Work, Power, Energy Assignment - II

1. A force acts on a 3.0 *g* particle in such a way that the position of the particle as a function of time is given by $x = 3t - 4t^2 + t^3$, where *x* is in *metres* and *t* is in seconds. The work done during the first $4\,s$ is

(a) 576 *mJ* (b) 450 *mJ* (c) 490 *mJ* (d) 530 *mJ*

2. 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 $\vec{F}$ on the particles is

(a) $-2Ka^2$ (b) $2Ka^2$ (c) $-Ka^2$ (d) Ka^2

3. The displacement *x* of a particle of mass *m kg* moving in one dimension, under the action of a force, is related to the time *t* by the equation $t = \sqrt{x} + 3$ where *x* is in *metres* and *t* is in seconds. The work done by the force in the first six second in joules is

(a) 0 (b) 3*m* (c) 6*m* (d) 9*m*

4. The velocity of a particle moving along a line varies with distance as $v = a\sqrt{x}$ where *a* is a constant. The work done by all forces when the particle moves from $x = 0$ to $x = l$ is (mass of the particle is *m*)

(a) 0 (b) $ma^2 l$ (c) $\frac{1}{2}ma^2 l$ (d) $\frac{1}{3}mal$

5. A particle free to move along the *x*-axis has potential energy given by $U(x) = k[1 - \exp(-x^2)]$ for $-\infty \le x \le +\infty$, where *k* is a positive constant of appropriate dimensions. Then

(a) At point away from the origin, the particle is in unstable equilibrium

(b) For any finite non-zero value of *x*, there is a force directed away from the origin

(c) If its total mechanical energy is $k/2$, it has its minimum kinetic energy at the origin

(d) For small displacements from $x = 0$, the motion is simple harmonic

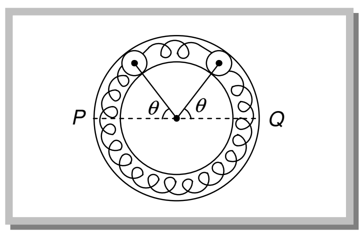
6. Two identical balls *A* and *B* of mass *m kg* are attached to two identical massless springs. The spring mass system is constrained to move inside a rigid smooth pipe bent in the form of a circle as shown in figure. The pipe is fixed in a horizontal plane. The centres of the balls can move in a circle of radius *r metre*. Each spring has a natural length of $r\pi$ *metre* and spring constant *K*. Initially, both the balls are displaced by an angle θ radian *w.r.t.* diameter *PQ* of the circles and released from rest. The speed of ball *A* when *A* and *B* are at the two ends of dia *PQ* is

(a) $R\theta\sqrt{\frac{m}{K}}$

(b) $2R\theta\sqrt{\frac{K}{m}}$

(c) $2R\theta\sqrt{\frac{m}{K}}$

(d) $2R\theta\sqrt{\frac{K}{m}}$



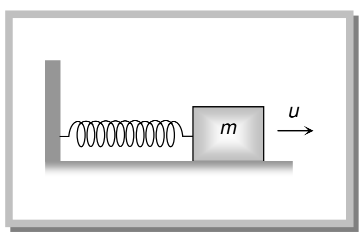
7. A block of mass *m* has initial velocity *u* having direction towards +*x* axis. The block stops after covering distance *S* causing similar extension in the spring of constant *K* holding it. If μ is the kinetic friction between the block and the surface on which it was moving, the distance *S* is given by

(a) $\frac{1}{K}\mu^2 m^2 g^2$

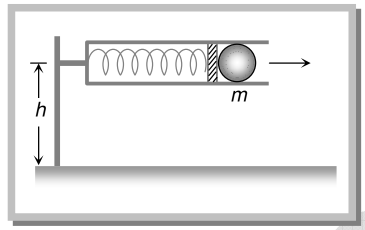
(b) $\frac{1}{K}(mKu^2 - \mu^2 m^2 g^2)^{\frac{1}{2}}$

(c) $\frac{1}{K}(\mu^2 m^2 g^2 + mKu^2 + \mu mg)^{\frac{1}{2}}$

(d) $\frac{1}{K}(\mu^2 m^2 g^2 - mKu^2 + \mu mg)^{\frac{1}{2}}$



8. A compressed spring of spring constant k releases a ball of mass m. If the height of spring is h and the spring is compressed through a distance x, the horizontal distance covered by ball to reach ground is



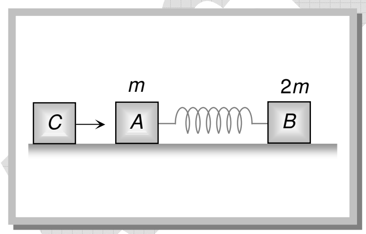
(a) $x\sqrt{\frac{kh}{mg}}$

(b) $\frac{xkh}{mg}$

(c) $x\sqrt{\frac{2kh}{mg}}$

(d) $\frac{mg}{x\sqrt{kh}}$

9. Two bodies A and B of masses m and $2m$ respectively are placed on a smooth floor. They are connected by a spring. A third body C of mass m moves with velocity V_0 along the line joining A and B and collides elastically with A as shown in fig. At a certain instant of time t_0 after collision, it is found that instantaneous velocities of A and B are the same. Further at this instant the compression of the spring is found to be x_0. Determine the spring constant



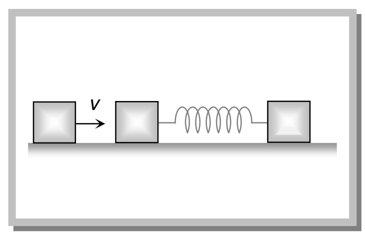
(a) $\frac{2mV_0^2}{3x_0^2}$

(b) $\frac{1}{3}\frac{mV_0^2}{x_0^2}$

(c) $\frac{1}{4}\frac{mV_0^2}{x^2}$

(d) $\frac{4}{5}\frac{mV_0^2}{x_0^2}$

10. Two blocks A and B each of mass m are connected by a massless spring of natural length L and spring constant k. The blocks are initially resting on a smooth horizontal floor with the spring at its natural length, as shown in figure. A third identical block C, also of mass m, moves on the floor with a speed v along the line joining A to B and collides with A. Then



(a) The kinetic energy of the A-B system, at maximum compression of the spring is zero

(b) The kinetic energy of the A-B system, at maximum compression of the spring is $\frac{mv^2}{4}$

(c) The maximum compression of the spring is $v\sqrt{\frac{m}{k}}$

(d) The maximum compression of the spring is $v\sqrt{\frac{m}{2k}}$

11. A light elastic string of natural length l is extended by an amount Fl/λ when subjected to a tension F. A small body of mass m is attached to a point O on a smooth horizontal table by, means of this elastic string. The body moves in a horizontal orbit of constant radius $(5l/4)$ and centre O with a tangential velocity. Find the value of v and calculate the ratio of kinetic energy to the elastic stored energy

(a) $\left(\frac{5\lambda l}{16m}\right)^{1/2}$, 5 : 1 (b) $\left(\frac{16m}{5\lambda l}\right)^{1/2}$, 5 : 1 (c) $\left(\frac{16\lambda l}{5m}\right)^{1/2}$, 1 : 5 (d) $\left(\frac{16m}{5\lambda l}\right)^{1/2}$, 1 : 5

12. A person decides to use his bath tub water to generate electric power to run a 40 W bulb. The bath tub is located at a height of h m from ground and it holds V *litres* of water. He installs a water driven wheel generator on ground. The rate at which water should drain from bath tub to light the bulb if efficiency of machine be 90% is

(a) $\frac{11.11}{\rho gh}$ (b) 44.44 ρgh (c) $\frac{44.44}{\rho gh}$ (d) $\frac{22.22}{\rho gh}$

13. An engine of mass one metric ton is ascending on a inclined plane, at an angle $\tan^{-1}\left(\frac{1}{2}\right)$ with horizontal, with a speed of 36 *km/hour*. If the coefficient of friction of the surface is $1/\sqrt{3}$ then the power (in watts of engine is)

(a) 94400 (b) 9440 (c) 944 (d) 94.4

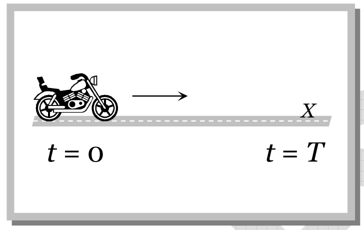
14. The aerodynamic drag on an airplane is given by $D = bv^2$. The power output of an airplane cruising at constant speed v in level flight is proportional to

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

15. A vehicle of mass *M* is accelerated on a horizontal frictionless road under a force changing its velocity from *u* to *v* in distance *S*. A constant power *P* is given by the engine of the vehicle, then *v* =

(a) $\left(u^3 + \frac{2PS}{M}\right)^{1/3}$ (b) $\left(\frac{PS}{M} + u^3\right)^{1/2}$ (c) $\left(\frac{PS}{M} + u^2\right)^{1/3}$ (d) $\left(\frac{3PS}{M} + u^3\right)^{1/3}$

16. A motorcycle of mass *m* resting on a frictionless road moves under the influence of a constant force *F*. The work done by this force in moving the motorcycle is given by $F^2t^2/2m$, where *t* it the time interval. Ratio of instantaneous power to average power of the motorcycle in *t* = *T* second is



(a) 1 : 1
(b) 2 : 1
(c) 3 : 2
(d) 1 : 2

17. The speed *v* reached by a car of mass *m*, driven with constant power *P*, is given by

(a) $v = \frac{3xP}{m}$ (b) $v = \left(\frac{3xP}{m}\right)^{1/2}$ (c) $v = \left(\frac{3xP}{m}\right)^{1/3}$ (d) $v = \left(\frac{3xP}{m}\right)^{2}$

18. A body of mass *m* accelerates uniformly from rest to a velocity v_0 in time k_0. The instantaneous power delivered to the body at any time *t* is

(a) $\frac{mv_0t}{t_0}$ (b) $\frac{mv_0^2t}{t_0}$ (c) $\frac{mv_0t^2}{t_0}$ (d) $\frac{mv_0^2}{t_0^2}t$

19. A ball falls vertically onto a floor, with momentum *P* and then bounces repeatedly. The coefficient of restitution is *e*. The total momentum imparted by the ball to the floor is

(a) $P(1+e)$ (b) $\frac{P}{1-e}$ (c) $P\left(1+\frac{1}{e}\right)$ (d) $P\left(\frac{1+e}{1-e}\right)$

20. A particle strikes a horizontal frictionless floor with a speed *u*, at an angle θ with the vertical and rebounds with a speed *v*, at an angle ϕ with the vertical. The coefficient of restitution between the particle and the floor is *e*. The magnitude of *v* is

(a) eu (b) $(1-e)u$ (c) $u\sqrt{\sin^2\theta + e^2\cos^2\theta}$ (d) $u\sqrt{e^2\sin^2\theta + \cos^2\theta}$

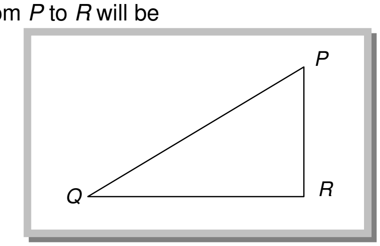
21. In the previous question the angle ϕ is equal to

(a) θ (b) $\tan^{-1}[e\tan\theta]$ (c) $\tan^{-1}[\frac{1}{e}\tan\theta]$ (d) $(1+e)\theta$

22. If the amount of work done by a force depends only on the initial and final, positions of the object which has been moved, then such a force is called

(a) Gravitational (b) Dissipative (c) Conservative (d) Retarding

23. For the path *PQR* in a conservative force field. The amounts work done in carrying a body from *P* to *Q* and from *Q* to *R* are 5 *Joule* and 2 *Joule* respectively. The work done in carrying the body from *P* to *R* will be



(a) 7 *J*
(b) 3 *J*
(c) $\sqrt{21}$ *J*
(d) Zero

24. There will be an increase in potential energy of the system, if work is done upon the system by

(a) Any conservative or non-conservative force (b) A non-conservative force
(c) A conservative force (d) None of the above

25. A car is moving along a straight horizontal road with a speed V_0. If the coefficient of friction between the types and the road is μ, the shortest distance in which the car can be stopped is

(a) $\frac{V_0^2}{2\mu g}$ (b) $\frac{V_0}{\mu g}$ (c) $\left(\frac{V_0}{\mu g}\right)^2$ (d) $\frac{V_0^2}{\mu}$

26. A car travelling at a speed of 30 *km/hour* is brought to a halt in 8 *m* by applying brakes. If the same car is travelling at 60 *km/hour*. It can be brought to a halt with the same braking force in

(a) 8 *m* (b) 16 *m* (c) 24 *m* (d) 32 *m*

27. The distance covered by a body to come to rest when it is moving with a speed of $4\,ms^{-1}$ is s when a retarding force F is applied. If the *K.E.* is doubled, the distance covered by it to come to rest for the same retarding force F is

(a) 4 *s* (b) 6 *s* (c) 2 *s* (d) 8 *s*

28. A body is gently dropped on a conveyor belt moving at $3\,ms^{-1}$. If $\mu = 0.5$, how far will the body move relative to the belt before coming to rest ($g = 10\,ms^{-2}$)

(a) 0.3 *m* (b) 0.6 *m* (c) 0.9 *m* (d) 1.8 *m*

29. A ladder 2.5 *m* long and 150 *N* weight has its center of gravity 1*m* from the bottom. A weight 40 *N* is attached to the top end. The work required to raise the ladder from the horizontal position to the vertical position is

(a) 190 *J* (b) 250 *J* (c) 285 *J* (d) 475 *J*

30. You lift heavy book from the floor of the room and keep it in the book-shelf having height 2*m*. In this process you take 5 seconds. The work done by you will depend upon

(a) Mass of the book and time taken (b) Weight of the book and height of the book-shelf

(c) Height of the book-shelf and time taken (d) Mass of the book, height of the book-shelf and time taken

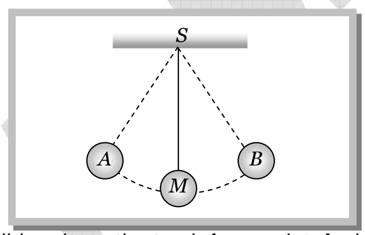
31. What is the velocity of the bob of a simple pendulum at its mean position, if it is able to rise to vertical height of 10*cm* (Take $g = 9.8\,m/s^{-1}$)

(a) 0.6 *m/s*

(b) 1.4 *m/s*

(c) 1.8 *m/s*

(d) 2.2 *m/s*



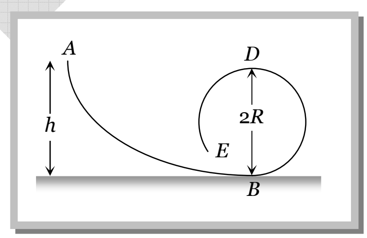
32. A frictionless track *ABCDE* ends in a circular loop of radius *R*. A body slides down the track from point *A* which is at a height $h = 5\ cm$. Maximum value of *R* for the body to successfully complete the loop is

(a) 5 *cm*

(b) $\frac{15}{4}\,cm$

(c) $\frac{10}{3}\,cm$

(d) 2 *cm*



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

(a) $\sqrt{u^2 - 2gL}$ (b) $\sqrt{2gL}$ (c) $\sqrt{u^2 - gL}$ (d) $\sqrt{2(u^2 - gL)}$

34. A simple pendulum of length 1*m* has a bob of 200 *g*. It is displaced through 60^o and then released. What will be its kinetic energy when it passes through the mean position

(a) 0.5 *J* (b) 1.0 *J* (c) 1.5 *J* (d) 2.0 *J*

35. If *v* be the instantaneous velocity of the body dropped from the top of a tower, when it is located at height *h*, then which of the following remains constant

(a) $gh + v^2$ (b) $gh + \frac{v^2}{2}$ (c) $gh - \frac{v^2}{2}$ (d) $gh - v^2$

36. A motor pump set lifts 300 *kg* of water per minute from a well of depth 20*m* and delivers to a height of 20*m*. Then its power is

(a) 3 *kW* (b) 1.96 *kW* (c) 0.98 *kW* (d) 3.92 *kW*

37. A force of $2\hat{i} + 3\hat{j} + 4\hat{k}\ N$ acts on a body for 4 sec and produces a displacement of $3\hat{i} + 4\hat{j} + 5\hat{k}\ m.$ The power used is

(a) 4.5 *W* (b) 6.5 *W* (c) 7.5 *W* (d) 9.5 *W*

38. A truck of mass 30, 000 *kg* moves up an inclined plane of slope 1 in 100 at a speed of 30 *kmph*. The power of the truck is (given $g = 10\ ms^{-1}$)

(a) 25 *kW* (b) 10 *kW* (c) 5 *kW* (d) 2.5 *kW*

39. A car of mass 1250 *kg* is moving at 30*m/s*. Its engine delivers 30 *kW* while resistive force due to surface is 750 *N*. What max acceleration can be given in the car

(a) $\frac{1}{3} m/s^2$ (b) $\frac{1}{4} m/s^2$ (c) $\frac{1}{5} m/s^2$ (d) $\frac{1}{6} m/s^2$

40. When friction is present in an otherwise conservative mechanical system, the rate of dissipation of mechanical energy is (where *f* is the frictional force and *v* is the speed of the system)

(a) *fv* (b) – *fv* (c) fv^2 (d) – fv^2

41. An elevator's motor produces 3000 *W* power. The speed with which it can lift a 1000 *kg* load is

(a) $30.6 ms^{-1}$ (b) $3.06\ ms^{-1}$ (c) $0.306 ms^{-1}$ (d) $300.6 ms^{-1}$

42. A body of mass *m kg* initially at rest attains a velocity of *v m/sec* in time *t* under the action of a constant force *F*. The power supplied to the mass is

(a) *mv/t* (b) mv^2/t (c) *Fv* (d) *Fv*/2

43. A car seller claims that his 1000 *kg* car can accelerate from rest to a speed of 24 ms^{-1} in just 8.0*s*. The engine of the car , on an average, should be of

(a) 60 *hp* (b) 48 *hp* (c) 80 *hp* (d) 24 *hp*

44. A neutron moving with a velocity '*v*' and kinetic energy '*E*' collides perfectly elastically head on with the nucleus of an atom of mass number '*A*' at rest. The energy received by the nucleus and the total energy of the system are related by

(a) $\frac{4A}{(A+1)^2}$ (b) $\left(\frac{A-1}{A+1}\right)^2$ (c) $\frac{(A+1)}{4A^2}$ (d) $\left(\frac{A+1}{A-1}\right)^2$

45. A body of mass *m* moving with velocity *V* makes a head - on collision with another body of mass 2*m* which is initially at rest. The ratio of kinetic energies of colliding body before and after collision will be

(a) 9 : 1 (b) 1 : 1 (c) 4 : 1 (d) 2 : 1

46. An object A collides head on elastically with a stationary object *B*. The object *B* will recoil with maximum speed if (*e* = 1)

(a) $M_B >> M_A$ (b) $M_B << M_A$

(c) $M_A = M_B$ (d) Can not be predicted due to incomplete data

47. In above question the transfer momentum to *B* will be maximum if

(a) $M_B >> M_A$ (b) $M_B << M_A$

(c) $M_A = M_B$ (d) Can not be predicted as information is incomplete

48. A ball collides elastically with another ball of the same mass. The collision is oblique and initially one of the body was at rest. After the collision, the two balls move with same speeds. What will be the angle between the initial and final velocities of the colliding ball

(a) 30^o (b) 45^o (c) 60^o (d) 90^o

49. A billiard ball moving at a speed $2m/s$ strikes an identical ball initially at rest, at a glancing blow. After the collision one ball is found to be moving at a speed of $1m/s$ at 60^o with the original line of motion. The velocity of the other ball shall be

(a) $(3)^{1/2} m/s$ at 30^o to the original direction (b) $1m/s$ at 60^o to the original direction

(c) $(3)^{1/2} m/s$ at 60^o to the original direction (d) $1m/s$ at 30^o to the original direction

50. A particle of mass m collides perfectly elastically with another particle of mass $M = 2m$. If the incident particle deflected by 90^o. The heavy mass will make an angle with the initial direction of *m* equal to

(a) 15^o (b) 30^o (c) 45^o (d) 60^o