number of people required to build structures such as the Great Pyramids and the rice terraces; power and energy requirements of human activities such as sleeping vs. sitting vs. standing, running vs. walking. **STEM_GP12WE-Ig-55**

Objectives:

1. Define Work, Energy and Power.
2. Solve problems involving Gravitational Potential Energy and Elastic Potential Energy
3. Illustrate properties and conservation of energy by calculating the Total work done and the Total Mechanical energy.
4. Solve problems involving Work, Energy and Power.

- **Title of Textbook/LM to Study**: Physics for Scientists and Engineers with Modern Physics by Serway & Jewett
- **Chapter:** 13 **Pages:** 362-388 **Topic:** Work, Power and Energy

Let Us Discover

Work- is the product of Fore and the component of displacement parallel to the force.

$$W = F \cdot d \cos\theta$$

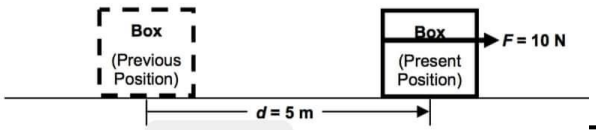
Where: **W**= work done, units are Joules **(J**), calorie (cal) and electron-volt (Ev)
F= force exerts on an object, unit in Newton (**N)**
θ= angle between force and displacement

Problem: A box was pushed with 10N force causing it to move by 5m to the same direction as the force. What is the work done?

Solution:

$W = F \cdot d \cos\theta$
$= (10\ N)\ (5\ m) \cos 0°$

The scenario can be imagined as follows:



W = 50 J

Energy- defined as the ability to do work. The unit is in Joules (J) just like work. **Mechanical Energy**- the energy possessed by a physical object due to its motion or state. Two types: Kinetic energy and potential energy.

Kinetic Energy – energy due to the motion of an object.

Potential energy- energy due to the state of object; state could mean the position of the object or the extent it was compressed or stretched.

Gravitational Potential Energy- energy due to height of location. The configuration is from the mass to the space.

$$U_{grav} = m\,g\,h$$

Where: U_{grav} = gravitational potential energy (J)

m = mass of object (kg)

g = magnitude of acceleration due to which is $9.8 m/s^2$

h = the change in the height of the object's location.

Problem: What is the Gravitational Potential energy of a 0.25kg box of face shield on the table 1.5m above the ground?

Given: m = 0.25kg, h=1.5m, g=$9.8 m/s^2$

Solution: $U_{grav} = m\,g\,h$

$= (0.25\text{ kg})\,(9.8\ m/s^2)\,(1.5\text{m})$

$U_{grav} = 3.675$ **J**

Elastic Potential Energy – energy due to stretching or compressing.

$$U_{spring} = \frac{1}{2}\,k\,x^2$$

Where: F_{spring} = force exerted by the spring

U_{spring} = elastic potential energy

k = spring constant

x = length of compression

Hooke's Law $F_{spring} = -kx$

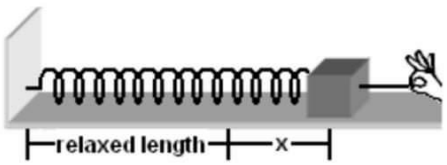
Problem: What is the Elastic potential energy if you apply 2N Force to a block attached to the free-end of the spring to keep the spring stretched from its relaxed length by 10mm if the spring constant is $\mathrm{k} = 2.5\mathrm{x}10^2\mathrm{N/m}$.

Given: F= 2N, X=1.5mm, $\mathrm{k} = 2.5\mathrm{x}10^2\mathrm{N/m}$.

Solution: $U_{spring} = \frac{1}{2}\,k\,x^2$

$= \frac{1}{2}\,(2.5x\ 10^2 N/m)(1.5x10^{-2}m)^2$

$U_{spring} = 0.028$ J



Law of Consevation of Energy – *"Energy cannot be created nor destroyed. It can only be transformed from one form to another, but the total amount of energy never changes."*

Total Mechanical Energy (TME)

- The sum of kinetic and potential energy.
- Constant unless energy was converted into something else other than mechanical energy, such as heat or light.

TME = K + U

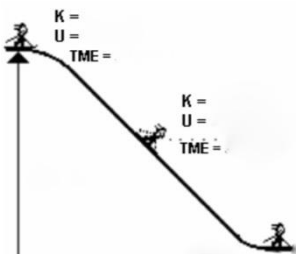
where: K= Kinetic Energy and

U= Potential Energy

Problem:

A 54.0 kg skater started sliding down from the top of a hill 55.0 m in height. What are the kinetic energy, potential energy and total mechanical energy (a) at the top of the hill? (b) at the bottom of the hill? (c) What are the kinetic energy, potential energy and total mechanical and total work done on the slope of the hill 20.0 m above the ground?

Illustration:



Solutions:

(a) On the top of the hill, the skater is just on the blink of sliding. Hence its velocity is zero.

K= $\frac{1}{2}\ m\ v^2$ U = mgh

= $\frac{1}{2}\ (54.0kg)\ (0)^2$ = (54.0 kg) (9.8 m/s^2)(55.0m)

k = 0 **U = 29,106 J**

TME= K + U = (0) + 29,106 J

TME= 29,106 J

(b) At the bottom of the hill, all potential energy ceases to exist because the height is zero.

U = mgh

= (54.0 kg) (9.8 m/s^2)(0)

U = 0

TME = 29,106 J

TME= K + U

29,106 J = K + 0

K= 29,106 J

(c) Along the slope 20.0 m above the ground, the total mechanical energy should remain the same. TME = 29,106J

To solve for Potential energy

U = mgh

= (54.0 kg) (9.8 m/s^2)(20.0 m)

= 10,584 J

To solve for kinetic energy

TME = k+U

K = TME- U

K = 29,106 J – 10,584 J

K = 18,522J

To solve for work. We may derived the change in Kinetic Energy, or the Negative Change in Potential energy.

W = ΔU = Ui – Uf

W= 29,106 J - 10,584 J

W = 18,522 J

W = ΔK = Ki – Kf

W = 18,522 J - 0

W = 18,522 J

Forms of energy:

- Electrical Energy – energy due to the movement of electrons, ex. Electricity and lightning.
- Radiant Energy – energy that is carried by electromagnetic waves, examples: visible light, x-rays, gamma rays and radio waves.
- Thermal or Heat Energy **–** energy due to motion of molecules.

- Sound Energy – produced when a force causes an object or substance to vibrate; energy is transferred through the substance in a longitudinal (compression / rarefaction) wave.
- Chemical Energy – energy stored in a chemical bonds of atoms and molecules, examples: biomass, petroleum, natural gas and propane.
- Nuclear Energy – energy stored in the nucleus of an atom. Holds the nucleus together. The energy can be released when the nuclei are combined or split apart.

Sources of Energy:

1. Non-renewable energy source
    - Energy sources that cannot be replenished.
    - Continuous consumption will eventually made the reservoir in Earth empty.
    - Examples are the fossil fuels such as natural gases, coal, petroleum, as well as uranium ore.
2. Renewable energy sources
    - Can be replenished in a short period of time.

    Examples are hydropower (water), solar, wind, geothermal, and biomass.

Power – the rate at which work is done.

$$P = \frac{W}{t} \quad \text{or} \quad P = F\,v$$

Where: P = power (Watts)
W = work (J)
F = magnitude of Force (N)
v = speed (m/s)
t = time (s)

Units of power: 1 watt = 1 Joule/second
1 horsepower = 750 watts

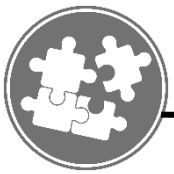
Problem:

Eddie jumps up 0.25m high with the force of 200N in 2 seconds. Find the Power he delivered?

Given: F=200N, t=2s, d = 0.25m

P= $\frac{W}{t}$

Solution: P= $\frac{(200\text{N})(0.25)}{(2\text{s})}$ = 25Watts



Let Us Try

Matching Type: Match Column A to Column B with the correct concept and principles. Write the letter of the correct answer on the space provided.

COLUMN A	COLUMN B
____1. It is the sum to Kinetic and Potential energy.	A. Power
____2. It is the product of Force and displacement.	B. Renewable Energy
____3. It is the ability to do work.	C. $\underline{U}_{spring}$
____4. It is the energy due to height of location.	D. $\underline{U}_{grav}$
____5. It is the energy due to stretching.	E. TME

____6. It is the product of Force and velocity
____7. What is the unit of TME
____8. What is the unit of of Force.
____9. What is the unit of Power
____10. It is an energy that can be replenished.

F. Joules
G. Energy
H. Work
I. Watts
J. Newton

Let Us Do

Fill in the blanks: Using your calculator, solve for the following problems and write your answer in the space provided.

	Formula:	Given	Implied Conditions	Required
1	W= Fd	F= 350 N, d= 5m, plain and same direction	~~Θ~~=?_____	W=?_____
2	U= mgh	m= 80kg, h= 20m	g=?_____	U= ?_____
3	P= Fv	m= 30kg, v= 35m/s	F=?_____	P= ?_____
4	P=W/t	m= 50 kg, d=10m, t=5s	W=?_____	P=?_____
5	U=mgh	U= 3500J, m=50kg	g=? _____	h=?_____
6	$U_{spring} = \frac{1}{2} k x^2$	U=67000K, x= $\mathrm{k} = 2.5\mathrm{x}10^2\mathrm{N/m}$		x=?_____

Let Us Apply

Problem Solving: Solve the problems and show your solution. You may follow the formula and steps illustrated above.

1. What is the Gravitational Potential energy of a hand sanitizer with a mass of 0.15kg that is mounted in the wall 1.2m above the ground?

2. What is the Elastic potential energy of a facemask ear garter if you apply 1.5N Force and stretched from its relaxed length by 5mm if the k constant is $\mathrm{k} = 2.5\mathrm{x}10^2\mathrm{N/m}$.

3. A biker weigh 60.0kg, biking at Kalatao diversion road started sliding down from the top of a hill 20.0 m in height. What are the kinetic energy, potential energy and total mechanical energy (a) at the top of the hill, (b) at the bottom of the hill, (c) What are the kinetic energy, potential energy and total mechanical and total work done on the slope of the hill 15.0 m above the ground?

4. Kelly pushed a table to mount properly her things to study her modules with 8N force causing it to move by 4m to the same direction of the force. What is the work done?

5. Find the power Zea delivered, if she jumps up 0.15m high with her weight of 150N in 1.5 seconds while practicing her tiktok dance steps.

Rubrics

Rubrics in solving Problems:

5 points – Correct and complete solution
4 points – 1 mistake with solution
3 points – 2 mistakes with solution
2 points - 3 mistakes with solution
1 point – wrong answer with solution
0 point – no answer at al

References

Serway & Jewett, *Physics for Scientists and Engineers with Modern Physics 7th Ed*
Chapter: 13 Pages 362-388
Halliday, D., Resnick R. & Walker, J., (1997), *Fundamentals of Physics (Fifth Ed).,* New York, John Wiley and Sons, Inc.
Henderson, Tom, (2004*), Work, Energy and Power, The Physics Classroom*, Retrieved June 14, 2006

SSLM Development Team

Writer: **Florgellette F. Garcia, MST**
Content Editor: **Jason A. Guanzon, MST**
LR Evaluator: **Samuel D. Rosal**
Illustrator:
Creative Arts Designer: **Reggie D. Galindez**
Education Program Supervisor: Science**: Edilbert A. Reyes**
Education Program Supervisor – Learning Resources: **Sally A. Palomo**
Curriculum Implementation Division Chief: **Juliet F. Lastimosa**
Asst. Schools Division Superintendent: **Carlos G. Susarno, Ph. D.**
Schools Division Superintendent: **Romelito G. Flores, CESO V**

Implied Conditions	Required
~~O~~= 0	W= 1750 J
g= 9.8 m/s^2	U= 15680 J
F= 294N	P= 10290 watts
W= 4900 J	P= 980 watts
g= 9.8 m/s^2	h= 7.14m
	x= 23.15m