5 - WORK, ENERGY AND POWER

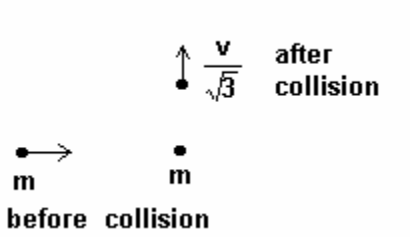
(Answers at the end of all questions)

1) A bullet fired into a fixed target loses half of its velocity after penetrating 3 cm. How much further will it penetrate before coming to rest assuming that it faces constant resistance to motion ?

(a) 2.0 cm (b) 3.0 cm (c) 1.0 cm (d) 1.5 cm [AIEEE 2005]

2) A mass 'm' moves with a velocity 'v' and collides inelastically with another identical mass. After collision the 1st mass moves with velocity $v/\sqrt{3}$ in a direction perpendicular to the initial direction of motion. Find the speed of the second mass after collision.

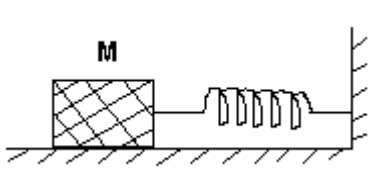
(a) $\sqrt{3}\,v$ (b) v (c) $\frac{v}{\sqrt{3}}$ (d) $\frac{2}{\sqrt{3}}v$



[AIEEE 2005]

3) The block of mass M moving on the frictionless horizontal surface collides with the spring of spring constant K and compresses it by length L. The maximum momentum of the block after collision is

(a) $\frac{KL^2}{2M}$ (b) $\sqrt{MK}.L$ (c) $\frac{ML^2}{K}$ (d) zero



[AIEEE 2005]

4) A spherical ball of mass 20 kg is stationary at the top of a hill of height 100 m. It rolls down a smooth surface to the ground, then climbs up another hill of height 30 m and finally rolls down to a horizontal base at a height of 20 m above the ground. The velocity attained by the ball is

(a) 20 m /s (b) 40 m /s (c) $10\sqrt{30}$ m /s (d) 10 m /s [AIEEE 2005]

5) A body of mass m is accelerated uniformly from rest to a speed v in time T. The instantaneous power delivered to the body as a function of time is given by

(a) $\frac{mv^2}{T^2}t^2$ (b) $\frac{mv^2}{T^2}t$ (c) $\frac{1}{2}.\frac{mv^2}{T^2}t^2$ (d) $\frac{1}{2}.\frac{mv^2}{T^2}t$

[AIEEE 2005, 2004]

6) A particle moves in a straight line with retardation proportional to its displacement. Its loss of kinetic energy for any displacement x is proportional to

(a) x^2 (b) e^x (c) x (d) $\log_e x$ [AIEEE 2004]

7) A uniform chain of length 2 m is kept on a table such that a length of 60 cm hangs freely from the edge of the table. The total mass of the chain is 4 kg. What is the work done in pulling the entire chain on the table ?

(a) 7.2 J (b) 3.6 J (c) 120 J (d) 1200 J [AIEEE 2004]

8) A force $\vec{F} = (5\hat{i} + 3 + 2\hat{)}$ N is applied over a particle which displaces it from its origin to the point $\vec{r} = (2\hat{i} - \hat{j})$ m. The work done on the particle in joules is

(a) - 7 (b) 7 (c) 10 (d) 13 [AIEEE 2004]

(Answers at the end of all questions)

9) A particle is acted upon by a force of constant magnitude which is always perpendicular to the velocity of the particle. If the motion of the particle takes place in a plane, it follows that
(a) its velocity is constant (b) its acceleration is constant
(c) its kinetic energy is constant (d) it moves on a straight line [AIEEE 2004]

10) A body falling from a height of 10 m rebounds from floor. If it loses 20 % energy in the impact, then coefficient of restitution is (take $g = 9.8\ m/s^2$)
(a) 0.89 (b) 0.56 (c) 0.23 (d) 0.18 [AIEEE 2002]

11) Consider the following two statements:
A: Linear momentum of a system of particles is zero.
B: Kinetic energy of a system of particles is zero. Then
(a) A implies B and B implies A. (b) A implies B but B does not imply A.
(c) A does not imply B but B implies A.
(d) A does not imply B and B does not imply A. [AIEEE 2002]

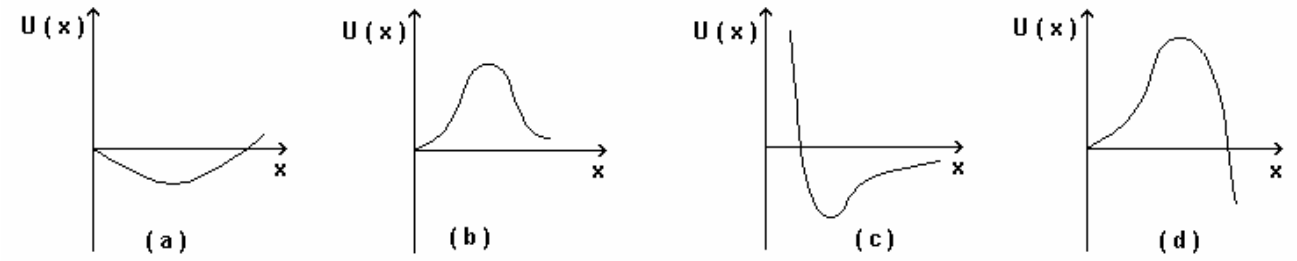
12) One-fourth chain is hanging down from a table. Work done to bring the hanging part of the chain on the table is (mass of chain = M and length = L)
(a) $\frac{MgL}{32}$ (b) $\frac{MgL}{16}$ (c) $\frac{MgL}{8}$ (d) $\frac{MgL}{4}$ [AIEEE 2002]

13) An engine generates a power of 10 kW. In how much time will it raise a mass of 200 kg through a height of 40 m ?

(a) 4 sec (b) 5 sec (c) 8 sec (d) 10 sec [AIEEE 2002]

14) If the speed of a vehicle increases by 2 m /s, its kinetic energy is doubled. The original speed of the vehicle in m /s is
(a) $(\sqrt{2} + 1)$ (b) $2(\sqrt{2} - 1)$ (c) $2(\sqrt{2} + 1)$ (d) $\sqrt{2}(\sqrt{2} + 1)$ [AIEEE 2002]

15) A particle, which is constrained to move along the X-axis, is subjected to a force in the same direction which varies with the distance x of the particle from the origin as $F(x) = -kx + ax^3$. Here k and a are positive constants. For $x \geq 0$, the functional form of the potential energy U (x) of the particle is



[IIT 2002]

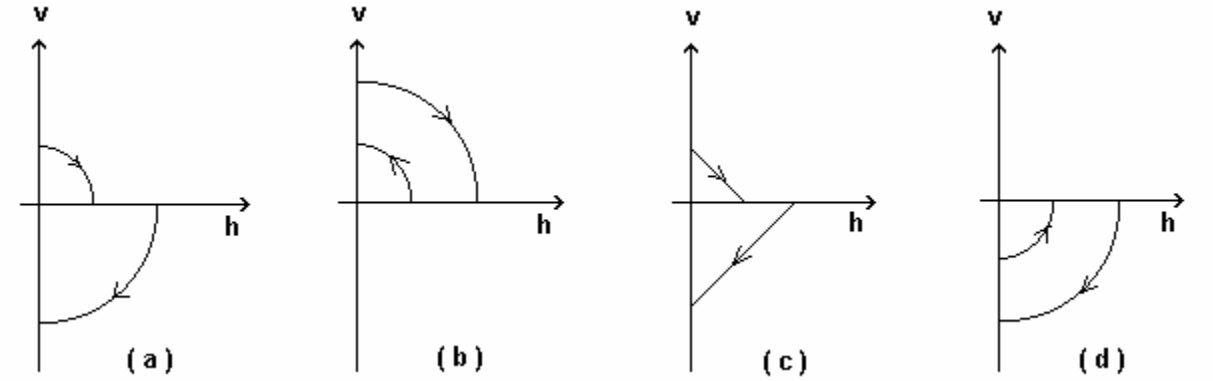
16) Two particles of masses m_1 and m_2 in projectile motion have velocities $\vec{v}_1 \neq \vec{v}_2$ respectively at time $t = 0$. They collide at time t_0. Their velocities become $\vec{v}_1'$ and $\vec{v}_2'$ at time $2t_0$ while still moving in air.

The value of $| (m_1 \vec{v}_1' + m_2 \vec{v}_2') - (m_1 \vec{v}_1 + m_2 \vec{v}_2) |$ is

(a) zero (b) $(m_1 + m_2) g t_0$ (c) $2 (m_1 + m_2) g t_0$ (d) $\frac{1}{2} (m_1 + m_2) g t_0$

[IIT 2001]

17) A ball is dropped vertically from a height d above the ground. It hits the ground and bounces up vertically to a height d / 2. Neglecting subsequent motion and air resistance, its velocity v varies with height h above the ground as



[IIT 2000]

18) A wind-powered generator converts wind energy into electrical energy. Assume that the generator converts a fixed fraction of the wind energy intercepted by its blades into electrical energy. For wind speed v, the electrical power output will be proportional to

(a) v (b) v^2 (c) v^3 (d) v^4 [IIT 2000]

19) A stone tied to a string of length l is whirled in a vertical circle with the other end of the string at the centre. At a certain instant of time, the stone is at its lowest position and has a speed u. The magnitude of the change in its velocity as it reaches a position where the string is horizontal is

(a) $\sqrt{u^2 - 2gl}$ (b) $\sqrt{2gl}$ (c) $\sqrt{u^2 - gl}$ (d) $\sqrt{2(u^2 - gl)}$ [IIT 1998]

20) A force $\vec{F} = - K (y \hat{i} + x \hat{j})$ (where K is a positive constant) acts on a particle moving in the xy plane. Starting from the origin, the particle is taken along the positive x-axis to the point (a, 0) and then parallel to the y-axis to the point (a, a). The total work done by the force F on the particle is

(a) $- 2Ka^2$ (b) $2Ka^2$ (c) $- Ka^2$ (d) Ka^2 [IIT 1998]

(Answers at the end of all questions)

21) An isolated particle of mass m is moving in a horizontal plane (x – y), along the x-axis, at a certain height above the ground. It suddenly explodes into two fragments of masses m /4 and 3m /4. An instant later, the smaller fragment is at y = + 15 cm. The larger fragment at this instant is at
(a) y = - 5 cm (b) y = + 20 cm (c) y = + 5 cm (d) y = - 20 cm [IIT 1997]

22) A particle of mass m is moving in a circular path of constant radius r such that its centripetal acceleration a_c is varying with time t as $a_c = k^2 r t^2$ where k is a constant. The power delivered to the particle by he forces acting on it is
(a) $2\pi mk^2r^2t$ (b) mk^2r^2t (c) $(mk^4r^2t^5)/3$ (d) zero [IIT 1994]

23) Two bodies M and N of equal mass are suspended from two separate massless springs of spring constants k_1 and k_2 respectively. If the two bodies oscillate vertically such that their maximum velocities are equal, the ratio of the amplitude of vibration of M to that of N is
(a) $\frac{k_1}{k_2}$ (b) $\sqrt{\frac{k_1}{k_2}}$ (c) $\frac{k_2}{k_1}$ (d) $\sqrt{\frac{k_2}{k_1}}$ [IIT 1988]

24) A shell is fired from a canon with velocity v m /s at an angle of θ with the horizontal direction. At the highest point in its path, it explodes into two pieces of equal mass. One of the pieces retraces its path to the canon and the speed in m /s of the other piece is
(a) $3v\cos\theta$ (b) $2v\cos\theta$ (c) $(3/2)v\cos\theta$ (d) $(\sqrt{3}/2\ v\cos\theta$ [IIT 1986]

25) A ball hits the floor and rebounds after an inelastic collision. In this case
(a) the momentum of the ball just after the collision is the same as that just before the collision
(b) the mechanical energy of the ball remains the same in the collision
(c) the total momentum of the ball and the earth is conserved
(d) the total energy of the ball and the earth is conserved [IIT 1986]

26) A uniform chain of length L and mass M is lying on a smooth table and one-third of its length is hanging vertically down over the edge of the table. If g is acceleration due to gravity, the work required to pull the hanging part on to the table is
(a) mgL (b) MgL/3 (c) MgL/9 (d) MgL/8 [AIEEE 1985]

27) A body is moved along a straight line by a machine delivering constant power. The distance moved by the body in time t is proportional to
(a) $t^{\frac{1}{2}}$ (b) $t^{\frac{3}{4}}$ (c) $t^{\frac{3}{2}}$ (d) t^2 [IIT 1984]

28) Two masses 1 g and 4 g are moving with equal kinetic energies. The ratio of the magnitudes of their linear momenta is
(a) 4 : 1 (b) $\sqrt{2}$: 1 (c) 1 : 2 (d) 1 : 16 [IIT 1980]

29) A particle of mass m is moving in a horizontal circle of radius r under a centripetal force given by (- k r^2) where k is a constant, then
(a) the total energy of the particle is (- k / 2r)
(b) the kinetic energy of the particle is (k / r)
(c) the potential energy of the particle is (k / 2r)
(d) the kinetic energy of the particle is (- k / r) [IIT 1977]

30) A lorry and a car moving with the same K. E. are brought to rest by applying the same retarding force, then
(a) lorry will come to rest in a shorter distance
(b) car will come to rest in a shorter distance
(c) both will come to rest in the same distance
(d) none of the above [IIT 1973]

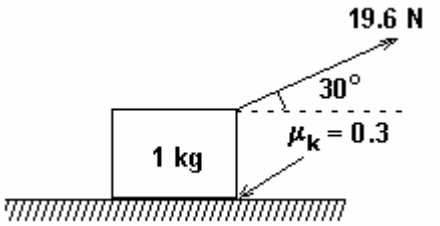
31) When the linear momentum of a particle is increased by 1 %, its kinetic energy increases by x %. When the kinetic energy of the particle is increased by 300 %, its linear momentum increases by y %. The ratio of y to x is

(a) 300 (b) 150 (c) 100 (d) 50

32) Two beads of masses m_1 and m_2 are threaded on a smooth circular vertical loop of radius R. Initially both the beads are at rest at the top of the loop and allowed to slide down in opposite directions. The sum of the magnitudes of their velocities after the perfectly elastic collision is

(a) $\sqrt{gR}$ (b) $2\sqrt{gR}$ (c) $3\sqrt{gR}$ (d) $4\sqrt{gR}$

33) A block of mass 1 kg kept on a surface is pulled by applying a force of 19.6 N though a string making an angle of 30° with the horizontal as shown in the figure. The coefficient of kinetic friction between the block and the surface is 0.3. The work done on the block when it is moved through a distance of 1 m is

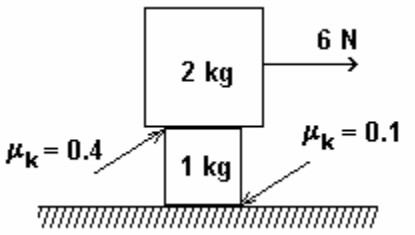


(a) 10 J (b) 14.3 J (c) 17.3 J (d) 20 J

34) A marble moving with some velocity collides perfectly elastically head-on with another marble at rest having mass 1.5 times the mass of the colliding marble. The percentage of kinetic energy retained by the colliding marble after the collision is

(a) 4 (b) 25 (c) 44 (d) 67

35) A force of 6 N is applied on the upper block as shown in the figure. The coefficients of kinetic friction between the surfaces are as shown in the figure. The work done by 1 kg mass on 2 kg mass when 2 kg mass moves through 1 m is



(a) 3 J (b) - 4 J (c) 1 J (d) 6 J

36) A wooden cube having mass 10 kg is dropped from the top of a building. After 1 s, a bullet of mass 20 g fired at it from the ground hits the block with a velocity of 1000 m / s at an angle of 30° to the horizontal moving upwards and gets imbedded in the block. The velocity of the block/bullet system immediately after the collision is

(a) 17 m / s (b) 27 m / s (c) 52 m / s (d) 10 m / s

Answers

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
c	d	b	b	b	a	b	b	c	a	c	a	c	c	d	c	a	c	d	c

21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
a	b	d	a	c,d	d	c	c	a	c	d	d	c	a	b	a