# STRAND 2

# ENERGY

**LEARNING OUTCOMES:**

At the end of this topic students should be able to:

- Calculate work done
- Differentiate between Potential and kinetic energy
- Apply Hook's Law
- Calculate specific heat capacity
- Describe energy transformations
- Understand and calculate variables using Boyles Law, Charles Law and Ideal Gas Law

## SUBSTRAND 2.1 ENERGY TRANSFORMATION

**LESSON 51**
**LO: DESCRIBE MECHANICAL ENERGY QUANTITATIVELY AS SUM OF K.E AND P.E**

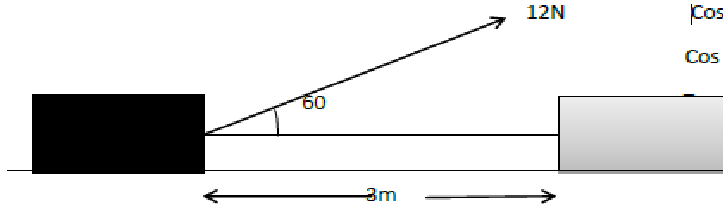
1. **Work done (W)**
   - Measured in Joules (J) / (Nm)
   - Energy involved in moving an object from one point to another.
   - process that transfers energy from one form to another.
   - Amount of work done depends on the force and distance involved.
   - Is a scalar quantity (no direction)

Work = force × distance (force is parallel to parallel travel)
Joules/Newton meter) (Newton) (Meter)

$$W = F \times d$$

**Example 1**

For the diagram shown, calculate the work done in moving the body horizontal distance in 3m.




Cos $\theta$ = A/H
Cos 60 = $F_x$/12
= 12 cos 60

Work done = Force x distance.
= $F_x$ x d
= 12cos 60 x 3
= **18 Joules.**

2. **Gravitational Potential Energy ($E_p$)**
   - Measured in Joules (J)
   - energy stored at height against gravity.

Gravitational Potential Energy = mass x gravity x height

$$P.E. = m\,g\,h$$

**EXAMPLE**

Kevin has 5 kg ball which he throws up 50 m high. The ball stuck at the top in a roof hanger. Calculate the potential energy.

P.E = mgh = 5 x 10 x 50 = 2500J

## 3. Kinetic Energy ($E_k$)

- Energy possessed by a body moving with a velocity, v.

Kinetic Energy = ½ x mass x $velocity^2$

K.E. = ½ m $v^2$

**EXAMPLE**

Calculate the K.E of a ball thrown at 5ms$^{-1}$ having a mass of 5 kg.

K.E =0.5 x m x $v^2$ = 0.5 x 5 x ($5^2$)= 62.5 J

**2016**

The kinetic energy is energy possessed by a moving object.

(i) Which quantity is directly proportional to mass of the moving object? **(1 mark)**

(ii) What shape would the graph of mass versus velocity be if kinetic energy is constant? **(1 mark)**

## 4. Power (P)

- rate at which work is done (is a measure of how fast energy is transferred)
- Measured in Watts (W)/(J/s)

$$\text{Power} = \frac{\text{Work done}}{\text{Time}}$$

where: workdone (J) and Time (s)

**EXAMPLE**

Calculate the power of a 1500 kg automobile car which accelerates at 10 ms$^{-2}$ having travelled a distance of 0.5m in 8 seconds.

$$P = \frac{WD}{T} = \frac{F\ x\ D}{T} = \frac{ma\ x\ D}{T} = \frac{1500x10x0.5}{8} = 937.5W/937.5\,Js^{-1}$$

**LESSON 52-53**

**EXP 5 POTENTIAL ENERGY OF A BALL**

**LESSON 54**

**LO: DETERMINE ENERGY IN SPRINGS**

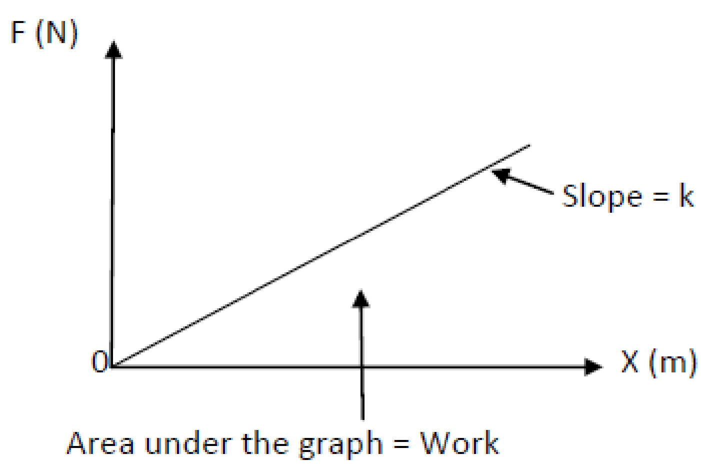
**HOOKE'S LAW**

– states that " Force applied is directly proportional to extension in an ideal spring."
$( F \alpha x )$

$$\boldsymbol{F = k\,x}$$

F: Force (N) x: extension (m) k: spring constant (N/m)

- The area under Force vs Extension graph gives elastic potential energy (work).
- A graph of extension force against extension of spring shows a linear relationship.




1. **Elastic Potential Energy** **($PE_{elastic}$)**
   - Is the energy stored in springs and can be released later.

$$\text{Elastic potential energy} = \frac{1}{2}\text{ x spring constant x } (\textit{compression or extension})^2$$

$$\boxed{\text{Elastic P.E.} = \frac{1}{2}kx^2}$$

**Example**

A mass of 0.5kg hung from the end of a spring extends the spring by 25cm.

(a) Calculate the spring constant

$F = mg$
$= (0.5)(10)$
$= 5N$

$F = k\,x$
$mg = k\,(0.25)$ (25cm = 0.25m)
$(0.5)(10) = (0.25)\,k$
$k = \frac{5}{0.25}$
$k = 20N/m$

(b) How much elastic potential energy is stored in the spring?

Elastic P.E. $= \frac{1}{2} k\,x^2$
$= \frac{1}{2}(20)(0.25^2)$
$= 0.63\ J$

**2020**

Mechanical energy is best defined as the sum of all

A. Kinetic energy and potential energy
B. Kinetic energy and chemical energy
C. Thermal and chemical energy
D. Chemical energy and potential energy

**2019**

A golf ball is struck and it follows a parabolic trajectory. Neglecting air resistance, which of the following statements about the ball's trajectory is **correct**?

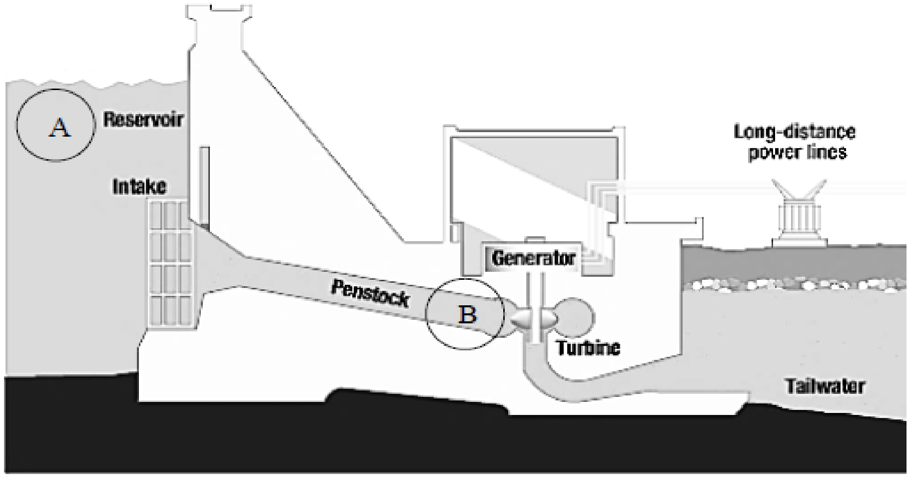
A. The total energy of the ball remains same.
B. The horizontal velocity at maximum height is zero.
C. The higher the ball goes the greater its kinetic energy.
D. At the maximum height kinetic energy will be maximum.

When an object is taken to a high altitude, its potential energy

A. increases.
B. decreases.
C. remains same.
D. becomes zero.

**2018**

A hydro-electric power station uses a water reservoir to generate electrical energy. The mass of water flowing through the turbines every second is 5000 $kgs^{-1}$.

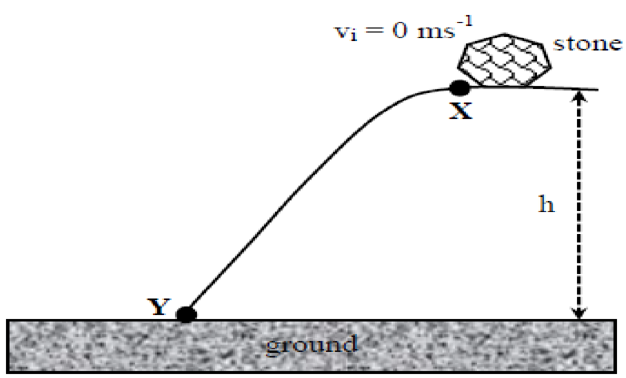



Source: https://www.tva.gov/Energy/Our-Power-System/Hydroelectric

(i) State the form of energy at point A and B on the diagram. **(1 mark)**

**2017**

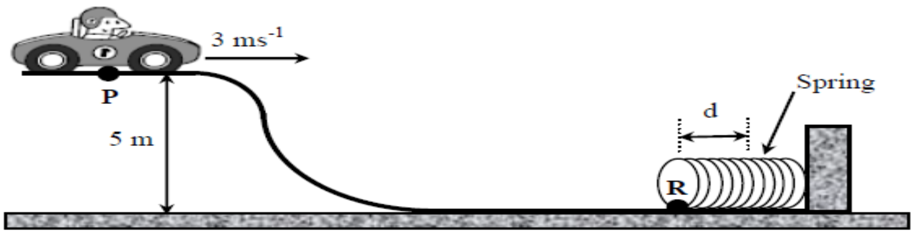
The diagram given below shows a stone at rest on the top of a hill, with two points labelled **X** and **Y**. Use this information to answer **Question 7**.




Which of the following **best** describes the energy transformation if the stone rolls from point **X** to point **Y**?

A. Kinetic energy to heat energy
B. Heat energy to potential energy
C. Potential energy to kinetic energy
D. Kinetic energy to potential energy

The diagram given below shows a 0.8 kg toy car being released from point **P** at a height of 5 m where its velocity is 3 $ms^{-1}$. A spring with spring constant 100 $Nm^{-1}$ is used to slow the toy car and to stop it at distance, d, from point **R**. Assume the track is frictionless.




Calculate the:

(i) potential energy at **P**. **(1 mark)**

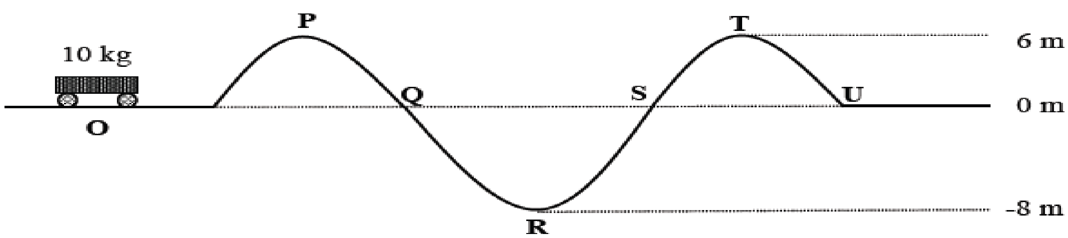
(ii) kinetic energy at **P**. **(1 mark)**

(iii) total energy at **R**. **(1 mark)**

(iv) distance, **d**, the spring is compressed. **(2 marks)**

**2016**

The diagram below shows a 10 kg cart placed on track at **O** and is given enough energy to enable it to get over hills **P** and **T** and return to a same level track at **U**. Assume the track from **O** to **U** is frictionless.



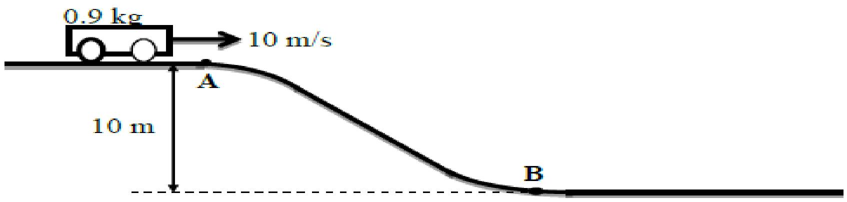

(i) How much kinetic energy should be given to the cart? **(1 mark)**

(ii) What is the cart's total kinetic energy at **R**? **(2 marks)**

(iii) What is the speed of the cart at **U**? **(1 mark)**

**2015**

A trolley of mass 0.9 kg moves at 10 m/s until it comes to a downward slope.




(i) Calculate the potential energy of the trolley at point A. **(1 mark)**

(ii) Calculate the kinetic energy of the trolley at point A. **(1 mark)**

(iii) What is the potential energy of the trolley at point B? **(1 mark)**

(iv) Calculate the kinetic energy of the trolley at point B. **(1 mark)**

(v) Calculate the velocity of the trolley at point B. **(1 mark)**

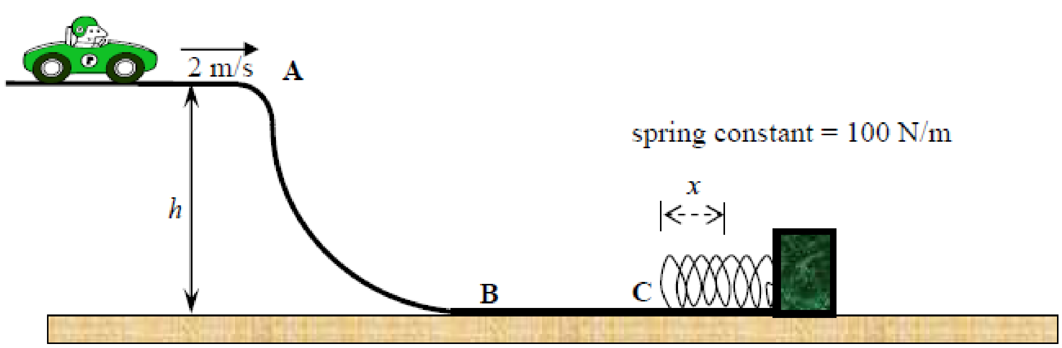
**2013**

Hooke's Law states that "the extension of a spring is directly proportional to the force applied." The **area** under the Force versus Extension graph gives the

A. kinetic energy.
B. spring constant.
C. total distance travelled.
D. elastic potential energy.

**2012**

The diagram below shows a 0.5 kg toy car being released from point **A** where its velocity is 2 m/s. It moves down a frictionless track to **B** where its velocity is 10 m/s.



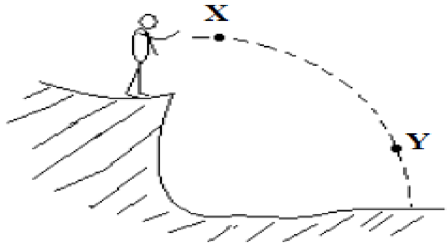

(i) Calculate the total energy at **B**. **(1 mark)**

(ii) Find the height, *h*, from which the toy car was released. **(1 mark)**

(iii) A spring with spring constant 100 N/m is used to slow the toy car and stop it some distance *x* from point C. Calculate this distance *x*. **(1 mark)**

**2011**

A person standing at the top of a cliff throws a stone as shown in the diagram below.

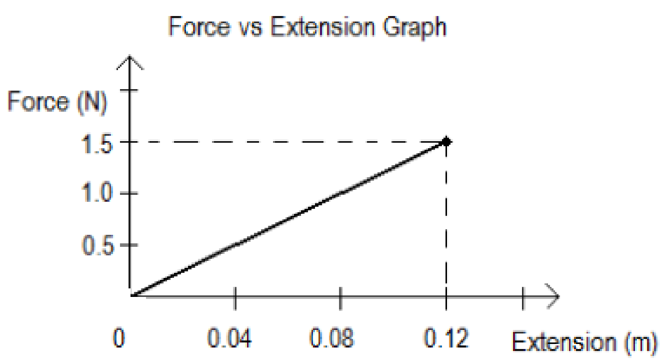



Which form of energy does the stone have at **X** and **Y**?

| | **Energy at X** | **Energy at Y** |
|---|---|---|
| A. | Gravitational only | Kinetic only |
| B. | Kinetic only | Gravitational only |
| C. | Gravitational only | Gravitational and Kinetic |
| D. | Gravitational and Kinetic | Gravitational and Kinetic |

**2010**

In an experiment on **Hooke's Law**, masses were attached to a light helical spring. The graph below shows the result of the experiment.

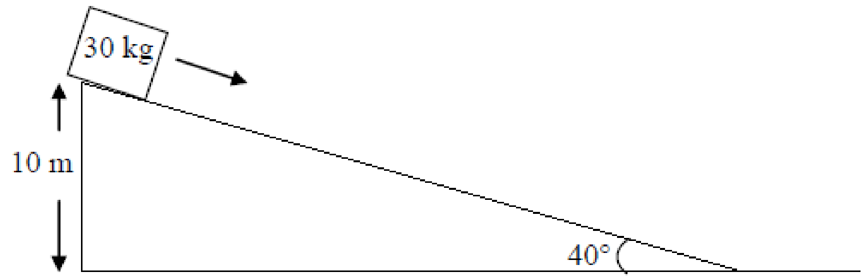



(i) Calculate the value of the spring constant. **(1 mark)**

(ii) How much energy is stored in the spring when it is extended by 0.12 m? **(1 mark)**

## 2009

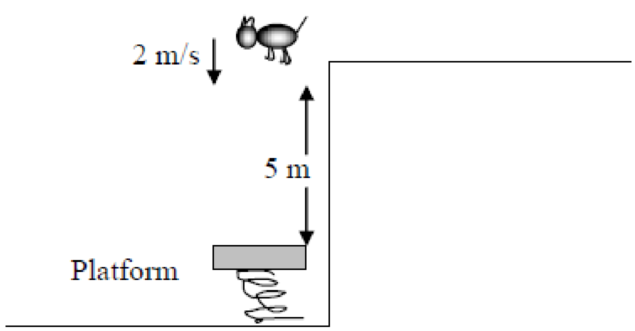
A 30 kg box slides down a frictionless slope as shown below. The box starts from rest and slides down a vertical distance of 10 m.




The work done by the box upon reaching the bottom of the slope would be

A. 230 J
B. 300 J
C. 1 500 J
D. 3 000 J

A cat of mass 4 kg jumps off a cliff with an initial vertical velocity of 2 m/s onto a platform situated 5 m below the cliff as shown below.




After touching the platform, the cat is bounced into the air to a vertical height of 4 m.

(i) Calculate the kinetic energy of the cat as it hits the platform. **(2 marks)**

(ii) The spring attached to the platform is compressed as the cat hits the platform. Determine the compression of the spring if its spring constant is 200 N/m. **(2 marks)**

(iii) How much energy is lost as the cat bounces off the platform ? **(2 marks)**

**2008**

A spring which obeys Hooke's Law is extended by 20 mm by a force of 120 N. The energy stored in this stretched spring, in Joules is

A. 1.2
B. 2.4
C. 240
D. 1200

**LESSON 55**

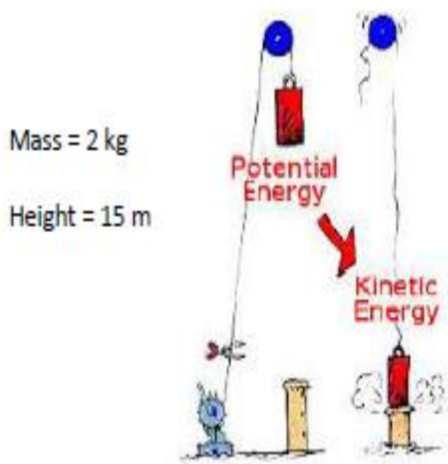
**LO: APPLY LAW OF CONSERVATION OF ENERGY TO SOLVE PROBLEM**

**LAW OF CONSERVATION OF ENERGY**
"Energy is neither created nor destroyed, it only transfers from one form to another."

**EXAMPLE (1. FALLING MASS)**

Example 7

A body is dropped from a height of 15m.What is its velocity as it reaches the ground.



Potential Energy = Kinetic Energy

P.E = K.E

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

2gh = $v^2$

v = $\sqrt{2gh}$

v = $\sqrt{2x10x15}$

v = $\sqrt{300}$

**v = 17.32m/s**

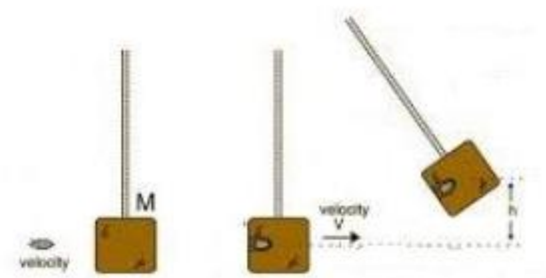
## EXAMPLE (2. PENDULUM)

**Example 8**

A bullet of mass 30g is fired with a speed of 400m/s in to a sandbag. The sandbag has a mass of 10kg and is suspended by two ropes so that it can swing. What is the maximum vertical height, h, that the sandbag rises as it recoils with the bullet embedded inside?

Mass of bullet = 30g

u = 400 m/s




Momentum of the bullet = Momentum of the bullet

Before collision after collision

$m_1u_1 + m_2u_2 = ( m_1 + m_2)$ v

(0.03 x 400) + (10 x 0) = (0.03 + 10) v

12 = 10.03v

v = $\frac{12}{10.03}$

**v = 1.2m/s**

Loss in kinetic energy = gain in gravitational potential energy

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

$$\frac{1}{2} \times (10.03) \times 1.2^2 = 10.03 \times 10 \times h$$

$$h = \frac{7.22}{100}$$

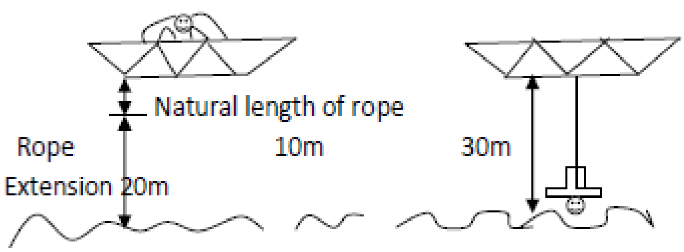
$$h = \underline{0.072m}$$

I.e. the sandbag raises a vertical height of 7.2cm.

## EXAMPLE (3. SKY DIVING)

**Example 9**

A bunging jumper of mass 75kg jumps off a bridge over a river. The spring constant of the rubber bands that make up the bunging rope is adjusted so that the jumper head just touches the river at maximum stretch (30m) before springing back up in to the air. If the natural length of the rope is 10m, calculate the rope spring constant. Assume no energy is lost due to friction




$$P.E = mgh$$

$$= 75 \times 10 \times 30 \quad = \quad 22500\ J$$

At the river level, the ropes extension from its natural length is:

x = Stretched length – natural length

x = 30 – 10

x = 20m

Potential Energy = Elastic Potential Energy

22500 J = ½ k $(x^2)$

22500 = ½ k $(20^2)$

22500 = ½ k (400)

22500 = 200 k

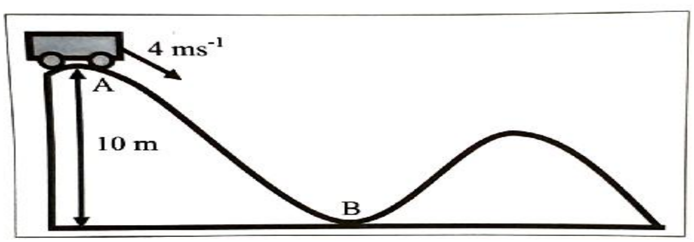
k = $\frac{22500}{200}$

k = 112.5N/m

**k = <u>110 N/m</u>** (2 significant figures)

**<u>2020</u>**

A cart of mass 200 kg is at a height of 10 m at point A. It rolls down the slope with a velocity of 4 $ms^{-1}$.




Calculate the:

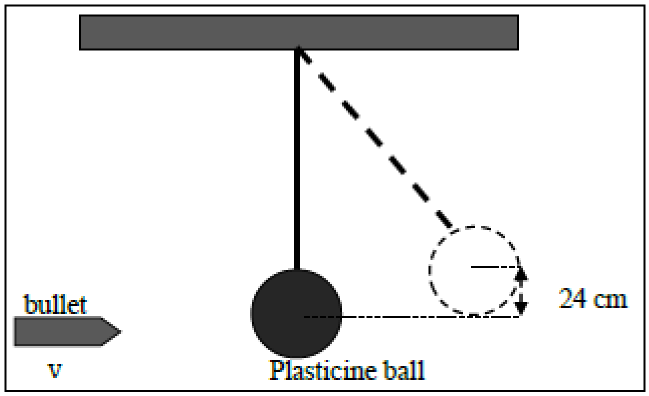
(i) potential energy of the trolley at point A. **(1 mark)**

(ii) mechanical energy of the trolley at point A. **(2 marks)**

(iii) kinetic energy of the trolley at point B. **(1 mark)**

**2020 Sample**

In an experiment to measure the speed of a bullet, the bullet was fired into a plasticine ball of mass 0.38 kg, suspended from a rigid support by a light thread. The impact speed of the bullet is v, while its mass is $5.2 \times 10^{-3}$ kg . The bullet embeds itself in the plasticine ball after impact, which causes it to rise to a height of 24 cm.



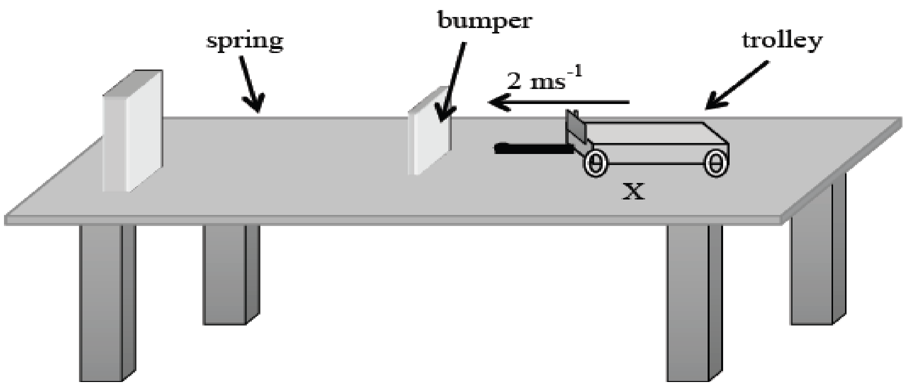

(i) Calculate the potential energy gained by the plasticine ball. **(1 mark)**

(ii) Calculate the impact speed, v, of the bullet. **(2 marks)**

(iii) Identify the important law that was verified in this set-up. **(1 mark)**

**2019**

A 600 g trolley, at position X, is moving along a frictionless table surface at a speed of 2 $ms^{-1}$. It collides with the bumper, compressing the spring, and then rebounds. The spring has a spring constant of 200 $Nm^{-1}$ .




Calculate the

(i) kinetic energy of the trolley at position X. **(1 mark)**

(ii) distance the spring compresses when the cart collides with the bumper before it rebounds. **(2 marks)**

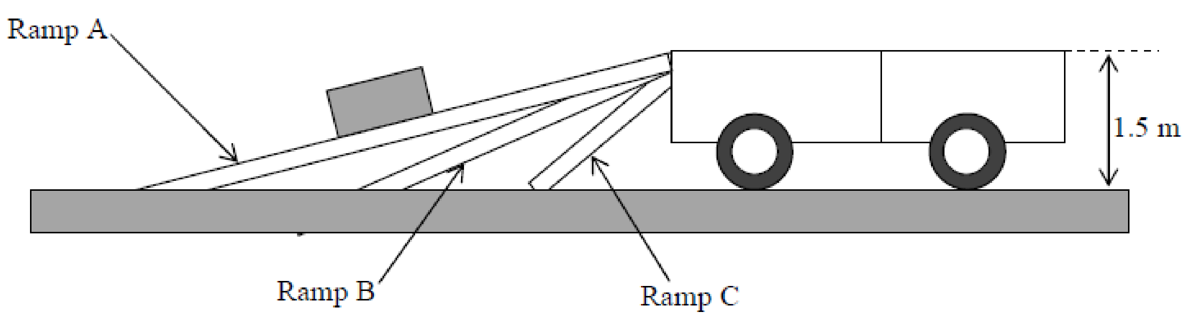
**2015/ 2013**

The **Law of Conservation of Energy** states that

A. for a body at rest, total mechanical energy is zero.
B. for a moving body, work done equals kinetic energy.
C. energy before a collision is more than the energy after a collision.
D. energy is neither created nor destroyed it only changes its form.

**2013**

The diagram below shows options for an inclined plane (ramp) to be used to lift a heavy mass onto a truck.

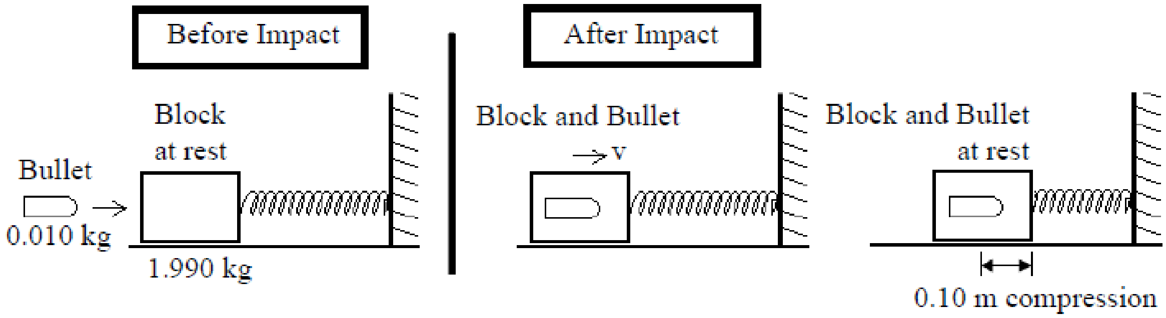



(i) Of the three options, which ramp, A, B or C would use the least amount of force? Give a reason for your answer. **(1 mark)**

(ii) Given that Ramp B has an angle of incline of 30° and the mass to be lifted is 45 kg, disregarding friction, calculate the amount of work done in lifting the mass to the top of the truck. **(1 mark)**

**2011**

c) In the diagram below, a bullet of mass 0.010 kg strikes and embeds itself in a block which has a spring attached to it. The mass of the block is 1.990 kg and is at rest on a frictionless horizontal surface. The spring has a spring constant of 200 N/m. After being hit by the bullet, the block compresses the spring by 0.10 m.



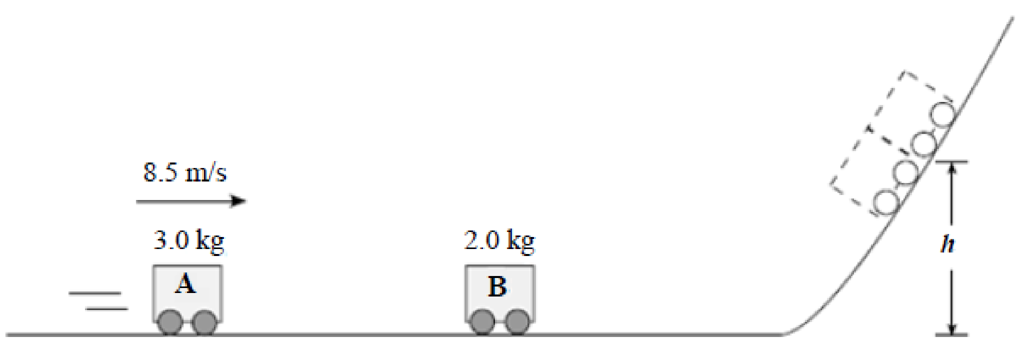

(i) Calculate the elastic potential energy stored in the spring by the block and bullet after impact. **(1 mark)**

(ii) Use the principle of conservation of energy to find the speed, v, of the block and bullet immediately after impact, before they compress the spring. **(2 marks)**

(iii) Find the speed of the bullet just before it hits the block. **(2 marks)**

**2010**

A 3.0 kg car, **A** travelling at 8.5 m/s on a frictionless track collides and sticks on to a stationary 2.0 kg car **B**.




(i) Calculate the momentum of car **A** before the collision. **(1 mark)**

(ii) Calculate the combined velocity after the collision. **(1 mark)**

(iii) Calculate the height, ***h*** the combined cars will reach after the collision. **(2 marks)**

**LESSON 56**

**LO: CALCULATE SPECIFIC HEAT**

**Heat Energy**

I. **Temperature , (t) [ $^{0}$C ]** – is the degrees of hotness of a body i.e. is a measure of average K.E of the particles.

**Example 3**

| 1kg water at 50°C | 10kg water at 10°C |
|---|---|
| Higher Temperature | Lower Temperature but more heat energy because it has more particles |

II. **Specific heat Capacity, (c)**

– amount of energy needed to raise the temperature of 1 kg of a substance by $1^{0}$ C.

- Unit:

$$\frac{J}{kg\,^{o}C}$$

Eg.

Specific heat capacity of water = 4200 Joules/kg°C .e.i. it requires 4200 Joules of energy to raise the temperature of 1kg of water by 1°C.

$$Specific\ heat\ capacity\,(c) = \frac{Energy\ either\ absorbed\ or\ liberated\,(Q)}{Mass\,(m) \times change\ in\ temperature\ (\Delta T)}$$

- If same quantity of heat is supplied to equal masses of different substances, different temperature changes occur. The difference in bodies is accounted by specific heat capacity.

Water 10°C + 10 Joules → 12°C

Metal 10°C + 10 Joules → 20°C

III. **<u>Heat Energy</u> , (H / Q)** – is the total amount of energy contained by all particles of the body.

$$\text{Energy } (Q) = \text{Specific heat capacity } (c) \times \text{Mass } (m) \times \text{ change in temperature } (\Delta T)$$

$$Q = cm\Delta T$$

heat added · specific heat · mass · change in temperature

$$\Delta T = T_f - T_i$$

**Example 5**

How much energy is required to heat 100gm of water from 10°C to 15°C

m = 100gm, c = 4200 J/kg°C, Δt = 15°C - 10°C

= 0.1kg = 5°C

Q = mcΔt = (0.1) x (4200) x (5) = <u>2100 J</u>

## 2020 Sample

The type of energy involved to heat 1 kg of water at 10 °C to 50 °C is

A. specific latent heat.
B. latent heat of fusion.
C. specific heat capacity.
D. latent heat of vaporisation.

## 2019

A piece of copper with a mass of 0.5 kg is heated from 20 °C to 150 °C. The specific heat capacity of copper is 380 $Jkg^{-1}{}^{\circ}C^{-1}$. Calculate the quantity of heat absorbed by the piece of copper.

## 2016

A steel bearing ball with a mass of 0.012 kg requires 132 J of energy when heated from 12°C to 28°C.

Calculate the specific heat capacity of the steel ball. **(2 marks)**

**2017**

A 0.4 kg iron block with specific heat capacity of 450 J $kg^{-1}$ $°C^{-1}$ is heated from 22°C to 52°C.

(i) Determine the change in temperature of the iron block. **(1 mark)**

(ii) Calculate the amount of heat absorbed by the iron block. **(1 mark)**

**2014**

A saucepan of mass 0.7 kg containing 0.5 kg of water at 20 °C is heated. It takes 5 minutes before the water starts to boil. Given that the specific heat capacity of water is 4 200 J/kg°C and the specific heat capacity of the saucepan material is 600 J/kg°C, calculate the heat energy absorbed by both the water and the saucepan. **(2 marks)**

**2013**

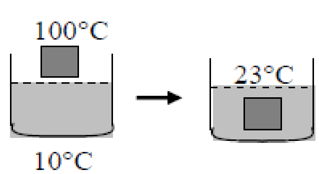
A student pours 0.20 kg of soup into a ceramic bowl having a mass of 0.40 kg. The initial temperature of the bowl is 20°C and the initial temperature of the soup is 50°C. After a while, both the bowl and the soup have a temperature of 40°C. The specific heat capacity of the soup is 4328 $Jkg^{-1}°C^{-1}$. Assume no heat is lost to the surrounding.

(i) Calculate the heat energy lost by the soup. **(1½ marks)**

(ii) Calculate the **specific heat capacity** of the ceramic material from which the bowl is made. **(1½ marks)**

**2012**

A piece of aluminium of mass 0.400 kg at 100°C is lowered into 0.500 kg of water at 10°C. The resulting temperature of the mixture is 23°C. Assume that there are no heat losses. Specific heat capacity of water is 4 200 J $kg^{-1}$ $°C^{-1}$



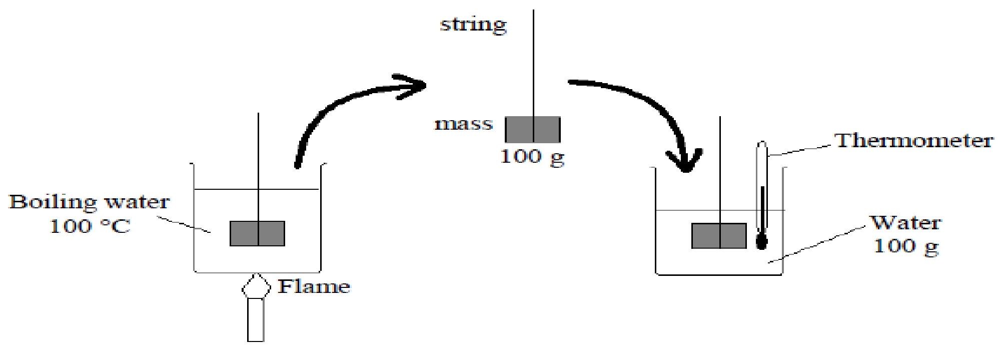

Calculate the following:

(i) heat gained by the water **(1 mark)**

(ii) specific heat capacity of aluminium **(1 mark)**

**2011**

In a Form 6 Physics experiment, a 100 g piece of metal is placed in boiling water at 100 °C for about 5 minutes. It is taken out and dropped into 100 g of water at 20 °C. The maximum final temperature of the mixture is 26.6 °C. The specific heat capacity of water is 4.2 J/g°C




Calculate the specific heat capacity of the metal. **(2 marks)**

**2010**

A kettle has a power rating of 3 kW. If 1.5 kg of water at 5 °C is put into the kettle and heated to boil at 100 °C:

(i) How much energy is needed to boil the kettle? (Assuming no heat is lost.) **(1 mark)**

(ii) How long will the kettle take to boil? **(1 mark)**

[specific heat capacity for water is 4 200 J/kg °C]

**2009**

A small metal block of mass 74 g is heated in an oven to 90° C. It is then taken from the oven and immediately put in a calorimeter, which is insulated to prevent heat losses. The calorimeter contains 300 g of water at 10° C. The heat capacity of the calorimeter is negligible and the final temperature is 14° C. Calculate the specific heat capacity of the metal block.
(Specific heat capacity of water is 4 200 J/°C/kg) **(3 marks)**

**2008**

An electric jug connected to 240V AC, raises the temperature of 500g of water from 27° C to 67° C in 3 minutes. (The specific heat capacity of water is 4200 J/kg °C.)

(i) How much heat energy is supplied to the water ? **(2 marks)**

(ii) Determine the power output of the electric jug. **(2 marks)**

IV. **Latent Heat, L** – is the amount of energy needed to change the state of 1kg of substance without changing its temperature.

$$Q = m\,L$$

Remember that there is no temperature change during the changes of state, and that the energy absorbed or liberated is therefore Potential Energy.

V. **Latent Heat of Fusion $L_f$** – is the amount of energy required to change the state from solid to liquid without change in temperature.

$$Q = m\,L_f$$

**Example**

Latent heat of fusion of ice = 336000 Joules/kg i.e. it requires 336000 Joules of energy to melt 1kg of ice.

VI. **Latent Heat of Vapourisation $L_V$** – is the amount of energy required to change the state from liquid to gas without change in temperature.

$$Q = m\,L_v$$

**Example**

Find the amount of energy released when 1gm of steam at 100℃ condenses and cools to 20℃.

Energy = steam $\longrightarrow$ water + water cools

At 100℃ 100 ℃ $\longrightarrow$ 20℃

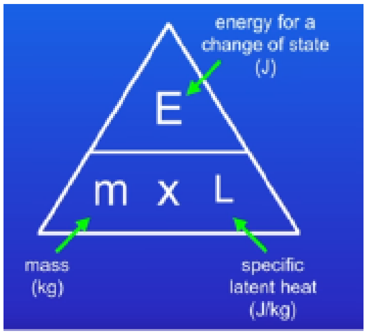
Energy = m L + mcΔt

Energy = (0.001x250000) + (0.001x4200x80)

Energy = 2250 + 336

= **<u>2586 Joules</u>**

## Specific Latent Heat




Specific Latent Heat: Energy needed to change the state of 1 kg of a substance

Specific Latent Heat of Fusion: Energy needed to melt 1 kg of a substance

Specific Latent Heat of Vaporisation: Energy needed to boil and evaporate 1 kg of a substance

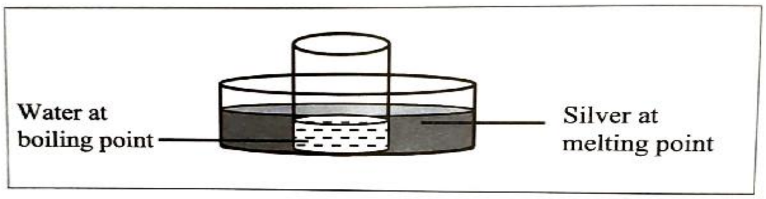
**<u>ACTIVITY</u>**

**<u>2020</u>**

Moana decides to use the heat energy from melted silver to evaporate water which is at its boiling point. She places a beaker of boiling water in melted silver as shown below.

**Use:**

Latent heat of fusion of silver as 88000 J $kg^{-1}$
Latent heat of vaporisation of water as 2260000 J $kg^{-1}$




Calculate the mass of water that could be evaporated from its boiling point, with the energy from 800 g of silver from its melting point. **(2 marks)**

**2020 Sample**

Ammonia is vaporised in order to freeze an ice rink. Raina uses heat from water to vaporise 1 g of ammonia.

Assuming this heat is taken from water at 0 °C, find the mass of water frozen for every gram of ammonia vaporised. **(2 marks)**

| |
|---|
| Specific latent heat of vaporisation of ammonia = $1.34 \times 10^6$ J/kg |
| Specific latent heat of fusion of ice = $3.34 \times 10^5$ J/kg |

**2019**

The name given to the amount of energy needed to turn 1 kg of water at 100 °C into steam at 100 °C is

A. specific latent heat.
B. latent heat of fusion.
C. specific heat capacity.
D. latent heat of vapourisation.

**2010**

What is the name given to the amount of energy needed to turn 1 kg of water at 100 °C into steam?

A. specific latent heat
B. specific heat capacity
C. latent heat of fusion
D. latent heat of vapourisation

**2018**

Sera placed 200 g of dry ice in a bucket and left it near the window. She returned after 5 days to find nothing was left in the bucket. Assuming that all ice had melted and evaporated over the 5 days, determine how much energy was used by the ice to completely evaporate.

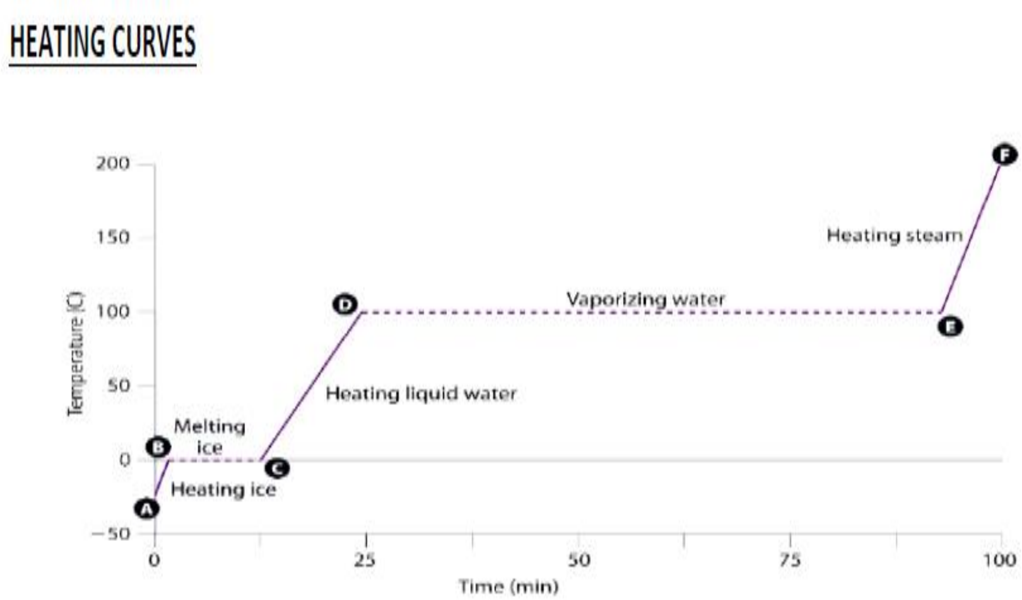
Specific heat of water = 4200 $Jkg^{-1}°C^{-1}$
Latent heat of vaporisation of water = $2.3 \times 10^6$ $Jkg^{-1}$
Latent heat of fusion of ice = 340 000 $Jkg^{-1}$

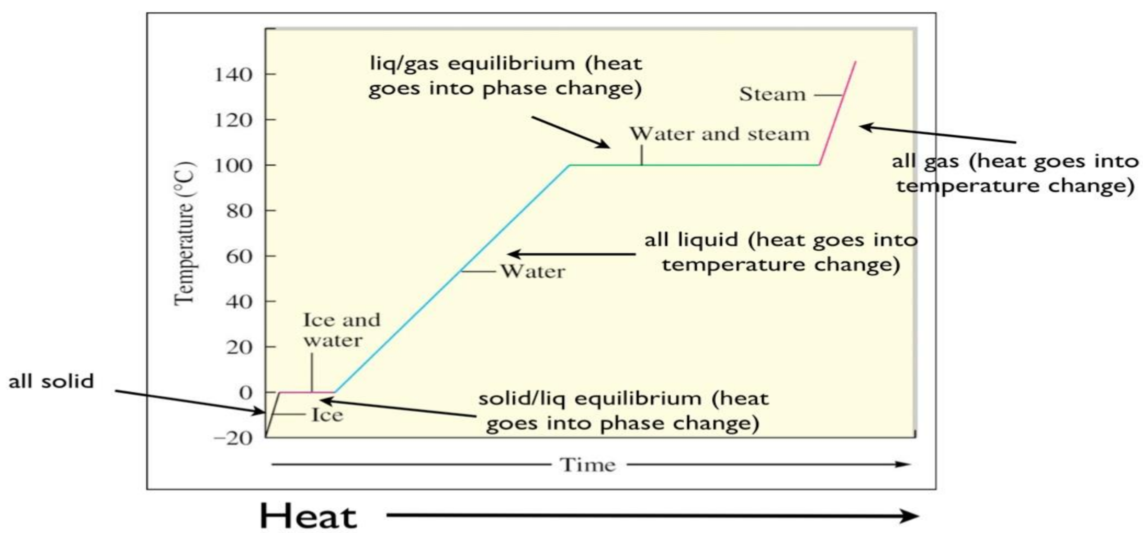
**(2 marks)**

**2009**

A 500 g mass falls from a height of 100 m. If all the energy lost by the mass can be totally harnessed, determine the mass, in kg, of ice at 0 °C that can be melted by this energy. (Latent heat of fusion of $H_2O$ is 335 000 J/kg.) **(2 marks)**

**HEATING CURVE FOR WATER**

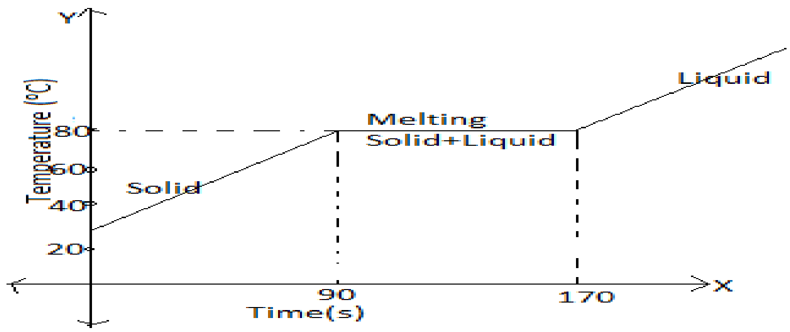


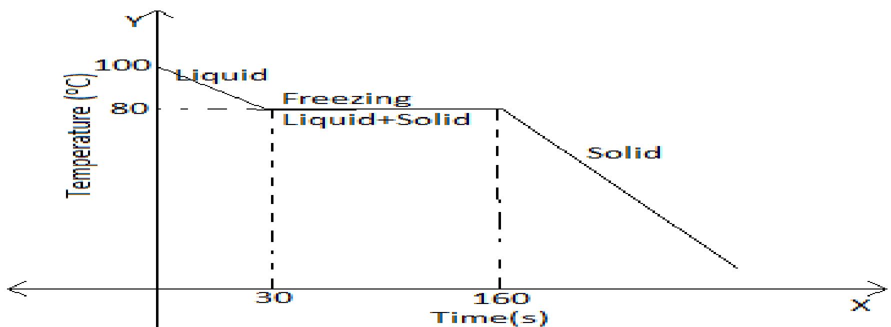
**EXAMPLE**

a. 1 kg of water at $30^0$C.
   -High temperature but less energy.
b. 10 kg of water at $10^0$C.
   -more heat energy since it has more particles.

**HEATING VS COOLING CURVE OF NAPTHALENE**



Heating curve for naphthalene

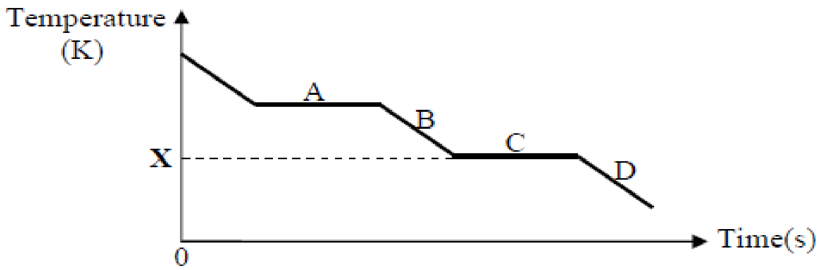


Cooling curve for naphthalene

ACTIVITY

2014

The graph below shows the cooling curve of water.

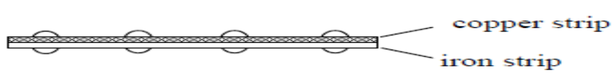



(i) In which section of the graph, A, B, C, or D is there a change of state from water to ice taking place? **(1 mark)**

(ii) What is the value of temperature at point **X**? **(1 mark)**

2012

The diagram below shows, a bimetallic strip made from equal lengths of copper and iron, riveted together at room temperature.




If copper expands more than iron when heated, then which diagram **best** shows the bimetallic strip on a very cool day?


In a Form 5 physics experiment, the cooling curve of naphthalene was studied. This was done by heating solid naphthalene until it melted and then allowing it to cool. The table of results is shown below.

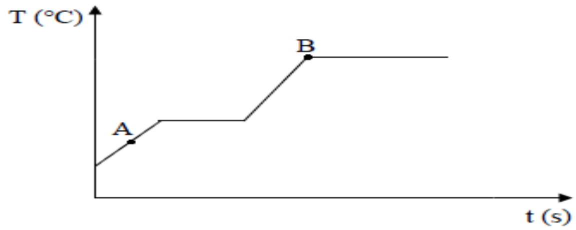
| **Time (min)** | 0 | 2 | 4 | 6 | 10 | 15 | 16 | 18 | 20 | 22 | 23 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Temperature (°C)** | 90 | 86 | 82 | 80 | 80 | 80 | 80 | 79 | 78 | 77 | 76 |

(i) State the time period in which latent heat of fusion is being released. **(1 mark)**

(ii) Explain the energy changes undergone by the molecules of naphthalene during the period when latent heat of fusion is being released. **(1 mark)**

2011

The graph below shows the temperature changes of an ideal substance while being heated.



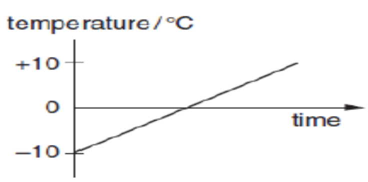

(i) Describe the substance at points **A** and **B**. **(1 mark)**

(ii) Describe what is happening to the average speed of the molecules from **A** to **B**. **(1 mark)**

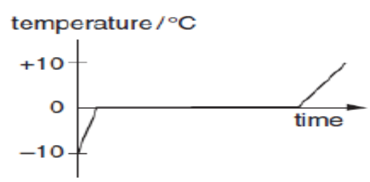
2010

Ice at -10 °C is heated at a constant rate until it is water at +10 °C. Which graph shows how the temperature changes with time?

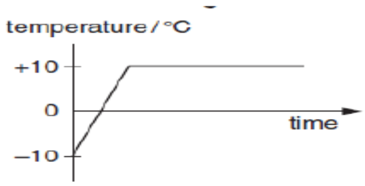
A.



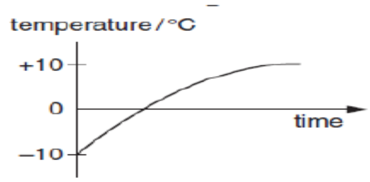

B.




C.




D.




## LESSON 57-58 EXP 6 SPECIFIC HEAT CAPACITY

## Lesson 59

## LO: DESCRIBE EVIDENCE OF GLOBAL WARMING, CONSEQUENCES AND POSSIBLE SOLUTIONS.

### 1. ALBEDO

-is the fraction of solar energy reflected from the Earth back into space.

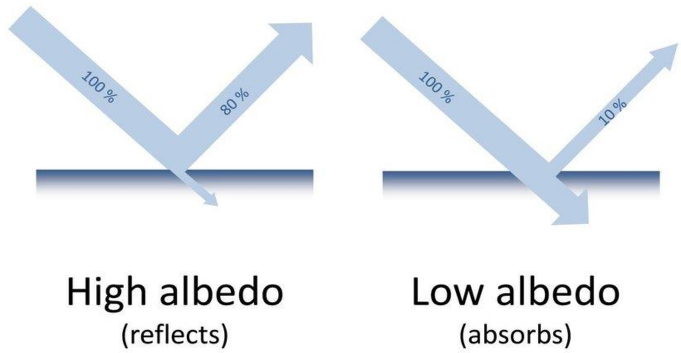
- is the ratio of light that a surface reflects compared to the total sunlight that falls on it.

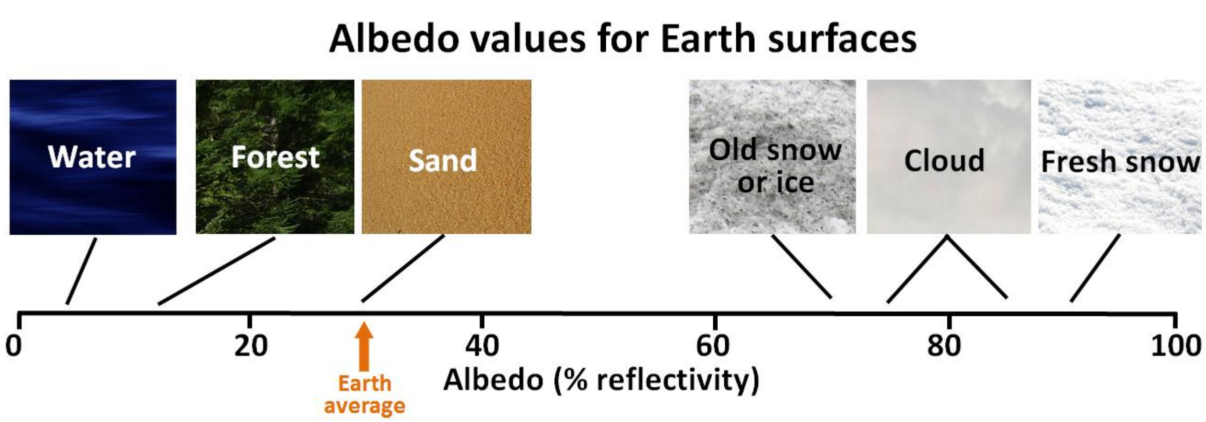
$$\boldsymbol{Albedo} = \frac{\textbf{Amount of reflected EMR}}{\textbf{amount of incoming EMR}}$$

-High albedo: surface reflects majority of the radiation that hits it and absorbs the rest. E.g bright/Light surfaces like Snow, White Tshirt

- Low albedo: surface reflects a small amount of incoming radiation and absorbs the rest. E.g Dark surfaces like Forest, Black Tshirt

- Earth’s albedo is inversely proportional to global mean surface temperature.



## 2. GREENHOUSE EFFECT

- Natural process by which atmosphere traps some of the Sun's energy, warming Earth enough to support life.
- Main greenhouse gases are carbon dioxide, chorofluorocarbons CFC's, Methane, water vapour, nitrous oxide, ozone.

### CAUSES

1. Burning of Fossil Fuels
2. Deforestation
3. Increase in Population
4. Farming ; Nitrous oxide fertilizer
5. Industrial Waste and Landfills

### CONSEQUENCES

| Environmental effects | Economic Impacts | Human Health Impacts |
|---|---|---|
| - Rise in overall average annual temperature; create holes in ozone layer.<br>- Rising sea levels and increase in coastal flooding.<br>- Heat waves are likely to increase in frequency. | - Agriculture, forestry and tourism affected.<br>- Damage to infrastructure (e.g roads and bridges)<br>- Additional economic stress on health and social support systems. | - Increase the risk of deaths from dehydration and heat stroke.<br>- Risk of water and food.<br>- Greater risk of respiratory and cardiovascular problems. |

### POSSIBLE SOLUTIONS

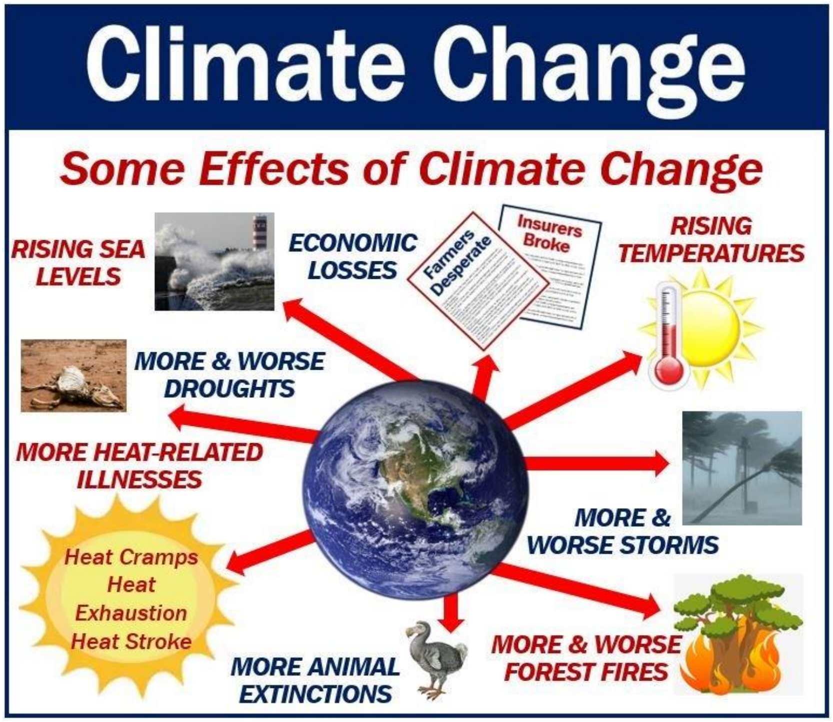
| Adaptation | Mitigation | Geo - engineering |
|---|---|---|

| | | |
|---|---|---|
| - Build sea walls.<br>- Relocate communities (upgrade infrastructures).<br>- Afforestation. | - Implement policies that reduce emission of greenhouse gases.<br>- Environmental campaign.<br>- Avoid burning of fossil fuels and household residue.<br>- Reduce use of CFC.<br>- Pollution should be controlled.<br>- Water logging should be avoided. | - Use alternative sources of energy.<br>- Using eco-friendly materials.<br>- Incineration plants should be established.<br>- Carbon market |

### 3. GLOBAL WARMING

- Rise in the average temperature of Earth's atmosphere and oceans.

| CAUSES | EFFECTS | SOLUTIONS |
|---|---|---|
| 1. Increase in greenhouse gases; $CO_2$<br>2. Burning of Fossil Fuels<br>3. Deforestation | 1. Climate Change.<br>2. Melting of Glaciers.<br>3. Rise in sea level.<br>4. Flooding in coastal areas.<br>5. Heavy drought.<br>6. Spread of diseases.<br>7. Severity of storms and other severe weather events.<br>8. Changes in wildlife adaptations and may cause extinction of animals. | 1. Managing forests and agriculture<br>2. Developing and deploying new low-carbon and zero-carbon technologies<br>3. Ensuring sustainable development<br>4. Phasing out fossil fuel electricity.<br>5. Reviving up renewables<br>6. Greening transportation<br>7. Boosting energy efficiency |

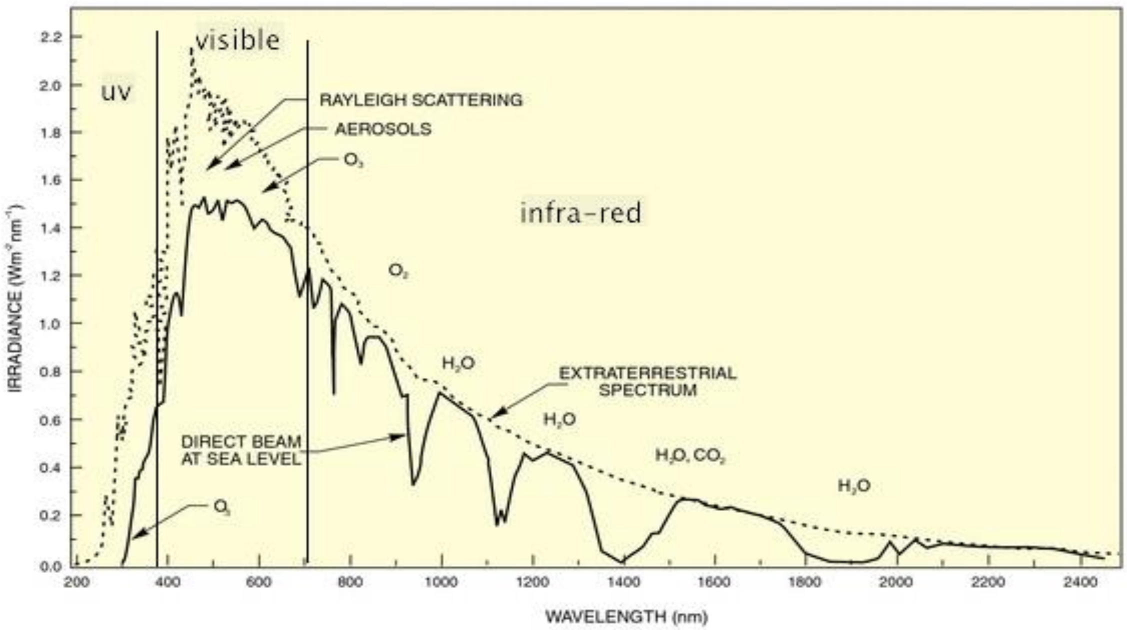



**ABSORPTION GRAPH OF THE ATMOSPHERE**

- Sun emits UV, Visible and IR.
- Earth's atmosphere absorbs UV and IR.
- The surface of the Earth absorbs Visible and re-radiates it as IR which is absorbed by the atmosphere trapping it like greenhouses.

Graph below shows:

- Energy Spectrum of Sun along with percentage of energy radiated by the Sun in UV, Visible and Infrared portion.
- Certain wavelengths of light absorbed in our atmosphere before they travel to the surface.




<u>2020</u>

Which of the following gases directly contribute to greenhouse effect?

A. Oxygen
B. Nitrogen
C. Carbon dioxide
D. Sulphur dioxide

<u>2020 Sample</u>

Which of the following is a greenhouse gas?

A. helium.
B. methane.
C. carbon monoxide.
D. carbon tetrachloride.

<u>2018</u>

Albedo is the fraction of the total incident solar radiation received on earth that gets reflected into space. If Earth's albedo is increased, then the global mean surface temperature would probably

A. increase.
B. decrease.
C. become zero.
D. remain the same.

2017

Snow has a high albedo and forests have a low albedo.

Define **albedo**. **(1 mark)**

2014

One of the consequences of the greenhouse effect and global warming is a rise in sea level. The driving force behind global warming has been increase in greenhouse gases.

Name the main greenhouse gas? (1 mark)

2010

Briefly explain what you understand by the term greenhouse effect? (2 marks)

State the causes and characteristics of cyclone? (2 marks)

2004

Briefly explain the importance of ozone layer in the atmosphere. (2 marks)