Transweb Educational Services Pvt Ltd
B -147, Sector -6 Noida, UP - 201301,
www.askiitians.com
Email: info@askiitians.com
Tel: 1800-2000-838

Class: 11
Subject: Physics
Topic: Work and Energy
No. of Questions: 20
Duration: 60 Min
Maximum Marks: 60

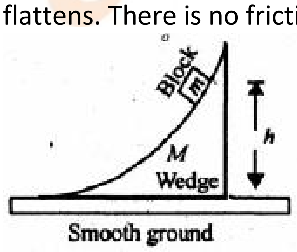
1. It is well known that a raindrop falls under the influence of the downward gravitational force and opposing resistive force. The latter is known to be proportional to the speed of the drop. Consider a drop of mass 1gm falling from a height of 1 km. If it hits the ground with a speed of 50 ms-1. The work done by the resistive force is
   A. -1.25 j
   B. -4.75 j
   C. -8.75 j
   D. -10 j

   Sol: C
   Energy at the ground = mgh – $W_{resistive\ force}$

2. A body of mass 0.5 kg travels in a straight line with velocity $v = ax^{3/2}$, where $a = 5\ m^{-1/2}s^{-1}$. The work done by the displacement from x = 0 to x = 2 m is
   A. 30 j
   B. 40 j
   C. 50 j
   D. 60 j

   Sol: C
   W = F.dx = ma.dx = m(v.dv/dx).dx = mv.dv

3. Read the passage and answer the question below:
   A block of mass m slides down a wedge of mass M as shown. The whole system is at rest, when the heightof the block is h above the ground. The wedge surface is smooth and gradually flattens. There is no friction between wedge and ground.



   If there is no friction anywhere, the speed of the wedge, as the block leaves the wedge, is

A. $m\sqrt{\frac{2gh}{(M+m)M}}$
B. $M\sqrt{\frac{2gh}{(M+m)m}}$
C. $(\sqrt{2gh})\frac{m}{M+m}$
D. $(\sqrt{2gh})\frac{M}{M+m}$

Sol: A
Apply conservation of momentum between m and M
$mv_m + Mv_M = 0$
Apply Conservation of energy,
$Mgh = ½.m.v_m^2 + ½.Mv_M^2$

4. A ball falls under gravity from a height 10 m with an initial velocity v_0. It hits the round, loses 50% of itsenergy in collision and it rises to the same height. What is the value of v_0?
   A. 14 m/s
   B. 7 m/s
   C. 28 m/s
   D. 9.8 m/s

Sol: A
(a) Let v be the velocity when it hits the ground.
Then v2 $= v_0^2 + 2g \times 10 = v_0^2 + 2 \times 9.8 \times 10$
i.e., $v^2 = v_0^2 + 196$
Let v' be the velocity after impact and it reaches the same height 10 m.
$v'^2 = 2 \times 9.8 \times 10$
$v'^2 = 196$
$v' = 14$ m/s
Ratio of kinetic energy before impact and after
impact $= \frac{\frac{1}{2}mv^2}{\frac{1}{2}mv'^2} = \frac{v^2}{v'^2} = \frac{v_0^2 + 196}{196} = 2$
$\therefore v_0^2 = 2 \times 196 - 196 = 196$
$v_0 = 14 \ m/s$

5. An object is acted upon by the forces $\vec{F}_1 = 4\hat{\imath}$ N and $= \vec{F}_2 = (\hat{\imath} - \hat{\jmath})N$. If the displacement of the object is D $= (\hat{\imath} - 6 - \hat{\jmath} - 6\,\hat{k})$ m, the kinetic energy of the object
   A. Remains constant
   B. Increases by 1 J
   C. Decreases by 1 J
   D. Decreases by 2 J

   Sol: C

   (c) : The work done on the object

   $W = \vec{F}_1.\vec{D} + \vec{F}_2.\vec{D}$,

   where $\vec{D}$ is the displaceme nt veetor.

   $\therefore W = 4(1) + (1)(1) + (-1)(6) = -1\,J$

   Frem work - energy the orem

   $W = KE_f - KE_i = -1\,J$

   $\Rightarrow$ 1inetic energy decreases by 1 J.

6. A body is moved along a straight line by a machine delivering a constant power. The distance moved by the body in time t is proportional to
   A. $t^{3/4}$
   B. $t^{3/2}$
   C. $t^{1/4}$
   D. $t^{1/2}$

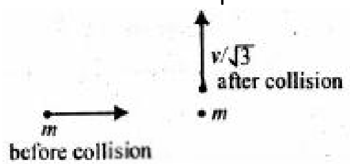
   Sol: B
   F.v = Power = constant
   (Mdv/dt)v =constant
   V^2 =K.t
   Put, v = dx/dt
   And solve

7. Trolley of mass 300 kg carrying a sandbag of 25 kg is moving uniformly with a speed of 36 km/h on a frictionless track. After a while, sand starts leaking out of a hole on the floor of the trolley at the rate of 0.05kg/s. Speed of the trolley when the entire sand bag is empty is
   A. 27 kmph
   B. 36 kmph
   C. 38 kmph
   D. 40 kmph

   Sol: B

As the momentum leaving out of the system (Vertical direction) is perpendicular to the direction of momentum of the trolley (Horizontal direction), momentum along the direction of momentum must remain constant.

8. A mass m moves with a velocity v and collides inelastically with another identical mass. After collisionthe first mass moves with velocity in a direction perpendicular to the initial direction of motion. Find the speed of the 2^{nd} mass after collision



A. $\frac{2}{\sqrt{3}}v$
B. $\sqrt{\frac{v}{\sqrt{3}}}$
C. v
D. $\sqrt{3v}$

Sol: A
Apply momentum conservation along the horizontal and vertical direction separately.

9. A ball of mass 1 kg collides with a wall with speed 8 ms^{-1} and rebounds on the same line with the same speed. If mass of the wall is taken as infinite, the work done by the ball on the wall is
A. 6 J
B. 8 J
C. 9 J
D. Zero

Sol: D
The wall doesn't move during the time of contact, thus displacement is zero, Hence the work done.

10. A spring of force constant 800 N/m has an extension 5 cm. The work done in extending it from 5 cm to 15 cm is
A. 16 J
B. 8 J
C. 32 J
D. 24 J

Sol: B
Use the formula,
Potential energy = ½.k.x^2

Transweb Educational Services Pvt Ltd
B -147, Sector -6 Noida, UP - 201301,
www.askiitians.com
Email: info@askiitians.com
Tel: 1800-2000-838

11. A nucleus ruptures into two nuclear parts which have their velocity ratio equal to 2 : 1. The ratio of their respective nuclear sizes (nuclear radii) is
    A. 1 : 2
    B. $1 : \sqrt{2}$
    C. $1 : 2^{1/3}$
    D. 1 : 8

    Sol: C
    Use momentum conservation equation,

    $m_1v_1 + m_2v_2 = 0$

    $m_1/m_2 = 1/2$

    mass = volume x density,

    Density is same for both components.

12. A mass 2m is tied to one end of a light rod of length ***l***. What horizontal velocity should be imparted tothe lower end so that it may just take up the horizontal position?
    A. $\sqrt{2gl}$
    B. $\sqrt{gl}$
    C. $\sqrt[2]{gl}$
    D. $\sqrt[4]{gl}$

    Sol: A
    Apply Energy Conservation in the two positions
    Potential energy increases by mgl, which is equal to the change in Kinetic energy.

13. The question contains Statement-I (Assertion) and Statement-2 (Reason). The question has fourchoices. You have to select the correct choice.

    Assertion : A block of mass 'M' is placed on moving railroad car moving with velocity 'v' The kinetic energy of the block is ½ M v^2 in all frames.
    Reason : The kinetic energy of a system or body is different in different frames.
    A. if statement-1 is true but statement-2 is false
    B. if statement-1 is false and statement-2 is true.
    C. if both statement-1 and statement-2 are true and statement-2 is the correct explanation of statement-1
    D. if both statement-1 and statement-2 are true but statement-2 is not the correct explanation of statement-1

Transweb Educational Services Pvt Ltd
B -147, Sector -6 Noida, UP - 201301,
www.askiitians.com
Email: info@askiitians.com
Tel: 1800-2000-838

Sol: B

14. A particle of mass m moves on the x-axis under the influence of a force of attraction towards the originO given by F = - $(k/x^2)\hat{i}$if the particle starts from rest at a distance 'a' from the origin, the speed it willattain to reach a poi 1 cm2 a distance x
    A. $\sqrt{\frac{2k}{m}}\left[\frac{a-x}{ax}\right]^{1/2}$
    B. $\sqrt{\frac{2k}{m}}\left[\frac{a+x}{ax}\right]^{1/2}$
    C. $\sqrt{\frac{k}{m}}\left[\frac{a-x}{ax}\right]^{1/2}$
    D. $\sqrt{\frac{m}{2k}}\left[\frac{a-x}{ax}\right]^{1/2}$

    Sol: A
    A)

$$F = -\frac{k}{x^2}$$

$$m\frac{vdv}{dx} = -\frac{k}{x^2}$$

$$vdv = -\frac{k}{m}\frac{dx}{x^2} \Rightarrow \int_0^v vdv = -\frac{k}{m}\int_a^x \frac{dx}{x^2}$$

$$\Rightarrow \frac{v^2}{2} = \left[+\frac{k}{m}\frac{1}{x}\right]_a^x = \frac{k}{m}\left(\frac{1}{x} - \frac{1}{a}\right)$$

$$\Rightarrow v = \sqrt{\frac{2k}{m}}\left[\frac{(a-x)}{ax}\right]^{1/2}$$

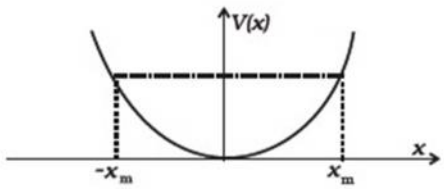
15. A neutron travelling with velocity *v* and kinetic energy E collides elastically head-on with a stationary nucleus of mass number A. The fraction of the total energy retained by the neutron is
    A. $\frac{(1-A)^2}{(1+A)^2}$
    B. $\frac{4A}{(1+A)^2}$
    C. $\left(\frac{A+1}{A}\right)^2$
    D. $\left(\frac{A}{A-1}\right)^2$

    Sol: A
    Apply momentum conservation and energy conservation.

Transweb Educational Services Pvt Ltd
B -147, Sector -6 Noida, UP - 201301,
www.askiitians.com
Email: info@askiitians.com
Tel: 1800-2000-838

16.

The potential energy function for a particle executing linear SHM is given by $(1/2)kx^2$ where k is the force constant of the oscillator (Fig. 6.2). For k = 0.5N/m, the graph of V(x) versus x is shown in the figure. A particle of total energy E turns back when it reaches $x = \pm x_m$. If V and K indicate the P.E. and K.E., respectively of the particle at $x = +x_m$, then which of the following is correct?



- (a) V = O, K = E
- (b) V = E, K = O
- (c) V < E, K = O
- (d) V = O, K < E.

B

Potential energy is maximum and equal to the total energy

17. One end of a spring of natural length h and spring constant k is fixed at the ground and the other is fitted with a smooth ring of mass m which is allowed to slide on a horizontal rod fixed at a height h. Initially, the spring makes an angle of 37° with the vertical when the system is released from rest. The speed of the ring when the spring becomes vertical

$$\left[Take \ \cos 37^\circ = \frac{1}{1.25} \right]$$

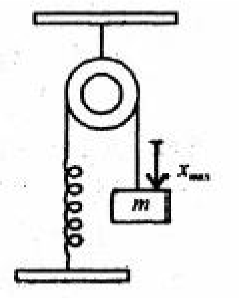
A. √k/m
B. h/2√k/m
C. h/3√k/m
D. h/4 √k/m

Ans. D

Transweb Educational Services Pvt Ltd
B -147, Sector -6 Noida, UP - 201301,
www.askiitians.com
Email: info@askiitians.com
Tel: 1800-2000-838

Initially there is only Potential energy = $1/2.k.x^2$
x = 5h/4
Finally, only kinetic energy is there as the spring has restored to its natural length.

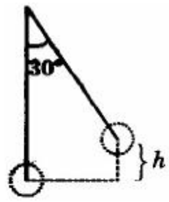
18. Consider the situation shown in figure. Initially the spring is unstretched when the system is released from rest. Assuming no friction in the pulley, the maximum elongation of the spring is



A. mg/k
B. 2mg/k
C. 3mg/k
D. 4mg/k

Ans. B
Apply energy conservation,
maximum extension in spring = x (let) = decrease in height
$mgx = 1/2.kx^2$

19. A mass of 1 kg suspended by a thread deviates through an angle of 30°. Find the tension of the thread at the moment the weight passes through the position of equilibrium.
    A. 12.4 N
    B. 15 N
    C. 24.8 N
    D. 6.2 N
    Ans. A



$T = mg + \frac{mv^2}{l}$

By the conservati on of energy

mgh $\frac{mv^2}{2}$

$v^2 = 2gh$

But $h = l - l\cos 30° = l(1 - \cos 30°)$

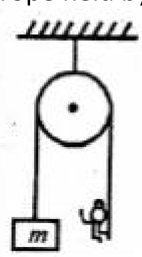
$\therefore v^2 = 2gl(1 - \cos 3o°)$

and $T = mg[1 + 2(1 - \cos 3o°)$

Given $m = 1\,kg;\ g = 9.8\,m/s^2\ \cos 30° = \frac{\sqrt{3}}{2}$

$\therefore T = 12.4\ N$

20. The question contains statement-I (Assertion) and Statement-2 (Reason).
The question has four choices. You have to select the correct choice.
A block of mass m is kept in equilibrium by a massless rope held by a monkey over a pulley as



shown. Now the monkey begins to climb the rope.
Assertion : The linear momentum of the monkey, rope and block system is conserved.
Reason : Contact forces between the monkey and rope and the tension in rope are internal forces of the system.

A. if statement-1 is true but statement-2 is false
B. if statement-1 is false and statement-2 is true.
C. if both statement-1 and statement-2 are true and statement-2 is the correct explanation of statement-1
D. if both statement-1 and statement-2 are true but statement-2 is not the correct explanation of statement-1

Ans. B
Conceptual question