Sangam SKM College – Nadi

Lesson Notes: Week 1

Year 12

Physics

Strand	Energy
Sub Strand	Energy Transformation
Content Learning Outcome	Relate transformations between energy in systems to the law of conservation of energy

Work:

- is done when a force applied to an object moves that object.
- is scalar and the unit is Joules, J
- W = Force x distance

Energy:

- is the capacity of a physical system to perform work
- energy can be converted in various forms but cannot be created or destroyed
- is scalar and the unit is Joules, J
- energy has **two forms**, kinetic and potential

  Kinetic energy: associated with objects in motion
- KE = $\frac{1}{2}mv^2$

  Potential energy: is the energy stored in an object or system of objects
- **four types** of potential energy

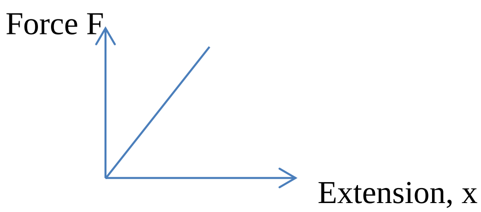
  1. Gravitational potential energy

  Energy stored in an object as the result of its altitude. PE = mgh

  2. Elastic potential energy

  is the energy stored as a result of applying a force to deform[compress/ stretch/ twist] an elastic object PE = $\frac{1}{2}kx^2$

  Recall: Hooke's Law F = kx



The gradient is the spring constant

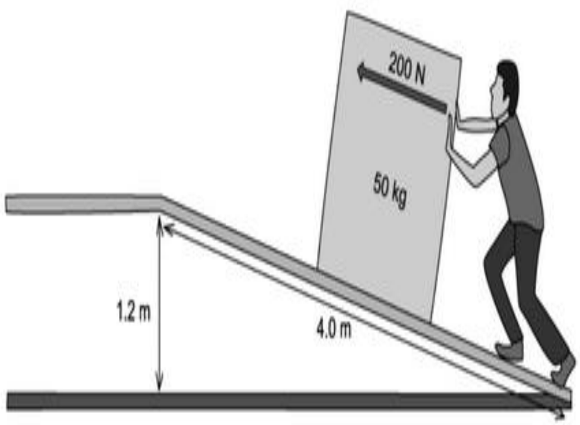
The area under curve is the work done or elastic potential energy

3. Chemical potential energy: the energy stored in the chemical bonds of the substance
4. Electric potential energy: the energy needed to move a charge against an electric field.

Power
- is the rate at which work is done
- $P = \frac{W}{t}$ or $P = \frac{E}{t}$

"The law of conservation of energy states that energy can neither be created nor destroyed but can only be converted from one form to another. The total energy of an isolated system remains conserved over time"

Examples
1. A builder pushes a heavy crate up a slope.



2. Calculate the work done by the builder.
   W = Fd
   = (200N)(4m)
   = 800J
3. Calculate the gain in gravitational potential energy of the crate.
   PE = mgh
   = $(50kg)(10ms^{-2})(1.2m)$
   = 600J
4. Explain why the answers are different.
   Energy lost as heat due to friction between surfaces.

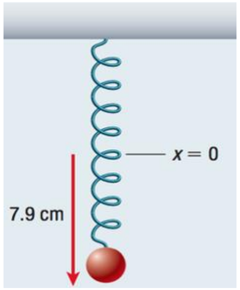
2. A spring has a spring constant, (k), of 3 N/m. It is stretched until it is extended by 50 cm. Calculate the elastic potential energy stored by the spring, assuming it is not stretched beyond the limit of proportionality.

$PE = \frac{1}{2}kx^2$

$= \frac{1}{2}(3)(0.5^2)$

= 0.375J

Activity
A spring hangs at rest from a support. If you suspend a 0.46kg mass, the extension is 7.9cm.



a. Calculate the spring constant
b. Find the elastic potential energy stored.
c. Calculate the displacement(extension)of the same spring when a 0.75kg mass hangs from it instead.

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Lesson Notes – Week 2

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Physics

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Heat and Temperature

- ***Heat***, ***H*** or ***Q*** is the measure of energy with which the molecules vibrate in a system
- ***Temperature*** is the measure of average kinetic energy of the molecules.

Parameter	Heat	Temperature
Definition	Total energy of an object that has molecular motion inside it	Measure of thermal energy of an object
SI unit	Joule	Kelvin
Symbol	Q	T

- Specific heat capacity, c, is the heat needed to raise the temperature of 1kg of substance by 1 degree Celsius.
- Similarly, heat capacity is the ratio between the energy provided to a substance and the corresponding increase in its temperature.

Water has the highest specific heat capacity of any liquid, meaning, it takes more energy to heat up & longer to cool down.

Formula for Heat energy when there is a change in temperature:

$$Q = mc\Delta T$$

Where

Q or H is the heat energy transferred, in Joules, J
m is the mass of the substance, in kg
c is the specific heat capacity of the substance, in $J/kg^{o}C$
ΔT is the change in temperature, in ^{o}C or K

Always check for consistency of units when using this formula

Example

How much energy is required to heat 100gram of water, of specific heat capacity 4200 J/kg^{o}C from 10 ℃ to 15 ℃?

$Q = mc\Delta T$

$= (0.1kg)(4200J/kg^oC)(5^oC)$

$= 2100$ J

- The <u>latent heat of fusion</u> will be the amount of thermal energy required to change a solid into a liquid, or vice versa.
- The <u>latent heat of vaporization</u> is the amount of thermal energy required to change a liquid into a gas, and vice versa.

Formula for Heat energy when there is a change of phase (change of state)

$$Q = mL$$

Where

Q or H is the heat energy transferred, in Joules, J

m is the mass of the substance, in kg

L is the latent heat, in J/kg

Example

Find the amount of energy released when 1gram of steam, of Latent heat of vaporization 2260000J/kg, at 100℃ condenses.

$Q = mL$

$= (0.001kg)(2260000J/kg)$

$= 2260$ J

Activity

a. Fill in the blank

Because of its ______(low/high) heat capacity, water can minimize changes in temperature, hence is used in car engines as a coolant.

b. It takes 41.72J to heat a piece of gold weighing 18.69g from 10^{o}C to 27^{o}C. What is the specific heat of gold?

c. How much heat does it take to melt 10g of ice, if the Latent heat of fusion is 336000J/kg?

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Lesson Notes – Week 3

Year 12

Physics

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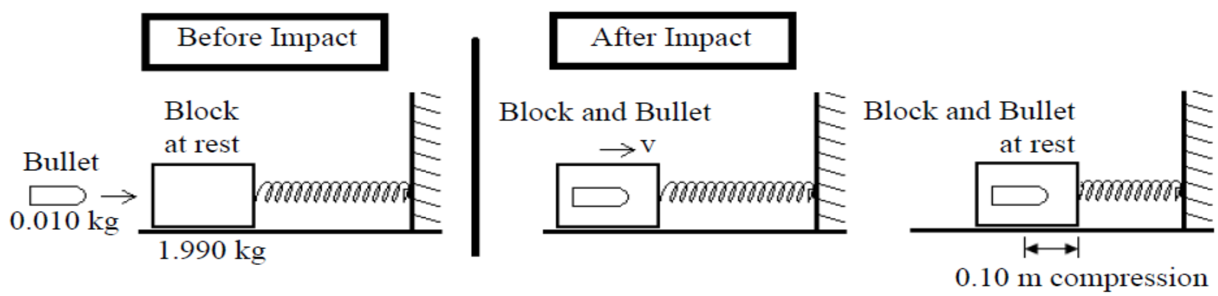
Energy Conservation Law

"The law of conservation of energy states that energy can neither be created nor destroyed but can only be converted from one form to another. The total energy of an isolated system remains conserved over time"

Examples

1. A bullet of mass 0.01kg strikes and embeds itself in a block which has a spring attached to it. The mass of the block is 1.99kg and is at rest on a frictionless horizontal surface. The spring has a spring constant of 200N/m. After being hit by the bullet, the block compresses the spring by 0.1m.



a. Calculate the elastic potential energy stored in the spring by the block and bullet after impact.

PE = $\frac{1}{2}kx^2$

= $\frac{1}{2}(200)(0.1)^2$

= 1 J

b. 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.

PE = KE

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

1 = $\frac{1}{2}(2)v^2$

v = 1 m/s

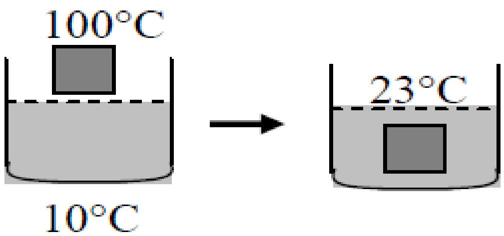
c. Find the speed of the bullet just before it hits the block.

Total momentum before collision = Total momentum after collision

0.01v = (2)(1)

v = 200 m/s

2. A piece of aluminium of mass 0.4kg at 100°C is lowered into 0.5kg 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 4200 J kg^{-1} $°C^{-1}$



Calculate the following:
a. heat gained by the water?
Q = mcΔT
Q = (0.5)(4200)(13)
Q = 27300 J

b. specific heat capacity of aluminium?
Heat gained by water = Heat loss by aluminium
27300 = mcΔT
27300 = (0.4)c(77)
c = 886.36 J/kg°C

Activity

1. 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 the same as energy after a collision.
D. energy is neither created nor destroyed; it only changes its form.

2. 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
How much heat energy is supplied to the water ?