Work, Energy and Power Important Questions With Answers

NEET Physics 2023

---

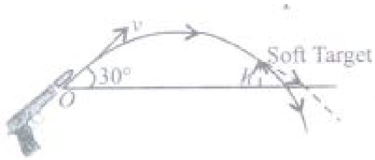
1. A particle of mass 1 g moving with a velocity $\overrightarrow{v_1} = 3\hat{i} - 2\hat{j} \text{ ms }^{-1}$ experiences a perfectly in elastic collision with another particle of mass 2 g and velocity $\overrightarrow{v_2} = 4\hat{j} - 6\hat{K} \text{ ms }^{-1}$ The velocity of the particle is
   a) 2.3 ms^{-1} **b) 4.6 ms^{-1}** c) 9.2 ms^{-1} d) 6 ms^{-1}

   Solution : -
   From conservation of momentum
   $$m_1\overrightarrow{v_1} + m_2\overrightarrow{v_2}\,(m_1 + m_2)\,\vec{v}$$
   $$1 \times \left(3\hat{i} - 2\hat{j}\right) + 2 \times (4\hat{j} - 6\hat{k}) = (1 + 2)\vec{v}$$
   $$\Rightarrow 3\hat{i} + 6\hat{j} = 12\hat{k} = 3\vec{v}. \quad \Rightarrow \vec{v}\hat{i} - 2\hat{j} - 4\hat{k}$$
   $$v = |\vec{v}| = \sqrt{1 + 4 + 16} = 4.6 \text{ ms }^{-1}$$
2. A metre scale of mass 100 kg is pivoted at one end. It is held at 30° with the horizontal. What is the potential energy associated with it?
   a) 0.10J b) 0.15J c) 0.20J **d) 0.25J**

   Solution : -
   Weight acts at the mid-point of the scale which is the centre of gravity of the scale. When the metre scale is held at 30° with the horizontal,
   h = l sin θ = 0.5 sin 30° = 0.25 m
   Hence, the centre of gravity rises by 0.25 m and potential energy
   = Mgh = 0.1 x 10 x 0.25 J = 0.25 J.
3. A bullet of mass m fired at 30° to the horizontal leaves the barrel of the gun with a velocity v. The bullet hits a soft target at a height h above the ground while it is moving downward and emerges out with half the kinetic energy it had before hitting the target. Which of the following statements is correct in respect of bullet after it emerges out of the target?
   a) The velocity of the bullet remains the same.
   b) The velocity of the bullet will be reduced to half its initial value.
   c) The velocity of the bullet will be more than half of its earlier velocity
   d) The bullet will continue to move along the same parabolic path.

   Solution : -
   Let v' be the velocity of the bullet after emerging from the target.
   Kinetic energy of the bullet emerging from the target
   $$\frac{1}{2}mv^2 = \frac{1}{2}\left(\frac{1}{2}mv^2\right) \text{ or } v^{'} = \frac{v}{\sqrt{2}} = 0.707v$$

i.e. velocity is more than half of its earlier velocity. As the bullet loses some of its vertical velocity component, therefore, velocity on emerging from the target changes. The bullet will move in a different parabolic path.



4. A truck and a car moving with the same kinetic energy are brought to rest by the application of brakes which provide equal retarding forces. Which of them will come to rest in a shorter distance?
   a) The truck b) The car **c) Both will travel the same distance before coming to rest**
   d) Cannot be predicted

   Solution : -
   Work done = Force x distance = Change in kinetic energy. Both the truck and the car had same kinetic energy and hence same amount of work is needed to be done. As retarding force applied is same for both, therefore, both the truck and the car travel the same distance before coming to rest.

5. A car is driven for 0.9 sec. If the car travelling initially with 36 km/h is stopped by the driver after observing a signal by the deceleration of 5 m/s^2, the total distance travelled by the car before coming to rest is:
   a) 19 m b) 26.5 m **c) 21 m** d) 28 m

6. A stationary body of mass 3 kg explodes into three equal pieces. Two of the pieces fly-off at right angles to each other, one with a velocity of $2\hat{i}$ m/s and the other with a velocity of $3\hat{j}$ m/s. If the explosion takes place in 10^{-5} see, the average force acting on the third piece (in newtons) is:
   a) $(2\hat{i}+3\hat{j})\times 10^{-5}$ **b)** $-(2\hat{i}+3\hat{j})\times 10^{-5}$ c) $(3\hat{j}-2\hat{i})\times 10^{5}$ d) $(2\hat{i}-3\hat{j})\times 10^{-5}$

   Solution : -
   Since, body explodes into three equal parts, therefore
   $m_1 = m_2 = m_3 = \frac{m}{3}$ = 1 kg.
   Let velocity of third part is $\vec{v}$. According to principle of conservation of linear momentum,
   Momentum of system before explosion = momentum of system after explosion
   $mv = m_1v_1 + m_2v_2 + m_3v_3$
   or $3\times 0 = 1\times 2\hat{i} + 1\times 3\hat{j} + 1\times\vec{v}$
   $\therefore \quad \vec{v} = -(2\hat{i}+3\hat{j})\ m/s$
   Force acting on the third particle
   $= \frac{m\vec{v}}{t} = \frac{-1\times(2\hat{i}+3\hat{j})}{10^{-5}}$
   = $-(2\hat{i}+3\hat{j})\times 10^{5}\ \ N$

7. If a body is placed on another body and is moving with it, then work done by frictional force on the upper body relative to ground is:
   a) -ve b) zero **c) +ve** d) unity

   Solution : -
   If a body is placed on a body and moving withth it, the force of friction on the upper body is in the direction of displacement; so work done by friction (which is a non-conservative force) on the upper body relative to the ground is positive.
   [Note: Frictional force on the lower/body is opposite to the displacement and work done in this case will be -ve.]

8. A ball collides elastically with another ball of the same mass. The collision is oblique and initially one of the balls was at rest. After the collision, the two balls move with same speeds. What will be the angle between the velocity of the balls after the collision?
   a) 30° b) 45° c) 60° d) 90°

9. A simple pendulum of length 1m has a wooden bob of mass 1 kg. It is struck by a bullet of mass 10^{-2} kg moving with a speed of 2 x 10^2 m S^{-1}. The height to which the bob rises before swinging back is
(Takeg = 10 m S^{-2})
a) 0.2m b) 0.6m c) 8m d) 1m

Solution : -
Momentum of bullet = 10^{-2} x 2 x 10^2 =2 kg ms^{-1}.
Let the combined velocity of the bob + bullet = v.
Momentum of bob + bullet = (10^{-2} + 1)v = 1.01 v.
By conservation of momentum, 1.01 v = 2 kg m S^{-1}
or $v = \frac{2}{1.01} = 1.98 \quad ms^{-1}$
By conservation of energy
$\frac{1}{2}(M + m)v^2 = (M + m)gh$
or $h = \frac{v^2}{2g} = \frac{(1.98)^2}{2 \times 10} = 0.196 \simeq 0.2 \quad m$

10. A projectile is moving at 20 m s^{-1} at its highest point, where it breaks into equal parts due to an internal explosion. One part moves vertically up at 30 m s^{-1} with respect to the ground. Then the other part will move at:
a) 20 ms^{-1} b) $10\sqrt{31} \ ms^{-1}$ **c) 50 ms^{-1}** d) 30 ms^{-1}

11. Two bodies of masses m and 4m are moving with equal kinetic energy. The ratio of their linear momenta is equal to:
a) 4 : 1 b) 1 : 1 **c) 1 : 2** d) 1 : 4

Solution : -
Since, $E = \frac{1}{2}\frac{p^2}{m}$
for m_1 = m, m_2 = 4 m
$E_1 = E_2$
So, $\frac{p_1}{p_2} = \sqrt{\frac{m_1}{m_2}} = \sqrt{\frac{m}{4m}}$
or, $p_1 : p_2 = 1 : 2$

12. A boy chews 100 g of ice in 5 minute. Iflatentheatoficeis 80 cal/sec, his power is:
a) 56W b) 28W **c) 112 W** d) 224 W

13. A ball loses 15.0% of its kinetic energy when it bounces back from a concrete wall. With what speed you must throw it vertically down from a height of 12.4 m to have it bounce back to the same height? (ignore air resistance)
a) 6.55 m/s b) 12.0 m/s c) 8.6 m/s d) 4.55 m/s

Solution : -
Given: h = 12.4, V = ?
$v^2 = u^2 + 2gh$
$v^2 = u^2 + 2 \times 9.8 \times 12.4$
$= u^2 + 243.04$
Kinetic energy of the ball when it just hits the wall
$= \frac{1}{2}mv^2 = \frac{1}{2}m\left(u^2 + 243.04\right)$
The KE of ball after the impact
$= \frac{(100 - 15)}{100} \times \frac{1}{2}m\left(u^2 + 243.04\right)$
$= \frac{85}{100} \times \frac{1}{2}m\left(u^2 + 243.04\right)$

Let v_2 be the upward velocity just after the collision with the ground.

So, $\frac{1}{2}mv_2^2 = \frac{85}{100} \times \frac{1}{2}m\left(u^2 + 243.04\right)$

$v_2^2 = \frac{85}{100}\left(u^2 + 243.04\right)$

Now, taking upward motion

v = 0,u = v_2

$v^2 = u^2 - 2gh$

$= \frac{85}{100}\left(u^2 + 243.04\right) - 2 \times 9.8 \times 12.4$

or $\frac{85}{100}u^2 = 36.46$ or $u^2 = 12.89$

∴ u = 6.55 m/s

14. A particle of mass 5 m initially at rest explodes into three fragments with mass ratio 3: 1: 1. Two of the fragments each of mass m are found to move with a speed 60 m/s in mutually perpendicular directions. The velocity of third fragment is:

a) $60\sqrt{2}\ ms^{-1}$ b) $20\sqrt{3}\ ms^{-1}$ c) $10\sqrt{2}\ ms^{-1}$ **d)** $20\sqrt{2}\ ms^{-1}$

Solution : -

Applying law of conservation of momentum,

$(m \times 60)^2 + (m \times 60)^2 = (3m \times V)^2$

Solving, we get; V = $20\sqrt{2}\ ms^{-1}$

15. A force of 10N displaces an object by 10 m. If work done is 50 J, then direction of force, make an angle with the direction of displacement:

a) 120^0 b) 90° **c) 60°** d) none of these

16. An engine pumps water continuously through a hole. If the speed with which water passes through the hole nozzle is v and k is the mass per unit length of the water jet as it leaves the nozzle, the rate at which kinetic energy is being imparted to the water is:

a) $\frac{1}{2}kv^2$ **b)** $\frac{1}{2}kv^3$ c) $\frac{v^2}{2k}$ d) $\frac{v^3}{2k}$

Solution : -

k = mass/length= $\frac{dm}{dx}$

v =- speed of water

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

$\frac{d}{dt}(KE) = \frac{1}{2}\left(\frac{dm}{dx}\right)\left(\frac{dx}{dt}\right)v^2 = \frac{1}{2}kvv^2 = \frac{kv^3}{2}$

17. On microscopic level, all forms of energy may be studied as:

a) potential b) kinetic **c) potential or kinetic** d) nuclear

Solution : -

On microscopic scale, all forms of energy are either kinetic or potential.

18. A 1.5 kg block is initially at rest on a horizontal frictionless surface when a horizontal force in the positive direction of x-axis is applied to the block. The force is given by:
$\vec{F} = \left(4 - x^2\right) \hat{i}$, where x is in metre and the initial position of the block is x = 0 The maximum kinetic energy of the block between x = 0 and x = 2. 0m is
a) 2.33 J b) 8.67 J **c) 5.33 J** d) 6.67 J

Solution : -
Let H be the total height of plane and h the height descended down the plane. Then:
h= s sinθ
From conservation of mechanic a! energy,
or $\frac{1}{2}mv^2$+ mg(H - h) = constant
or $\frac{1}{2}mv^2$-mgh = constant
or v^2 - 2gh = constant

19. A bolt of mass 0.2 kg falls from the ceiling of an elevator moving down with an uniform speed of 5 m s^{-1}. It hits the floor of the elevator (length of the elevator = 5 m) and does not rebound. The amount of heat produced by the impact is (Takeg = 10m S^{-2})
a) 5 J **b) 10 J** c) 15 J d) 20 J

Solution : -
Here, m = 0.2 kg, v = 5 m S^{-1}
h = length of elevator = 5 ill
As relative velocity of the bolt w.r.t. elevator is zero, therefore, in the impact, only potential energy of the bolt is converted into heat energy.
Amount of heat produced
= Potential energy lost by the ball = mgh
= (0.2 kg) (10 m s^{-2}) (5 m) = 10 J

20. A beam of cathode rays is subjected to crossed Electric (E) and Magnetic fields (B). The fields are adjusted such that the beam is not deflected. The specific charge of the cathode rays is given by _________
a) $\frac{B^2}{2VE^2}$ b) $\frac{2VB^2}{E^2}$ c) $\frac{2VE^2}{B^2}$ **d)** $\frac{E^2}{2VB^2}$

Solution : -
For no deflectipn of beam eE = evB
$\Rightarrow v = \frac{E}{B}$
$\text{Also, } \frac{1}{2}mv^2 = eV$
$\Rightarrow v = \frac{E}{B}$
$\therefore \frac{e}{m} = \frac{v^2}{2V} = \frac{E^2}{2VB^2}$

21. 2A ball of mass 0.2 kg is thrown vertically upwards by applying a force by hand. If the hand moves 0.2 m while applying the force and the ball goes upto 2 m height further. Find the magnitude of force. (Consider g = 10 m/s^2)
a) 22 N b) 4 N c) 16 N **d) 20 N**

Solution : -
The work done by the hand = Fs. But this is equal to the maximum potential energy of the ball.
$\therefore$ mgh = Fs or 0.2 x 10 x 2 = F x 0.2
$\therefore \quad F = \frac{0.2 \times 10 \times 2}{0.2} =$ 20 N.

22. In case of rifle shooting the kick will be minimum when:

a) In case of rifle shooting the kick will be minimum when: b) a light rifle is held tightly against shoulder
c) a heavy rifle is held loosely against shoulder **d) a heavy rifle is held tightly against shoulder**

Solution : -

From above question, it follows that if $M >> m, |\vec{V}| << |\vec{v}|$ i. e., heavier the rifle, lesser will be the recoil speed. Further, if the rifle is held tightly against shoulder, we will be hurt lesser

23. A plastic ball is dropped from a height of 1m and rebounds several times from the floor. If 1.03 sec elapse from the moment it is dropped to the second impact with the floor, what is the coefficient of restitution?

a) 0.03 **b) 0.64** c) 0.02 d) 0.05

Solution : -

The time elapsed from the moment it is dropped to the second impact with the floor is,

$$t = \sqrt{\frac{2h}{g}}(1+2e)$$

where h is the initial height of the body from the ground

$$1.03 = \sqrt{\frac{2}{9.8}}(1+2e)$$

Solving, we get; e = 0.64

24. The work-energy theorem states that the change in

a) kinetic energy of a particle is equal to the work done on it by the net force
b) kinetic energy of a particle is equal to the work done by one of the forces acting on it
c) potential energy of a particle is equal to the work done on it by the net force
d) potential energy of a particle is equal to the work done by one of the forces acting on it

Solution : -

The work-energy theorem states that the change in kinetic energy of a particle is equal to the work done on it by the net force.

i.e., $K_f - K_i = W_{net}$

25. A spring gun of spring constant 90 N/cm is compressed 12 cm by a ball of mass 16 g. If the trigger is pulled, the velocity of the ball is:

a) $50ms^{-1}$ b) $9ms^{-1}$ c) $40ms^{-1}$ **d) $90ms^{-1}$**

Solution : -

Kinetic energy of ball = potential energy of spring

I. e., $\frac{1}{2}mv^2 = \frac{1}{2}kx^2$

$\therefore$ $16 \times 10^{-3} \times v^2 = \frac{90}{10^{-2}} \times \left(12 \times 10^{-2}\right)^2$

or $v^2 = \frac{90 \times 144 \times 10^{-4}}{10^{-2} \times 16 \times 10^{-3}}$

or $v = 90ms^{-1}$

26. A spherical ball of mass ml collides head on with another ball of mass m_2 at rest. The collision is elastic. The fraction of kinetic energy lost by m_1 is :

a) $\frac{4m_1m_2}{(m_1+m_2)^2}$ b) $\frac{m_1}{m_1+m_2}$ c) $\frac{m_2}{m_1+m_2}$ d) $\frac{m_1m_2}{(m_1+m_2)^2}$

Solution : -

According to momentum conservation, we get

$m_1v_{1i} = m_1v_{1j} + m_2v_{2j}$ ... (i)

where V_{1i} is the initial velocity of spherical ball of mass

m_1 before collision and v_{1f} and v_{2f} are the final velocities of the balls of masses m1 and m2 after collision.
According to kinetic energy conservation, we get

$\frac{1}{2}m_1v_{1i}^2 = \frac{1}{2}m_1v_{1f}^2 + \frac{1}{2}m_2v_{2f}^2$

$m_1v_{1i}^2 = m_1v_{1f} + m_2v_{2f}^2$ ... (i)

From Eqs. (i) and (ii), it follows that

$m_1v_{1i}\left(v_{2f} - v_{1i}\right) = m_1v_{1f}\left(v_{2f} - v_{1f}\right)$

or $v_{2f}(v_{1i} - v_{1f}) = v_{1i}^2 - v_{1f}^2 = (v_{1i} - v_{1f})(v_{1i} + v_{1f})$

$\therefore V_{2j} = V_{1i} + V_{1j}$

Substituting this in Eq. (i), we get

$v_{1f} = \frac{(m_1 - m_2)}{m_1 + m_2}v_{1i}$ ... (ii)

The initial kinetic energy of the mass m_1 is

$K_{1i} = \frac{1}{2}m_1v_{1i}^2$

The final kinetic energy of the mass m_1 is

$K_{1f} = \frac{1}{2}m_1v_{1f}^2 = \frac{1}{2}m_1\left(\frac{m_1 - m_2}{m_1 + m_2}\right)^2 v_{1i}^2$ (Using (iii))

The fraction of kinetic energy lost by mi is

$f = \frac{K_{1i} - K_{1f}}{K_{1i}} = \frac{\frac{1}{2}m_1v_{1f}^2 - \frac{1}{2}m_1\left(\frac{m_1 - m_2}{m_1 + m_2}\right)^2 v_{1i}^2}{\frac{1}{2}m_1v_{1i}^2}$

$= 1 - \left(\frac{m_1 - m_2}{m_1 + m_2}\right)^2 = \frac{4m_1m_2}{(m_1 + m_2)^2}$

27. block of mass 2 kg is dropped from a height of 40 cm on a spring whose force-constant is 1960 N m^{-1}. The maximum distance through which the spring is compressed by :

a) 5 cm b) 15 cm c) 20 cm **d) 10 cm**

Solution : -

mg (h + x) = kx $= \frac{1}{2}kx^2$

Here, m = 2 kg, h = 40 cm

k = 1960 N m^{-1} and g = 10 m S^{-2}

$\therefore$ 2 x 10(0.40 + x) = $\frac{1}{2}$ x 1960 x^2

On solving, we get x = 10 cm.

28. A ball is dropped from height 20 m. If coefficient of restitution is 0.9, what will be the height attained after first bounce?

a) 1.62 m **b) 16.2 m** c) 18 m d) 14 m

Solution : -

Height attained after first bounce:

$h_1 = e^2h$

h_1 = (0.9)2 x 20 = 0.9 x 0.9 x 20 = 16.2 m .

29. Assertion: The work done by the spring force in a cyclic process is zero.

Reason: Spring force is a conservative force.

a) If both assertion and reason are true and reason is the correct explanation of assertion.

b) If both assertion and reason are true but reason is not the correct explanation of assertion.

c) If assertion is true but reason is false. d) If both assertion and reason are false

Solution : -

In case of spring force, the work done only depends on the initial and final positions. So spring force is a conservative force and in cyclic process the initial and final positions are same, hence work done is zero.

30. A spacecraft of mass M moves with velocity V in free space at first, then it explodes, breaking into two pieces. If after explosion a piece of mass m comes to rest, the other piece of spacecraft will have a velocity:

a) $\frac{MV}{M-m}$ b) $\frac{MV}{M+m}$ c) $\frac{mV}{M-m}$ d) $\frac{mV}{M+m}$

Solution : -

According to law of conservation of momentum

$\vec{p_s} = constant$ or $\vec{p_{spaceraft}} = \vec{p_{pieces}}$

or MV = m x 0 + (M - m)v or $v = \left(\frac{MV}{M-m}\right)$

31. A bomb of mass 30 kg at rest explodes into two pieces of masses 18 kg and 12 kg. The velocity of 18 kg mass is 6 ms^{-1}. The kinetic energy of the other mass is _________

a) 324J **b) 486J** c) 256J d) 524J

Solution : -

According to the principle of conservation of linear momentum,

$m_1 v_1 + m_2 v_2 = 0$

$v_2 = \left(\frac{-m_1}{m_2}\right) v_1 = \left(\frac{-18}{12}\right) 6 = -9 \text{ ms}^{-1}$

$E. = \frac{1}{2} m_2 v_2^2 = \frac{1}{2} \times 12 \times 9^2 = 486 \text{ J}$

32. In two separate collisions, the coefficients of restitutions 'e_1' and 'e_2' are in the ratio 3: 1. In the first collision the relative velocity of approach is twice the relative velocity of separation. Then the ratio between the relative velocity of approach and relative velocity of separation in the second collision is:

a) 1:6 b) 2:3 c) 3:2 **d) 6:1**

Solution : -

$\frac{e_1}{e_2} = \frac{3}{1}$

But $e_1 = \frac{v}{2v} = \frac{1}{2}$

$\therefore 3e_2 = \frac{1}{2}$ or $e_2 = \frac{1}{6}$

Ratio between relative velocity of approach and relative velocity of separation = 6:1

33. A spring is compressed between two toy carts of masses m_1 and m_2. When the toy carts are released the spring exerts on each toy cart equal and opposite forces for the same time t. If the coefficients of friction J.l between the ground and the toy carts are equal, then the displacements of the toy carts are in the ratio

a) $\frac{s_1}{s_2} = \frac{m_2}{m_1}$ b) $\frac{s_1}{s_2} = \frac{m_1}{m_2}$ **c)** $\frac{s_1}{s_2} = \left(\frac{m_2}{m_1}\right)^2$ d) $\frac{s_1}{s_2} = \left(\frac{m_1}{m_2}\right)^2$

Solution : -

Minimum stopping distance = s

Force of friction = μmg

Work done against the friction = W =μmgs

Initial kinetic energy of the toy cart=($p^{2/}$2m)

μmgs = (p^2/2m)

or s = (p^2/2μgm2)

For the two toy carts, momentum is numerically the same. Further μ and g are the same for the toy carts.

$$\frac{s_1}{s_2} = \left(\frac{m_2}{m_1}\right)^2$$

As displacements s_1 and s_2 are in opposite directions, hence

$$\frac{s_1}{s_2} = \left(\frac{m_2}{m_1}\right)^2$$

34. A particle of mass m, strikes on ground with angle of incidence 45°. If coefficient of restitution $e = 1\sqrt{2}$, the velocity of reflection is:

a) $\frac{\sqrt{3}}{2}v$ b) $\sqrt{3}v$ c) $\frac{1}{2}v$ d) $\sqrt{3}v$

35. In an elastic collision between two bodies, complete energy is transferred when:

a) both bodies have equal mass b) both bodies are moving

c) heavy body is moving and lighter one is at rest d) heavy body is moving and lighter one is at rest

36. A block of mass 5 kg is resting on a smooth surface. At what angle a force of 20 N be acted on the body so that it will acquired a kinetic energy of 40 J after moving 4 m?

a) 30° b) 45° **c) 60°** d) 120°

Solution : -

According to work-energy theorem

W = Change in kinetic energy

$$FS\cos\theta = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$$

Substituting the given values, we get

20 x 4 x cos 8 = 40 - 0

$$\cos\theta = \frac{40}{80} = \frac{1}{2}$$

$$\theta = cos^{-1}\left(\frac{1}{2}\right) = 60^0$$

37. A block of mass 0.50 kg is moving with a speed of 2.00 ms^{-1} on a smooth surface. It strikes another mass of 1.00 kg and then they move together as a single body. The energy loss during the collision is:

a) 0.16 J b) 1.00 J **c) 0.67 J** d) 0.34 J

38. Which of the following statements is correct?

a) Heat is absorbed in exothermic reaction. b) Heat is released in endothermic reaction.

c) Energy released in burning 1 litre of gasoline is 300 MJ.

d) Chemical energy is associated with the forces that give rise to the stability of substances.

Solution : -

In exothermic reaction heat is released. In endothermic reaction heat is absorbed.

Energy released in burning 1 litre of gasoline is 30 MJ (=3x107J).

39. For photoelectric ernission frorn certain metal the cut-off frequency is n. If radiation of frequency 2v impinges on the metal plate, the maximum possible velocity of the emitted electron will be ___________ (m is the electron mass)

a) $\sqrt{hv/m}$ **b)** $\sqrt{2hv/m}$ c) $2\sqrt{hv/m}$ d) $\sqrt{hv/(2m)}$

Solution : -

According to photo electric equation

$hv' = hv + K_{\max}$

$h \cdot 2v = hv + \frac{1}{2}mv_{\max}^2 \quad [\therefore v' = 2v$

$\Rightarrow hv = \frac{1}{2}mV_{\max}^2 \Rightarrow V_{\max} = \sqrt{\frac{2hv}{m}}$

40. Consider a drop of rain water having mass 1g falling from a height of 1 km. It hits the ground with a speed of 50 m/ s. Take g constant with a value of 10 m/s^2. The work done by the (i) gravitational force and the (ii) resistive force of air is _________

a) (i)-10 J, (ii)-8.25 J b) $(\mathrm{i})\ 1.25\ \mathrm{J}, (\ \mathrm{ii}\ ) - 8.25\ \mathrm{J}$ c) $(\mathrm{i})\ 100\ \mathrm{J},\ (\mathrm{ii})\ - 8.75\ \mathrm{J}$

d) $(\mathrm{i})\ 10\ \mathrm{J},\ (\mathrm{ii})\ - 8.75\ \mathrm{J}$

Solution : -

According to work KE theorem, we have change in

K.E. = work done by ail of the forces.

Work done by gravitational force,

W_g = mgh

$= 10^{-3} \times 10 \times 1 \times 10^3$

= 10 g

Now, from work-KE theorem, we have

$\mathrm{D}K = W_{\text{gravity}} + W_{\text{air resistance}}$

$\Rightarrow \frac{1}{2} \times mv^2 = mgh + \mathrm{W}_{\text{air resistance}}$

$\Rightarrow \mathrm{W}_{\text{air resistance}} = \frac{1}{2}mv^2 - mgh$

$= 10^{-3}\left(\frac{1}{2} \times 50 \times 50 - 10 \times 10^3\right)$

$= -8.75\ \text{Joules}$

41. A bus can be stopped by applying a retarding force F when it is moving with a speed u on a level road. The distance covered by it before coming to rest is s. If the load of the bus increases by 50% because of passengers, for the same speed and same retarding force, the distance covered by the bus to come to rest shall be:

a) 1.5 s b) 2 s c) 1 s d) 2.5 s

Solution : -

First case: $\frac{1}{2}mv^2 = Fs$

$\frac{1}{2}\left(m + \frac{m}{2}\right)v^2 = Fs'$

Dividing eqn. (ii) by eqn. (i), $\frac{s'}{s} = \frac{3}{2}$ or s' = 1.5 s .

42. A ball of mass M falls from a height h on a floor which the coefficient of restitution is e. The height attained by the ball after two rebounds is

a) e^{2}h b) eh^2 **c) e^{4}h** d) $\frac{h}{e^4}$

Solution : -

A ball falling from height h reaches the floor with velocity

$\sqrt{2gh}$

By definition

e=$\frac{velocity of separation}{velocity of separation}$

∴.Rebound velocity = e$\sqrt{2gh}$
∴.Rebound height = e^2h
After two rebounds, height = e^4h

43. A smooth sphere is moving on a horizontal surface with velocity vector $2\hat{i} + 2\hat{j}$ immediately before it hits a vertical wall. The wall is parallel to $\hat{j}$ vector and the coefficient of restitution between the sphere and the wall is e = $\frac{1}{2}$ The velocity vector of the sphere after it hits the wall is:
a) $\hat{i} - \hat{j}$ **b)** $-\hat{i} + 2\hat{j}$ c) $-\hat{i} - \hat{j}$ d) $2\hat{i} - \hat{j}$
Solution : -
$\hat{j}$ component, i. e. , component of velocity parallel to wall remains unchanged while $\hat{i}$ component will become $(-\frac{1}{2})(2\hat{i})$ or $-\hat{i}$
Therefore, velocity vector of the sphere after it hits the wall is $-\hat{i} + 2\hat{j}$

44. Two particles of masses m_l ,m_2 move with initial velocities u_1 and u_2. On collision, one of the particles gets excited to higher level, after absorbing energy E. If final velocities of particle be v_1 and v_2 then we must have:
a) $\frac{1}{2}m_1u_1^2 + \frac{1}{2}m_2u_2^2 + \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2 - E$
b) $\frac{1}{2}m_1u_1^2 + \frac{1}{2}m_2u_2^2 - E = \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2$
c) $\frac{1}{2}m_1u_1^2 + \frac{1}{2}m_2u_2^2 + E = \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2$
d) $\frac{1}{2}m_1u_1^2 + \frac{1}{2}m_2u_2^2 + \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2 - E$

45. Two trucks, one loaded (A) and the other unloaded (B) are moving and have same kinetic energy. The mass of A is double that of B. Brakes are applied to both and are brought to rest. If distance covered by A before coming to rest is S_1 and that by B is S_2, then:
a) $S_l = S_2$ b) $S_1 = 2S_2$ c) $2s_1 = S_2$ d) $S_1 = 4S_2$
Solution : -
According to above question, stopping distance,
s = (K/F)
AsK and F are the same for both the trucks A and B, hence $s_1 = s_2$.
[**Note:** It is worth noting that if a light and a heavy body are moving with same kinetic energy and same retarding force is applied, both will stop after travelling same distance.]

46. Assertion: The conservation of kinetic energy in elastic collision applies after the collision is over and does not hold at every instant of the collision.
Reason: During a collision the total linear momentum is conserved at each instant of the collision.
a) If both assertion and reason are true and reason is the correct explanation of assertion.
b) If both assertion and reason are true but reason is not the correct explanation of assertion.
c) If assertion is true but reason is false. d) If both assertion and reason are false

47. Work equal to 25 J is done on a mass of 2 kg to set it in motion. If whole of it is used to increase the kinetic energy, then velocity acquired by the mass (in m s^{-1}) is:
a) 5 b) 12.5 c) 25 **d) 50**

48. A mass of 0.5 kg moving with a speed of 1.5 m/s on a horizontal smooth surface, collides with a nearly weightless spring of force constant k = 50 N/m. The maximum compression of the spring would be ___________
a) 0.5m **b) 0.15m** c) 0.12m d) 1.5m

Solution : -

$Here, \frac{1}{2}mv^2 = \frac{1}{2}kx^2$

$\Rightarrow \quad mv^2 = kx^2$

$or 0.5 \times (1.5)^2 = 50 \times x^2$

$\therefore \; x = 0.15 \text{ m}$

49. A particle of mass m_1 is moving with a velocity v_1 and another particle of mass m_2 is moving with a velocity v_2. Both of them have the same momentum but their different kinetic energies are E_1 and E_2 respectively. If $m_1 > m_2$ then ____________

a) $E_1 = E_2$ **b)** $E_2 > E_1$ c) $\frac{E_1}{E_2} = \frac{m_1}{m_2}$ d) $E_1 > E_2$

Solution : -

$E = \frac{p^2}{2m}$

$\Rightarrow E_1 = \frac{p_1^2}{2m_1} \text{ and } E_2 = \frac{p_2^2}{2m_2}$

$\Rightarrow m_1 = \frac{p_1^2}{2E_1} \text{ and } m_2 = \frac{p_2^2}{2E_2}$

$\because m_1 > m_2 \Rightarrow \frac{m_1}{m_2} > 1$

$\therefore \frac{p_1^2 E_2}{E_1 p_2^2} > 1 \Rightarrow \frac{E_2}{E_1} > 1 \quad [\because p_1 = p_2]$

$\text{or, } E_2 > E_1$

50. In the question number 15, the work done by applied force is

a) 10 J b) 50 J **c) 100 J** d) 150 J

Solution : -

Work done by applied force is

W = Fd = 10N x 10m = 100 J