Board – CBSE	Class – 9th	Topic – Work and Energy

Q.1 A pair of bullocks exerts a force of 140 N on a plough. The field being ploughed is 15 m long. How much work is done in ploughing the length of the field?

Ans: $Force = 140\ N$

$S = 15\ m$

$W = ?$

$W = F \times s$

$= 140\ N \times 15\ m$

$= 2100 Nm$

$W = 2100\ J$

∴ Work done in ploughing the length of the field is 2100 J.

Q.2 What is the kinetic energy of an object?

Ans: The energy possessed by an object due to its motion is called the object's kinetic energy.

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

Where m is the mass of the object and v is the velocity of the object.

Q.3 Avinash can run with a speed of 8 ms^{-1} against the frictional force of 10 N, and Kapil can move with a speed of 3 ms^{-1} against the frictional force of 25 N. Who is more powerful and why?

Ans: Given, force applied by Avinash $= 10\ N$,

Speed of Avinash $= 8\ ms^{-1}$

Power of Avinash = F.v $= 10 \times 8 = 80\ W$

Now, force applied by Kapil $= 25\ N$

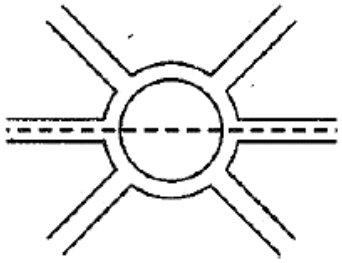
Speed of Kapil $= 3\ ms^{-1}$

Power of Kapil $= FV = 25 \times 3 = 75\ W$

Since, Avinash has more power $(80 - 75) = 5\ W$ than Kapil.

So, Avinash is more powerful.

Q.4 A boy is moving on a straight road against a frictional force of 5 N. After travelling a distance of 1. 5 km, he forgot the correct path at a roundabout of radius 100 m, as shown in the figure. However, he moves on the circular path for one and half-cycle and then moves forward up to 2. 0 km. Calculate the work done by him.



Ans: Given, force applied by a boy against friction $= 5\ N$

Displacement on the circular path = One cycle + Half cycled = 0 + Half cycle

$= 0 +$ Diameter of the circular path ($\therefore$ Displacement depends on initial and final point)

$= 0 + 2r = 0 + 2\times100\ [\because r = 100\ m]$

$= 0 + 200 = 200\ m$

$\therefore$ Total displacements $= 1.5\ km + 200\ m + 2.0\ km = 1.5\times1000 + 200 + 2\times 1000\ km\ (1\ km = 1000\ m) = 3700\ m$

Work done by boy $= F\cdot\theta$

$= 5\times3700\times cos0 = 18500\ J$

Q.5 Can any object have momentum even if its mechanical energy is zero? Explain.

Ans: Since, mechanical energy = potential energy + kinetic energy

If mechanical energy $= 0$

So, $PE + KE = 0$

$\Rightarrow PE = - KE$

So, we can say that body may have momentum in case mechanical energy is zero

Q.6 The weight of a person on planet A is about half that on the earth. He can jump up to 0. 4 m in height on the surface of the earth. How high he can jump on the Planet A?

Ans: It is given that weight of the person on the earth $= w$

{i.e., $w = mg$)

And as he can jump up to height ($h, = 0.4\, m$)

So, potential energy at this point $= mgh = mg \times 0.4$ ...(i)

And it is given that

Weight of the person on the other planet $= \frac{w}{2}$

And if he could jump to a height (h_2) its potential energy would be

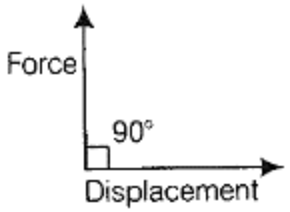
$\frac{w}{2} h_2 = \frac{mg}{2} h_2$

And from Eqs (i) and (ii)

$0.4 = \frac{mg}{2} h_2$

$\Rightarrow h_2 = 0.4 \times 2 = 0.8\, m$

Q.7 Is it possible that an object is in a state of accelerated motion due to external force acting on it, but the force is doing no work? Explain it with an example.



Ans: Yes, when a force acts in a direction perpendicular to the direction of displacement. e.g., the earth revolves around the sun under the gravitational force of the sun on earth, but no work is done by the sun, though the earth has centripetal acceleration.

Q.8 Four men lift a 250 kg box to a height of 1 m and hold it without raising or lowering it.

(a) How much work is done by the men in lifting the box?

(b) How much work do they do in just holding it?

(c) Why do they get tired while holding it? [given $= 10\, ms^{-2}$].

Ans: Given, $m = 250\ kg$, height $(h) = 1\ m$ and acceleration due to gravity $g = 10\ ms^{-2}$

(a) Work done by the man in lifting the box

$W = Potential\ energy\ of\ box\ W = mgh$

$W = 250 \times 1 \times 10 = 2500\ J$

(b) Work done is zero in holding a box because displacement is zero.

(c) In holding the box, the energy of man loses. Due to a loss of energy, he felt tired.

Q.9 What is power? How do you differentiate kilowatt from kilowatt-hour? The Jog Falls in Karnataka state are nearly $20\ m$ high. 2000 tonnes of waterfalls from it in a minute. Calculate the equivalent power if all this energy can be utilized?

$[g = 10\ ms^{-2}]$

Ans: (i) Power is defined as the rate of doing work or the transfer of energy.

The unit of power is watt or kilowatt. $[1\ kW = 1000\ W]$

(ii) Kilowatt is the unit of power while kilowatt hour is bigger unit of energy

$1kWh = 1000 \times 3600 \Rightarrow 1$ kilowatt hour $= 3.6 \times 10^6\ J$

(iii) Given, mass of water $= 2000$ tonnes $[\therefore 1$ tonne $= 1000\ kg]$

$\therefore$ Mass of water $= 2000 \times 1000 = 2 \times 10^5\ kg$

We know that power $= \frac{energy}{time}$

$p = \frac{mgh}{t}\ [\therefore energy = mgh]$

$p = \frac{2 \times 10^6 \times 10 \times 20}{60}\ [given, h = 20\ m\ and\ g = 10\ ms^{-2}]$

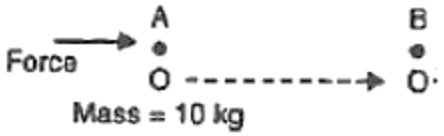
$P = 6.67 \times 10^6 w$

This power can be utilized.

Q.10 A mass of $10\ kg$ is at a point A on a table. It is moved to point B. Suppose the line joining A and B is horizontal. What is the work done on the object by the gravitational force? Explain your answer.

Ans: Force acts on a body of mass $10\ kg$ to move it horizontally from A to B, as shown above. Work is said to be done on the object by force.

But the work done on the object by the gravitational force is zero.



Q.11 A certain household has consumed 250 units of energy during a month. How much energy is this in joules?

Ans: Commercial unit of energy 250 units

1 unit $= 1kWh$

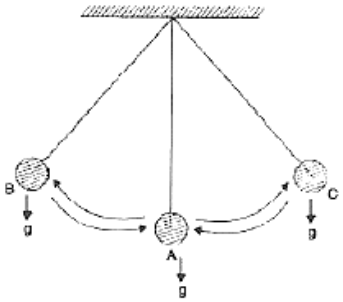
$\therefore 250$ units $- 250kWh$

$1kWh = 3.6\times10^{6} J$

250 units $250\times3.6\times10^{6} J$

Energy in Joules $= 9\times10^{8} J$

Q.12 An object of mass $40\,kg$ is raised to a height of $5\,m$ above the ground. What is its potential energy? If the object is allowed to fall, find its kinetic energy when it is halfway down.



Ans: $Mass = 40\,kg$

$h = 5\,m$

$P.E. = ? \left[g = 10\,m/s^{2}\right]$

$P.E. = mgh$

$= 40\times10\times5$

$P.E. = 2000\,J$

When the object falls, the potential energy gets transformed into kinetic energy. When the object is halfway down

P.E = will become half, i.e., $\frac{2000}{2} = 1000j$ and P.E = K.E ∴ Kinetic energy = $1000\ J$

Q.13 An electric heater is rated $1500\ W$. How much energy does it use in 10 hours.

Ans: Power = $1500\ W \rightarrow 1.5\ kW$

time = 10 hour

Energy =?

Energy = power × Time taken

$= 1.5 \times 10 = 15kWh$

∴ The energy required = $15kWH$

Q.14 Illustrate the law of energy conservation by discussing the energy changes that occur when we draw a pendulum bob to one side and allow it to oscillate. Why does the bob eventually come to rest? What happens to its energy eventually? Is it a violation of the law of conservation of energy?

Ans: Let be the mean position of the pendulum. When it is raised to point ' B ' and released, it starts oscillating from B to A, A to C and back to A. It repeats this motion again and again.

At points B and C, the height of the pendulum is maximum; hence the potential energy at these points is maximum.

When the pendulum moves from B - A - C, its maximum speed is at A during oscillation. Hence the maximum kinetic energy is at A, and potential energy at this point is minimum. This shows that the potential energy at B is transformed to kinetic energy at A. Again, this energy is transformed into potential energy at C.

This energy transformation goes on, and the pendulum oscillates; it does not violate the law of energy conservation.

Bob comes to rest because three forces are acting on it,

(i) Gravitational force exerted by earth ' g ' which .es to bring the bob at rest.

(ii) Air resistance force that acts opposite the motion of the pendulum.

(iii) Restoring force, the pendulum is tied at a point. The upward tension pulls also

tries to get the pendulum to its original position.

Q.15 Find the enemy in kwh consumed in 10 hours by four devices of power 500 W each

Ans: Power $=$ 500 W $=$ 0. 5 kW

Time $=$ 10 hours

Devices $=$ 4

$\therefore$ Energy consumed in kWh $=$ 0. 5 kW×10 hours ×4

$=$ 20kWh

Q.16 A freely falling object eventually stops on reaching the ground. What happens to its kinetic energy?

Ans: When a body is freely falling, the energy remains conserved. Potential energy is transformed into kinetic energy. But when the body reaches the ground, its velocity (v $=$ 0) becomes zero. Hence the kinetic energy is also zero.

Q.17 A force of 7 N as on an object. The displacement is, say 8 m, in the direction of the force. Let us take it that the force acts on the object through displacement. What is the work done in this case?

Ans: F $=$ 7 N

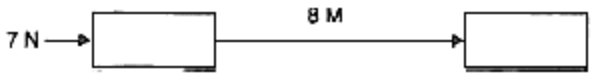
S $=$ 8 m

W $=$ F×s

$=$ 7 N×8 m

W $=$ 56 J

$\therefore$ Work done is 56 J



Q.18 An Object thrown at a certain angle to the ground moves in a curved path and falls back to the ground. The initial and the final points of the path of the object lie on the same horizontal line. What is the work done by the force of gravity on the object?

Ans: Work done by the force of gravity on the object is zero. The force of gravity acts in the vertically downward direction. The distance is covered by the object of force, the horizontal direction. As there is no displacement in the hence the work done is zero.

Q.19 Define watt. Express kilowatt in terms of joule per second. A 150 kg car engine develops 500 W for each kg. What force does it exert in moving the car at a speed of 20 ms^{-1}?

Ans: (i) One watt is the power of a body that does work at the rate of $\frac{1\,J}{s}$

$1\ watt\ = 1\frac{joule}{second}$

(ii) 1 kilowatt = 1000 watt = $\frac{1000\,J}{s}$

(iii) Given, $m = 150\ kg, P = 500\ W$ and $v = 20\ ms^{-1}$

A car engine 150 kg develops 500 watts for each kh.

So, total power = 150×500 = 75000 W

We have power = force x speed

75000 = Force ×20

Force, $F = \frac{75000}{20} = 3750\ N$

Q.20 Write an expression for the work done when a force is acting on an object in the direction of its displacement.

Ans: Work done = W

Force = F

Displacement = s

Work done is equal to the product of the force and displacement. $W = F \times s$