Multiple Choice Questions

1. When a body falls freely towards the earth, then its total energy

(a) increases (b) decreases

(c) remains constant (d) first increases and then decreases

Answer: (c) remains constant

When the body falls freely towards the earth, then the sum of potential energy and kinetic energy remains the same. And the total energy is equivalent to the sum of kinetic energy and potential energy. Therefore, the total energy remains constant.

2. A car is accelerated on a leveled road and attains a velocity 4 times its initial velocity. In this process, the potential energy of the car

(a) does not change (b) becomes twice to that of initial

(c) becomes 4 times that of initial (d) becomes 16 times that of initial

Answer: (a) does not change

The potential energy of the system depends upon the height at which the object is situated. As the formula of calculating the potential energy is the product of the 'mass of the object' and gravity and its height. Since in this case, a car is on a leveled road and the height is zero. So the potential energy of the car does not change.

3. In case of negative work the angle between the force and displacement is

(a) 0^0 (b) 45^0 (c) 90^0 (d) 180^0

Answer: (d) 180^0

We are aware of the formula of the work done is:

$W = FS \cos \theta$

Here F is the force and 'S' is the displacement.

So, from the above formula it is clear that the value of angle $\cos 180^0 = -1$

Therefore, the force and displacement will take place in the opposite direction i.e. have an angle of 180^0 and thus the work done is negative.

4. An iron sphere of mass 10 kg has the same diameter as an aluminium sphere of mass is 3.5 kg. Both spheres are dropped simultaneously from a tower. When they are 10 m above the ground, they have the same

(a) acceleration (b) momenta

(c) potential energy (d) kinetic energy

Answer: (a) acceleration

Acceleration does not depend on the mass and velocity of the object rather it is due to gravity. while all the other options like momenta, potential energy, and kinetic energy all depend on mass, velocity, height, and other factors.

5. A girl is carrying a school bag of 3 kg on her back and moves 200 m on a levelled road. The work done against the gravitational force will be (g =10ms^{-2})

(a) 6×103 J (b) 6J (c) 0.6J (d) zero

Answer: (d) zero

The formula of the work done w = FS cos θ

In this case the work done by the gravitational force is perpendicular to the displacement of the girl. So, the Θ = 90^{o} and the value of cos90^{o} = 0. hence, the work done is zero.

6. Which one of the following is not the unit of energy?

(a) joule (b) newton meter

(c) kilowatt (d) kilowatt-hour

Answer: (c) kilowatt

Kilowatt is not the unit of energy as Kilowatt is the unit of power. Power is a change in work done divided by total time.

While all other three i.e. Joule, Newton meter, and kilowatt-hour is the unit of energy.

7. The work done on an object does not depend upon the-:

(a) displacement

(b) force applied

(c) the angle between force and displacement

(d) the initial velocity of the object

Answer: (d) the initial velocity of the object

Work done on an object depends on the force applied on the object and the displacement covered by the object and also on the angle formed between the force and the displacement. The work done does not depend upon the initial velocity of the object.

8. Water stored in a dam possesses

(a) no energy (b) electrical energy

(c) kinetic energy (d) potential energy

Answer: (d) potential energy

The energy stored in the object due to its position is known as potential energy. and the water is stored in a dam and thus possesses potential energy.

9. A body is falling from a height 'h'. After it has fallen a height h /2 , it will possess

(a) only potential energy

(b) only kinetic energy

(c) half potential energy and half kinetic energy

(d) more kinetic and less potential energy

Answer: (c) half potential energy and half kinetic energy

The kinetic energy of the body is maximum at the ground level and the potential energy of an object is maximum at the height, h. so when an object is at height h/2 i.e. half the distance so, it will have half potential energy and half kinetic energy.

Short Answer Questions:

10. A rocket is moving up with a velocity v. If the velocity of this rocket is suddenly tripled, what will be the ratio of two kinetic energies?

Ans: Let's assume that:

Initial velocity = v

When velocity is tripled v' = 3v

Therefore the initial kinetic energy is , KE = $\frac{1}{2}mv^2$

Final kinetic energy will be , KE' = $\frac{1}{2}mv'^2$

Putting the value of v'=3 , we will get : KE' = $\frac{1}{2}mv'^2 = \frac{1}{2}m(3v)^2 = 9\,(\frac{1}{2}mv^2)$

By comparing the two equations we get

KE : KE' = 1 : 9

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

Answer: To solve this question we will use the formula of the 'Power'. We know that ,

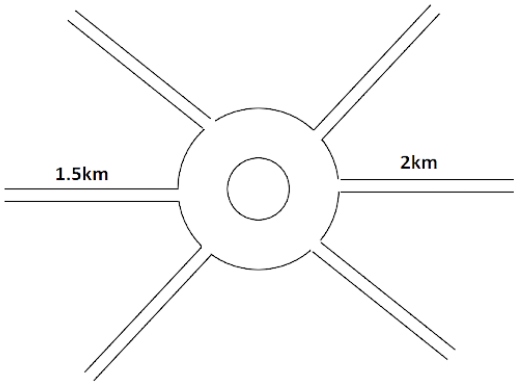
Power = Force × Displacement

Power of Avinash , $P_A = F_A \times V_A = 10 \times 8 = 80W$

Now calculating the power of Kapil, $P_K = F_K \times V_K = 25 \times 3 = 75W$

So, as we can see that Avinash is more powerful than Kapil.

12. A boy is moving on a straight road against a frictional force of 5N. After traveling a distance of 1.5 km he forgot the correct path at a roundabout (Fig. 11.1) of radius 100 m. However, he moves on the circular path for one and half-cycles and then he moves forward up to 2.0 km. Calculate the work done by him.



Answer: In this case first we will not calculate the circumference, because we need a displacement and not a distance.

Therefore, Displacement = 1500m + 200m + 200m = 3700m

Now, calculating the total work done, $W = F \times S = 5 \times 3700m = 18500$ J

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

Answer: The answer is Yes. Mechanical energy is defined by both potential energy and kinetic energy. So if momentum is zero, this implies that velocity is zero and thus the kinetic energy is zero. But the object may have potential energy and thus an object can have mechanical energy even if its momentum is zero.

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

Answer: The answer is zero. Mechanical energy is defined by both potential energy and kinetic energy. So, if mechanical energy is zero, this implies that kinetic energy is zero, thus velocity is zero and thus momentum is also zero.

15. The power of a motor pump is 2 kW. How much water per minute the pump can raise to a height of 10m? (Given g = $10ms^{-2}$).

Answer: We know the formula of 'Power' is: $P = \frac{W}{\Delta t}$

Also, we can write ,

$P = \frac{W}{\Delta t} = \frac{mgh}{\Delta t}$

Now, putting the values in the formula we will get:

$2 = \frac{m\ x\ 10\ x\ 10}{60}$

$2 = \frac{12000}{10}$ = 1200 kg

Therefore, the answer is 1200kg.

16. The weight of a person on planet A is about half that on the earth. He can jump up to

0.4 m height on the surface of the earth. How high he can jump on planet A?

Answer: In the question, it is given that the weight of a person on planet A is about half that on the earth so, this implies that also, the acceleration due to gravity will be half of that of earth. So he will be able to jump double the height that he can jump on the earth. Therefore he can jump 0.8 m on planet A.

17. The velocity of a body moving in a straight line is increased by applying a constant force F, for some distance in the direction of the motion. Prove that the increase in the kinetic energy of the body is equal to the work done by the force on the body.

Answer: We will use the equation $v^2 - u^2 = 2as$

On rearranging it we will get $S = \frac{v^2 - u^2}{2as}$

Now we know that , work done , $W = F \times S$

Also, $F = m \times a$

So, work done by this force F will be : $W = ma\left(\frac{v^2 - u^2}{2as}\right) = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$

$W = (K\ E_f) - (K\ E_i)$

18. Is it possible that an object is in the state of accelerated motion due to external force acting on it, but no work is being done by the force. Explain it with an example.

Answer: Yes, this can be true in the case of circular motion. In a circular motion, the force will always be perpendicular to the displacement of the object.

19. A ball is dropped from a height of 10 m. If the energy of the ball reduces by 40% after striking the ground, how high can the ball bounce back? (g = 10ms^{-2})

Answer: work done = mgh = m × 10 ×10 = 100mJ

As, the energy is reduced by 40%, therefore the energy remaining is 60 % i.e. 60 mJ

Now, putting the values, we will get:

60 m = m × 10 × h'

h' = 6m

20. If an electric iron of 1200 W is used for 30 minutes every day, find electric energy consumed in the month of April?

Answer: we know that formula to calculate Electrical energy is:

Electrical energy = Power × Time × Days

Now, the values given in the question are –

Power , $P = \frac{1200}{1000}$ KW

Time = $\frac{30}{60}$ hr = 0.5 hr

Now putting the values, we get: Electrical energy = Power × Time × Days

E= 1.2 × 0.5 × 30

E = 18 KWh

Long Answer Questions:

21. A light and a heavy object have the same momentum. Find out the ratio of their kinetic energies. Which one has larger kinetic energy?

Answer: Let's assume

$p_1 = m_1 v_1$ and $p_2 = m_2 v_2$.

Also, we know that

$p_1 = p_2$

This means that $m_1 v_1 = m_2 v_2$.

Also, $m_1 < m_2$.

So, $v_1 > v_2$

Now, kinetic energy of first body (KE_1) = $\frac{1}{2}$ $m_1(v_1)^2$ = $\frac{1}{2}$ $m_1(v_1)$ v_1

Now, kinetic energy of first body (KE_2) = $\frac{1}{2}$ $2_1(v_2)^2$ = $\frac{1}{2}$ $m_2(v_2)$ v_2

On dividing both the equations to find the ratio, we get: $\frac{(KE_1)}{(KE_2)}$

$\frac{1}{2}$ $m_1(v_1)$ v_1 = $\frac{1}{2}$ $m_2(v_2)$ v_2

= $\frac{v_1}{v_2}$

We know that $v_1 > v_2$.

So, $(KE_1) > (KE_2)$

22. An automobile engine propels a 1000 kg car (A) along a levelled road at a speed of 36 kmh^{-1} . Find the power of the opposing frictional force is 100 N. Now, suppose after traveling a distance of 200 m, this car collides with another stationary car (B) of the same mass and comes to rest. Let its engine also stop at the same time. Now the car (B) starts moving on the same level road without getting its engine started. Find the speed of the car (B) just after the collision

Answer: We are given that mass of body A is equal to the mass of body B $m_A – m_B$ = 1000 kg

Also, v = 36kmh^{-1} = 10ms^{-1}

And the frictional force is 100 N the engine of car A applies a force equal to the frictional force because car A is in uniform motion. Also the formula of power is:

P = $\frac{Force\ x\ Distance}{Time}$ = force x velocity

On outing the values, we get:

P = 1000W

Also, we know that after the collision:

$m_Au_A + m_Bu_B = m_Av_A + m_Bv_B$

1000 × 10 + 1000 × 0 = 1000 × 0 + 1000 × vB

v_B = 10ms^{-1}

23. A girl having mass of 35 kg sits on a trolley of mass 55 kg. The trolley is given an initial velocity of 4ms^{-1} by applying a force. The trolley comes to rest after traversing a distance of 16m . (a) How much work is done on the trolley? (b) How much work is done by the girl? (b) How much work is done by the girl?

Answer: we know that. Mass of girl = 35 kg

mass of trolley = 5 kg,

u = 4ms^{-1}

v = 0

and s = 16m

(a) First calculate the acceleration by the equation: $v^2 - u^2 - 2as$

A = $\frac{v^2 - u^2}{2s}$ = $\frac{0-16}{2\ X\ 16}$ = - 0.5 ms^{-1}

Also,

W = F × S

W = m × a × s

W = 40 x 0.5 X 16

W = 320 J

(b) In this case force applied by the girl is zero, hence the work done is zero.

24. 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? (g =10ms^{-2}) .**

Answer: (a) we know that

F = 250 kg × 10ms^{-2} = 2500 N

S = 1 m

W = F × S

W = 2500 N x 1m

W = 2500 Nm

(b) In this case 'displacement' is zero, thus work done is zero.

(c) In this case, the force applied is equal and opposite to the gravitational force experienced by the box, so its net displacement is zero but the muscular force is being applied, and thus they get tired while holding the box.

25. 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 =10ms^{-2}).

Answer: We are given h = 20 m, and mass = 2000 × 10^3 kg = 2 × 10^6 kg

Also, we know the formula of the power as: $P = \frac{W}{\Delta t} = \frac{mgh}{\Delta t}$

$P = \frac{2\ x\ 10^6}{60}$ x 10 x 20

$P = \frac{2}{3}$ x 10^7 W

26. How is the power related to the speed at which a body can be lifted? How many kilograms will a man working at the power of 100W, be able to lift at a constant speed of 1 ms^{-1} vertically? (g =10ms^{-2}).

Answer: We know that $P = \frac{W}{\Delta t} = \frac{mgh}{\Delta t}$

Also, we can write this in the form of:

$P = mg\ \frac{h}{\Delta t}$

And $\frac{h}{\Delta t}$ = v = speed

On rearranging we will get:

$m = \frac{power}{speed\ x\ g}$

Now on putting the values we will get:

$m = \frac{100}{10\ x\ 1}$ = 10 kg

27. 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 20ms^{-1}?

Answer: A watt is a unit of power or radiant flux. One watt is the power of an agent that does work at the rate of Js^{-1}.

Also we can write 1 Kilowatt = 1000 Js^{-1} formula of the force is:

Force = $\frac{Power}{Velocity}$

Force = $\frac{1500\ x\ 1500}{20}$

F = 3.75 × 10^3 N

F = 3750N

28. Compare the power at which each of the following is moving upwards against the force of gravity? (given g =10 ms^{-2}).

Answer: (i) a butterfly of mass 1.0 g that flies upward at a rate of 0.5ms^{-1}.

(ii) a 250 g squirrel climbing up on a tree at a rate of 0.5 ms^{-1} .

Answer: (I) power = mg × velocity,

m = 1g = 10^{-3} kg

Therefore , power = 10^{-3} × 10 × 0.5

P = 5 × 10^{-3} W

(ii) **m** = 250 × 10^{-3} W

P = 250 × 10^{-3} × 10 × 0.5 W

P = 1.25W Squirrel is climbing with more power than a butterfly.