**PENANG SANGAM HIGH SCHOOL**
**YEAR 12 PHYSICS**
**WEEK 16**

| **Strand** | ENERGY |
|---|---|
| Sub Strand | Work Power And Energy. |
| Content Learning Outcome | At the end of the lesson students should be able to<br>• Describe mechanical energy quantitatively as the sum of kinetic and potential energy |

**Lesson Notes**

## Energy

**Energy is the capacity to do work. Energy is a scalar quantity as it only has size and no direction. It is measured in Joules, J.**

### Forms of energy

Sound Energy- is produced when an object is made to vibrate. Sound energy travels out as waves in all directions. Sound needs a medium to travel through, such as air, water, wood, and even metal! Examples: Voices, whistles, horns and musical instruments.

Chemical Energy - is really a form of potential energy and is the energy stored in food, gasoline or chemical combinations.
Examples: Striking a match, combining vinegar and baking soda to form CO2 Gas.

Radiant Energy - is a combination of heat and light energy. Light energy, like sound energy, travels out in all directions in waves.
Examples: A light bulb, the glowing coils on a toaster, the sun, and even headlights on cars.

Electrical Energy - Energy produced by electrons moving through a substance is known as electrical energy. We mostly see electric energy in batteries

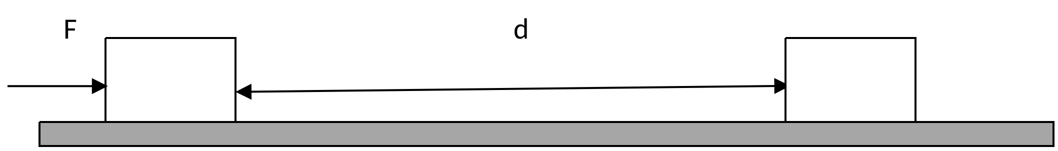
and from the outlets in our homes. Electrical energy lights our homes, run motors, and makers our TVs and radios work.
Examples: CD players, TVs and Video games.

Atomic Energy - is produced when you split atoms. A tremendous amount of energy is released when this happens.
Examples:Atomic bombs, nuclear power plants, nuclear submarines, and the sun.

Mechanical Energy – is possessed by a body due to its motion or due to its position. Mechanical energy can either be kinetic energy ( energy of motion) or potential energy ( stored energy
Examples: a rolling bicycle, moving gears, and running cars.

**Work done**

a. when the force is constant

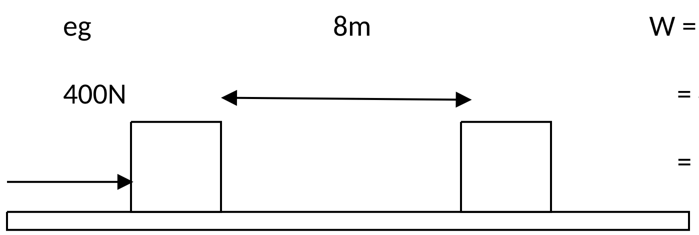



Work done by a force is given by the formula

W = F x d ( the force and the distance substituted must be in the same line )

Find the work done

eg



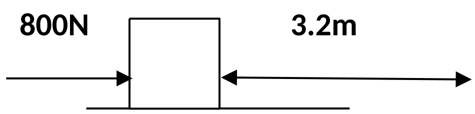

W = F x d

= 400 x 8

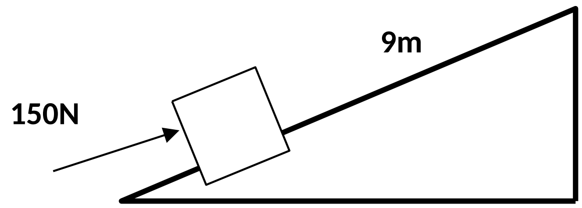
= 3200N

**Find the work done for the following**

**1.**




**2.**




**MECHANICAL ENERGY**

**Mechanical energy can either be kinetic energy or potential energy**

**KINETIC ENERGY -** due to motion or the objects velocity

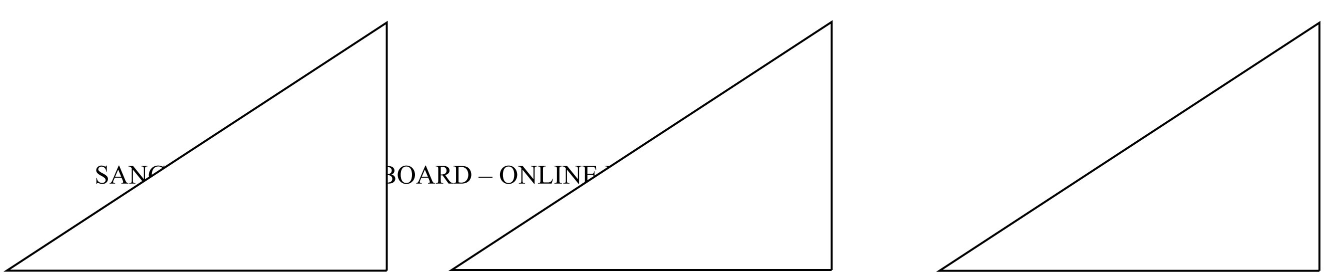
$E_K = ½ \, m \, v^2$ ( mass in kg, velocity in m/s and kinetic energy in joules )

Eg A 6kg mass is moving at 8m/s. Find its kinetic energy.

$$E_K = ½ \, m \, v^2$$
$$= ½ \, (6) \, (8)^2$$
$$= 192 \text{ J}$$

1. A ball of mass 0.4kg is kicked with a velocity of 12m/s. find its kinetic energy

2. The velocity of a 40kg cart changes from 5m/s to 9m/s. Find the gain in kinetic energy.



3. A 7kg mass has a kinetic energy of 300J. Find its velocity.

**POTENTIAL ENERGY**

This means the energy is stored and can be used to do work at a later stage.

The two types of potential energy we will study are

a. Potential energy due to an objects position in a planets gravitational field
b. Potential energy due to the shape of an object eg in stretched rubber band, bent stick, extended or compressed spring.
a. Potential energy due to an objects position in a planets gravitational field and this is given by

$E_P = m\ g\ h$ ( mass in kg, g is the size of gravity in $m/s^2$ and h is the height in m )

On earth the size of gravity is $10m/s^2$

Eg A 7kg mass is placed at a height of 12m find the potential energy it has.

$E_P = m\ g\ h$

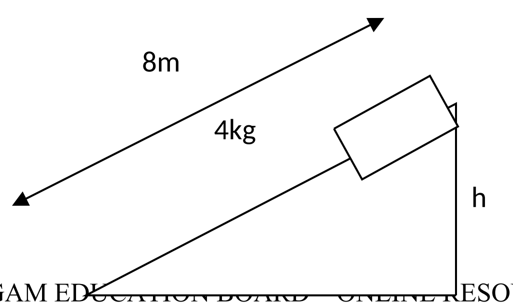
$= 7\ (10\ )\ (12)$

$= 840J$

1. A bird of mass 2.5kg is at a height of 20m above the ground. Find its potential energy.

2. A 9kg mass has a potential energy of 600J. find the height it is placed at.

3. A 4kg mass is placed as shown



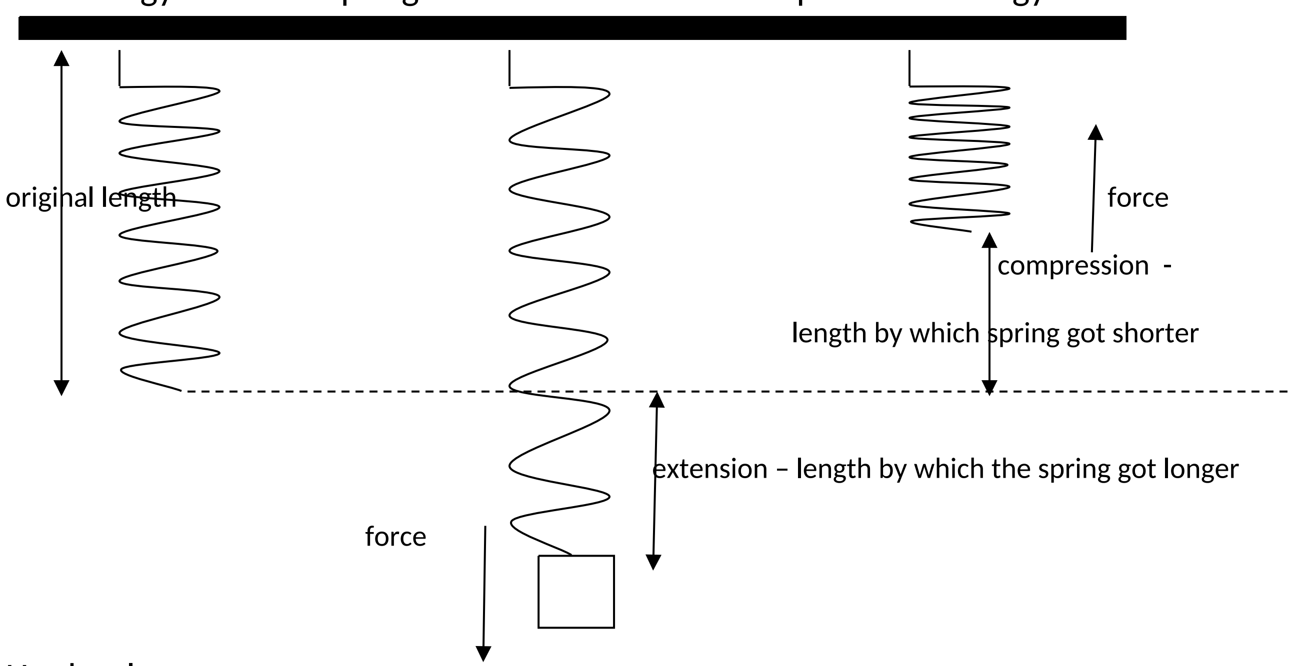
3m

Find its potential energy

Potential energy due to the shape of an object eg in stretched rubber band, bent stick, extended or compressed spring.

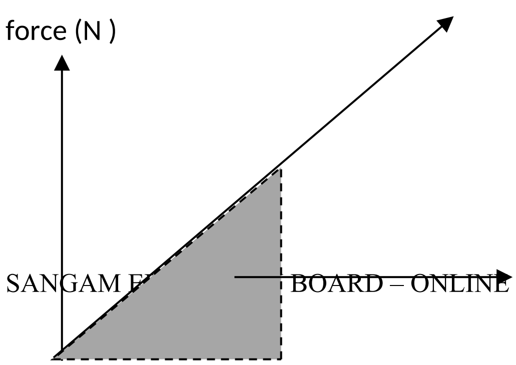
**Springs**

The energy stored in springs is in the form of elastic potential energy.




Hookes law

For a spring the force and extension (or compression ) are directly proportional



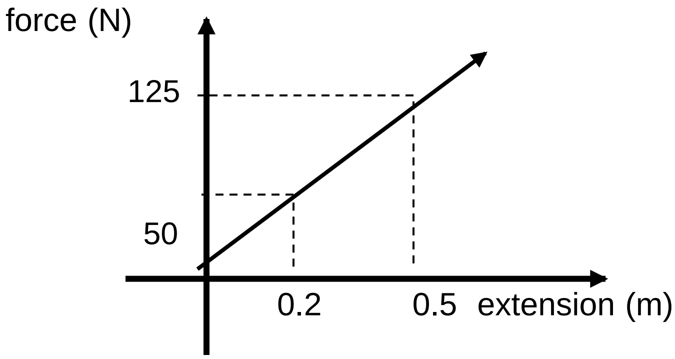

slope gives the spring constant, k in N/m area gives the workdone or energy stored in the spring

extension (m )

formulas for springs

| |
|---|
| F = kx |
| F is the force, k is the spring constant or stiffness of the spring in N/m |
| x is either the extension or compression in m |
| the energy stored or the work done in a spring is $E_S = ½ k x^2$ |

eg Given below is a force/ extension graph of a spring




i. Find the spring constant of the spring.

Either a. find the slope or use F = kx

50 = k (0.2)

K= 50/0.2

= 250N/m

ii. Find the force required to extend spring by 0.8m

F = kx

= (250 )(0.8 )

= 200N

iii. Find the energy stored in the spring when it is extended by 0.2m

**either find the area under the graph uptil 0.2m or use $E_S = ½ k x^2$**

A = ½ b h or **$E_S = ½ k x^2$**

$= \frac{1}{2}(0.2)(50)$ $\qquad\qquad$ $= \frac{1}{2}(250)(0.2)^2$

$= 5J$ $\qquad\qquad$ $= 5J$

**Total energy $E_T$ – is the sum of all the forms of energy a object has. Energy is a scalar quantity so just add the size.**

**Conservation of energy**

Energy can not be created nor can it be destroyed, however its form can change.

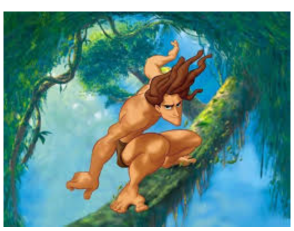
The total energy $E_T$ of a system always remains the same.

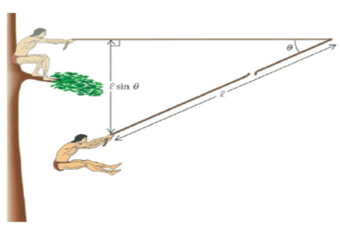
| WORD | Forms of energy |
|---|---|
| Velocity, speed | Kinetic, $E_K$ |
| Height | Potential , $E_P$ |
| Extension or compression | Potential , $E_S$ |

**Energy is only stored in the spring if there is a compression or extension. There is no energy stored in the spring if the spring is at its original length.**

Always write expression of total energy first.

Tarzan sits on a branch that is 40m above the ground. He swings down as shown.





If Tarzans mass is 95kg

a. Find his total energy when he sits on the branch

$$E_T = E_P$$

$$E_T = mgh$$

$$= (95)(10)(40)$$

$= 38{,}000J$

b. Find his total energy at the bottom of the swing

38,000J ( total energy remains the same )

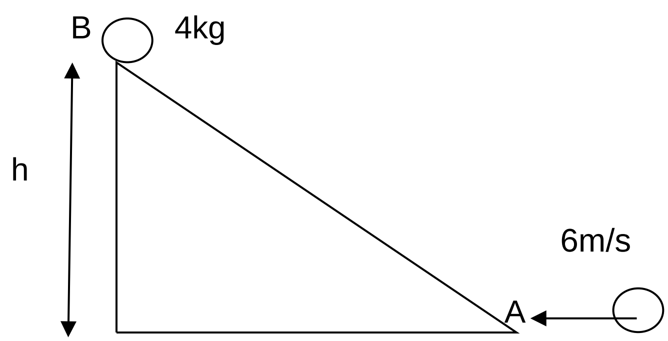
c. His velocity at the bottom of the swing

$$E_T = E_k$$

$$E_T = \frac{1}{2}mv^2$$

38 000 = ½ (95 )$v^2$ and solve for v

2. A 4kg mass rolls towards a incline plane as shown.

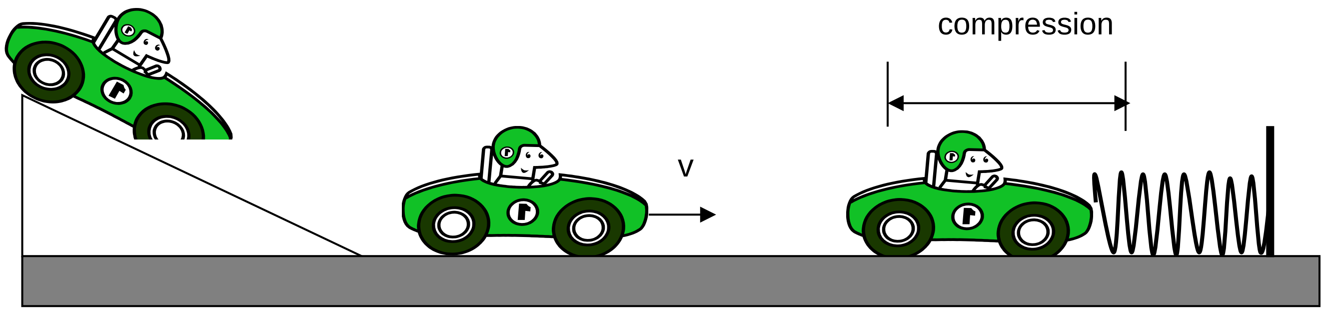



i. Find the total energy at A

ii. Find the total energy at B

iii. Find the height reached at B

2.A toy car of mass 0.5kg rolls down from a ramp of height 4m as shown. It then comes in contact with a spring of spring constant 300N/m. it compresses the spring and becomes stationary.




i. Find the total energy of the toy car when it is at the top of the ramp.

ii. Find the velocity of the toy car at the bottom of the ramp.

iii. Find the compression in the spring as the toy car compresses the spring.