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Class 9th K.V.S.

WORK AND ENERGY

Work:- work is done when a force produces motion.

The work done by a force on a body depends on two factors :-

i) Magnitude of the force
ii) Distance ~~through~~ through which the body moves.

* its S.I. unit is Joule.
* it is Scaler quantity

work done in moving a body is equal to the product of force and the displacement of the body in the direction of force.

So, work = force x Displacement in the Direction of force

work = force x Displacement

$W = F \times S$

1 Joule :- When a force of 1 newton moves a body through a distance of 1 metre in its own direction, then the work done is known as 1 Joule.

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1 Joule = 1 newton × 1 metre

1J = 1Nm.

Work is said to be done when:-

i) a moving object comes to rest.
ii) an object at rest starts moving
iii) velocity of an object changes
iv) shape of an object changes.

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Q.1 A force of 7N acts on an object. The displacement is say 8m. in the direction of the force. Let us take it that the force acts on the object through the displacement. what is the work done in this case?

Ans F = 7N
S = 8m
W = ?

W = F × S
W = 7 × 8
W = 56 Joule Ans

Q.2 when do we say that work is done?

Ans work is done when a forces produces motion in an object. Or work is said to be done if by applying the force body is displaced

Q.3 write an expression for the work done

Q.4 Ans

Q.5 Ans

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when a force is acting on an object in the direction of its displacement?

Ans if a force F acts on an object and S is the displacement of the object in the direction of force, then:-

Work done = Force x Displacement

$W = F \times S$

Q.4 Define 1 Joule of work.

Ans when a force of 1 newton moves a body through a distance at 1 metre in its own direction, then the work done is known as 1 Joule.

$1J = 1N \times 1M$

$1J = 1Nm$

Q.5 A pair of bullocks exerts a force of 140 N on a plough. The field being ploughed is 15m long. How much work is done in ploughing the length of the field?

Ans $F = 140N$

$S = 15M$

$W = ?$

$W = F \times S$

$W = 140 \times 15$

$W = 2100$ Joule Ans

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Energy:- The energy is the ability to do work.

* its unit is Joule
* it is Scalar quantity

1 KiloJoule = 1000 Joule

1 KJ = 1000 J.

Forms of energy:-

1- Kinetic energy
2- Potential energy
3- Chemical energy
4- Heat energy
5- Light energy
6- Sound energy
7- Electrical energy
8- Nuclear energy

Kinetic energy:- The energy of a body due to its motion is called kinetic energy.

eg:- A moving cricket ball, A moving bullet.

Formula of kinetic energy:-

motion equation of third equation is

$$v^2 - u^2 = 2as$$

or $s = \frac{v^2 - u^2}{2a}$

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we know that work

$W = F \times S$ [$\because F = ma$]

$W = mg \times \frac{v^2 - u^2}{2g}$

$W = m \times \frac{v^2 - u^2}{2}$

$W = \frac{1}{2} \times m(v^2 - u^2)$

$\because u = 0$

$W = \frac{1}{2} m v^2$

$$E_K = \frac{1}{2} m v^2$$

Potential energy:— The energy of a body due to its position or change in shape is known as potential energy.

gravitational potential energy:— The energy of a body due to its position above the ground is called gravitational potential energy.

Machenical energy:— The sum of the potential and kinetic energy is called machenical energy.

formulat of potential Energy.:—

we know that

work done = Force x Displacement

$\because F = ma$

acceleration due to gravity So, $F = mg$

body due energy bullet.

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$W = Mg \times h$

$W = Mgh$

$E_p = Mgh$

Mechanical Energy or Constant

$= mgh + \frac{1}{2} MV^2$

Law of conservation of energy :—

energy can only be converted from one form to another ; it can neither be created or destroyed.

Home-work

Q.1 Any

What is the kinetic energy of an object?

The energy of a body due to its motion is called kinetic energy.

Q.2 Any

Write an expression for the kinetic energy of an object.

Kinetic energy of an object $= \frac{1}{2} MV^2$.

M = mass of an object.

V = Velocity / speed of the object.

Q.3

The kinetic energy of an object of mass. m moving with a velocity of 5m/s is 25 J. what will be its kinetic energy when its velocity

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is doubled? what will be its kinetic energy when its velocity is increased three times?

Ans

Mass = ?

$E_k = 25\ J$

$v = 5\ m/s$

Kinetic energy = $\frac{1}{2}mv^2$

$25\ J = \frac{1}{2} \times m \times (5)^2$

$25 \times 2 = m \times 25$

$\frac{50}{25} = m$

$m = 2\ kg$

In first case when its velocity is doubled

$M = 2\ kg$

$V = 5 \times 2 = 10\ m/s$

$E_k = ?$

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

$E_k = \frac{1}{2} \times 2 \times (10)^2$

$E_k = 100\ J$ Ans

in second case, when its velocity is tripled

$M = 2\ kg$, $V = 5 \times 3 = 15\ m/s$

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

$E_k = \frac{1}{2} \times 2 \times (15)^2$

$E_k = 225\ J$ Ans

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Power:— Power is defined as the rate of doing work.

* Power = $\frac{\text{Work done}}{\text{Time taken}}$ or $P = \frac{W}{t}$

* Power is a scalar quantity.
* its S.I. unit is watt.

average power:— power is also defined as the rate at which energy consumed.

$$P_{av} = \frac{\text{Energy consumed}}{\text{Time taken}}$$

$$\boxed{P_{av} = \frac{E}{t}}$$

Units of power:—

1 watt is the power of an appliance which consumes energy at the rate of 1 Joule per second.

$$1 \text{ watt} = \frac{1 \text{ Joule}}{1 \text{ second}}$$

or $1 W = \frac{1 J}{1 s}$

$1 \text{ watt} = 1 J/s$

1 kW = 1000 W

1 Mega watt = 1000000 W

1 MW = 10^6 W

1 horse power = 746 watt

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Commercial unit of energy :— The Commercial unit of energy is kilowatt.

* its S.I. unit of Joule.

Question What is 1 kw/h.

Ans The energy used in one hour at the rate of 1 kw is called 1 kw/h.

Relation between kilowatt-Hour and joule :—

1 kilowatt-hour is the amount of energy consumed at the rate of 1 kilowatt for 1 hour.

1 kilowatt-hour = 1 kilowatt for 1 hour

or 1 kilowatt hour = 1000 watts for 1 hour —— (I)

But :- $1 \text{ watt} = \frac{1 \text{ Joule}}{1 \text{ Second}}$

for equation I st

1 kilowatt hour = $1000 \times \frac{\text{Joules}}{\text{Seconds}}$ for 1 hour

$\because$ 1 Hour = 60 × 60 Seconds

$\therefore$ 1 kw/h = $1000 \frac{\text{Joules}}{\text{Seconds}} \times 60 \times 60$ Seconds

1 kw/h = 36,00,000 J.

or $\boxed{1 \text{ kw/h} = 3.6 \times 10^6 \text{ J}}$

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EXERCISE

Q.1 ~~Look at the~~

Q.3 A battery lights a bulb. Describe the energy changes involved in the process.

Ans Chemical energy ⟶ Electrical energy ⟶ Heat energy ⟶ Light energy.

Q.4 Certain ---------- force.

→ in first case:—

$M = 20\ kg$

$V = 5\ m/s$

$K.E. = \frac{1}{2} mv^2$

$K.E. = \frac{1}{2} \times 20 \times (5)^2$

$K.E. = \frac{1}{2} 10 \times 25$

$K.E. = 250\ J$

in second case

$M = 20\ kg$

$V = 2\ m/s$

$K.E. = \frac{1}{2} \times mv^2$

$K.E. = \frac{1}{2} \times 20 \times (2)^2$

$E_K = 10 \times 4$

$E_K = 40\ J$

work done by force = change in kinetic energy

$= 250 - 40$

$= 210\ J$ Ans

Q.5 Ans

Q.6 Ans

Q.7 Ans

Q.8 Ans

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Q.5 An object - - - - - - - - - - - - - - - - Your answer.
Any The work done is zero, This is because the gravitational force and displacement are perpandicular to each other.

Q.6 The potential - - - - - - - - - - - - ? Why?
Any it does not violate the law of ~~constant~~ Conservation of energy. whatever, is the decrease in potential energy due to loss of height, same is the increase in the K.E. due to increase in velocity of the body.

Q.7 What are the various energy transformation that occur when you are riding a bicycle?
Any The chemical energy of the food changes into heat and then to muscular energy on paddling, The muscular energy changes into machanical energy.

Q.8 Does the transfer - - - - - - - - - - - - going?
Any Energy transfer does not take place as no displacement takes place in the direction of applied force. The energy spent is used to overcome inertia of rest of the rock.

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Q.9 A certain household has consumed 250 units of energy during a month. How much energy is this in joules?

Ans Energy Consumed = 250 units
= 250 Kw/h

1 Killowatt hour = 3.6×10^6

250 Killowatt hour = $3.6 \times 10^6 \times 250$

= 9×10^8 Joules Ans

Q.11 What is the work done by the force of gravity on a satellite moving round the earth? Justify your answer.

Ans When a satellite move round the earth, then at each point of its path, the direction of force of gravity on the satellite is perpendicular to the direction of its displacement. Hence, the work done on the satellite by the force of gravity is zero.

Q.13 A person holds a bundle of hay over his head for 30 minutes and gets tired. Has He done some work or not? Justify your answer.

Ans The person does not do work because no displacement takes place in the direction of applied force as the force acts in the vertically upward direction.

Q.14 Ans

Q.16 Ans

Q.17 Ans

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Q.14 An electric heater is rated 1500 w. How much energy does it use in 10 hours?

Any $P = 1500\ w = \frac{1500}{1000} = 1.5\ kw$

$t = 10\ h$

$\text{Power} = \frac{\text{Energy Consumed}}{\text{time}}$

$1.5 = \frac{\text{Energy Consumed}}{10}$

$\text{Energy Consumed} = 1.5 \times 10$

$= 15$ units Any

Q.16 An object - - - - - - - - - - - - - - to rest?

Any Kinetic energy of an object of mass 'm' moving with a velocity 'v' is given by the expression $\frac{1}{2}mv^2$. To bring the object to rest, an equal amount of work i.e. $\frac{1}{2}mv^2$ is required to be done on the object.

Q.17 Calculate - - - - - - - - - - - - - - 60 km/h?

Any $M = 1500\ kg$

$V = 60\ km/h = \frac{\cancel{60}^{10} \times 5}{\cancel{18}_{3}} = \frac{50}{3}\ m/s$

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

$K_E = \frac{1}{\cancel{2}} \times \overset{750}{\cancel{1500}} \times \left(\frac{50}{3}\right)^2$

$K_E = \frac{750 \times 2500}{9} = 208333.3\ J$ Any

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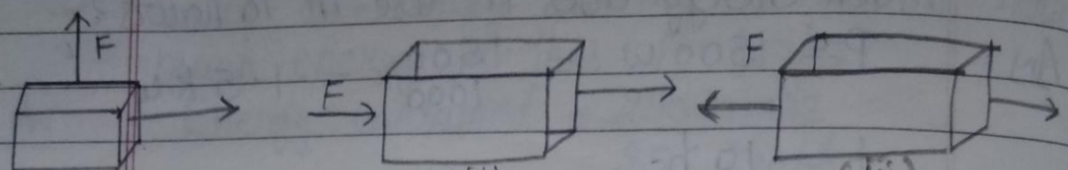
Q.18 In each of the - - - - - - - - Zero.



(i) (ii) (iii)

i) The direction of force F and the direction of displacement are at right angles to each other. So, the work done is zero.

ii) the displacement is in the direction of Force F. So the work done is positive.

iii) the force F acts in a direction opposite to the direction of displacement, So the work done is negative.

Q.19 Soni says - - - - - - - - - - ? why?

Ans Yes, acceleration in an object could be zero even when several forces are acting on it. This happens when all the forces cancel out each other i.e. the net force acting on the object is zero.

Q.20 Find the energy in kWh consumed in 10 h by four devices of power 500 W each.

Ans
Power of one device = 500 W

Power of Four device = 500 × 4

= 2000

$= \frac{20000}{1000} = 20\ kWh$

T = 10h

$P = \frac{\text{Energy Consumed}}{\text{Time}}$

$2 = \frac{\text{Energy Consumed}}{10}$

Energy Consumed = 10 × 2
= 20 units Ans

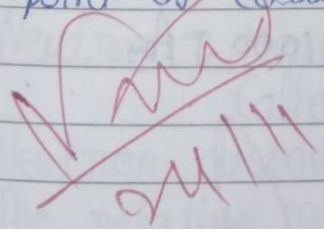
Q. 21 (2017) A freely falling object eventually stops on reaching the ground. what happens to its kinetic energy.

Ans As the object hits the hard ground its kinetic energy gets convetated into:-

i) heat energy (the object and the ground become slightly worm)

ii) Sound energy (sound is heard when the object hits the ground)

iii) Potential energy of centrifugation of the body and the ground (the object and the ground get deformed a little bit at the point of collision).



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Q.10 An object of mass 40 kg is raised to a height of 5m above the ground. what is its potential energy? if the object is allowed to fall, find its kinetic energy when it is half-way down.

⇒ $m = 40\ kg$ $g = 10 m/s^2$ $h = 5m$

$E_p = m \times g \times h$

$= 40 \times 10 \times 5 = 2000$ Joules Ans

the object is at a height of 5m. when this object is allowed to fall and it is half way down.

$h = \frac{5}{2} = 2.5$

$m = 40\ kg$

$E_p = m \times g \times h$

$= 40 \times 10 \times 2.5 = 1000$ Joules

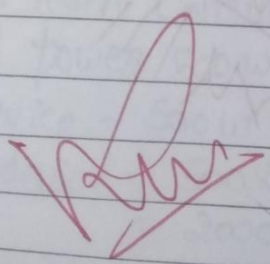
Law of Conservation of energy:-

Total potential energy = potential energy + Kinetic energy
half way down

$2000 = 1000 +$ Kinetic energy

Kinetic energy $= 2000 - 1000$

$= 1000\ J$ Ans



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