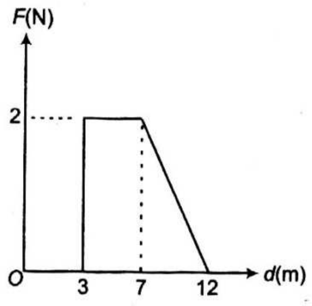
Work, Energy and Power

2011

1. Force F on a particle moving in a straight line varies with distance d as shown in the figure. The work done on the particle during its displacement of 12m is



a) 12J b) 26J c) 13J d) 18J

2. A body of mass M hits normally a rigid wall with velocity v and bounces back with the same velocity. The impulse experience by the body is

a) 1.5 mv b) 2mv c) Zero d) Mv

3. A person of mass 60kg is inside a lift of mass 940kg and presses the button on control panel. The lift starts moving upwards with acceleration $1.0ms^{-2}$**. If** $g = 10ms^{-2}$**, the tension in the supporting cable is**

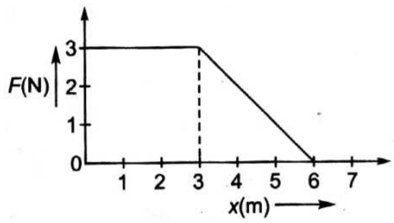
a) 9680 N b) 11000N c) 1200N d) 8600N

2010

4. A plate of mass m, length b and breadth a, is initially lying on a horizontal floor with length parallel to the floor and breadth perpendicular to the floor. The work done to exect it on its breadth is

a) $mg\left[\frac{b}{2}\right]$ b) $mg\left[a+\frac{b}{2}\right]$ c) $mg\left[\frac{b-a}{2}\right]$ d) $mg\left[\frac{b+a}{2}\right]$

5. A force F acting on an object varies with distance x as shown here. The force is in newton and x is in metre. The work done by the force in moving the object from x = 0 m to x = 6m is



a) 4.5J b) 13.5J c) 9J d) 18J

2009

6. A quarter horse power motor runs at a speed of 600rpm. Assuming 40% efficiency, the work done by the motor in one rotation will be

a) 7.46J b) 7400J c) 7.46 erg d) 74.6 J

2008

7. A particle of mass 100g is thrown vertically upwards with a speed of $5ms^{-1}$. The work done by the force of gravity during the time, the particle goes up is

a) -0.5J b) -1.2J c) 1.25J d) 0.5J

8. How much work done must be done by a force on 50kg body in order to accelerate it from rest to $20ms^{-1}$ in 10s?

a) $10^3 J$ b) $10^4 J$ c) $2\times10^3 J$ d) $4\times10^4 J$

9. When the bob of a simple pendulum swings, the work done by tension in the string is

a) >0 b) <0 c) Zero d) Maximum

10. The work done by a particle moving with a velocity of 0.7c (where c is the velocity of light) in empty space free of electromagnetic field and far away from all matter is

a) Positive b) Negative c) Zero d) Infinite

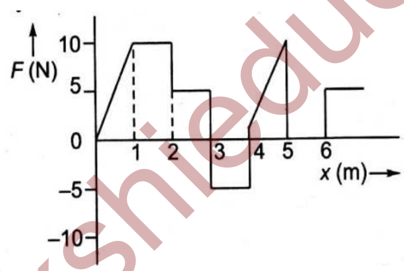
2007

11. A vertical spring with force constant k is fixed on a table. A ball of mass m at a height h above the free upper end of the spring falls vertically on the spring, so that the spring is compressed by a distance d. The net work done in the process is

a) $mg(h+d)+\frac{1}{2}kd^2$ b) $mg(h+d)-\frac{1}{2}kd^2$

c) $mg(h-d)-\frac{1}{2}kd^2$ d) $mg(h-d)+\frac{1}{2}kd^2$

12. The relationship between the force F and position x of a body is as shown in figure. The work done in displacing the body from x = 1m to x = 5m will be



a) 30J b) 15J c) 25J d) 20J

Energy

2011

13. **The potential energy of a system increase if work is done**

    a) By the system against a conservative force

    b) By the system against a non-conservative force

    c) Upon the system by a conservative force

    d) Upon the system by a non-conservative force

2010

14. **A bomb of 12kg explodes into two pieces of masses 4kg and 8kg. The velocity of 8kg mass is $6ms^{-1}$. The kinetic energy o the other mass is**

    a) 348 J b) 332J c) 324J d) 288J

15. **A coin is of mass 4.8kg and radius 1m, is rolling on a horizontal surface without sliding, with an angular velocity of 600rad/min. What is the total kinetic energy of the coin?**

    a) 360J b) $1440\pi^2 J$ c) $4000\pi^2 J$ d) $600\pi^2 J$

16. **An open water tight railway wagon of mass 5×10^3 kg coasts at an initial velocity of 1.2 m/s without friction on a railway track. Rain falls vertically downwards into the wagon. What change occurs in kinetic energy of the wagon, when it has collected 10^3 kg of water?**

    a) 900J b) 300J c) 1560J d) 1200J

17. A person, with outstretched arms, is spinning on a rotating stool. He sudden brings his arms down to his sides. Which of the following is true about his kinetic energy K and angular momentum L?

a) 900J b) 300J c) 1560J d) 1200J

2009

18. A particle of mass m at rest is acted upon by a force P for a time t. Tis kinetic energy after an interval t is

a) $\frac{P^2t^2}{m}$ b) $\frac{P^2t^2}{2m}$ c) $\frac{P^2t^2}{3m}$ d) $\frac{Pt}{2m}$

19. A body of mass 2kg makes an elastic collision with another body at rest and continues to move in the original direction with one-fourth its original speed. The mass of the second body which collides with the first body is

a) 2kg b) 1.2kg c) 3kg d) 1.5kg

2007

20. The driver of a car travelling at velocity v suddenly sees a broad wall infront of him at a distance d. He should

a) Brake sharply b) Turn sharply c) Both a and b d) None of these

21. A free α- particle and a free proton, which are separated by a distance of 10^{-10} m are released. The KE of α-particle when at infinite separation is

a) $46\times10^{-19}J$ b) $23\times10^{-19}J$ c) $36.8\times10^{-19}J$ d) $9.2\times10^{-19}J$

22. A child is swinging a swing. Minimum and maximum heights of swing from earth's surface are 0.75m and 2m respectively. The maximum velocity of this swing is

a) $5ms^{-1}$ b) $10ms^{-1}$ c) $15ms^{-1}$ d) $20ms^{-1}$

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

a) $40ms^{-1}$ b) $20ms^{-1}$ c) $10ms^{-1}$ d) $10\sqrt{30}ms^{-1}$

24. Two bodies A and B having masses in the ratio of 3 : 1 posses the same kinetic energy. The ratio of linear momentum of B to A is

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

25. An open kinetic edge of mass m is dropped from a height h on a wooden floor. If the blade penetrates s into the wood, the average resistance offered by the wood to the blade is

a) Mg b) $Mg\left(\frac{h}{s}\right)$ c) $Mg\left(1-\frac{h}{s}\right)$ d) $Mg\left(1+\frac{h}{s}\right)^2$

26. A stationary particle explodes into two particles of masses m_1 and m_2 which move in opposite directions with velocities v_1 and v_2. The ratio of their kinetic energies E_1/E_2 is

a) 1 b) m_1v_2/m_2v_1 c) m_2/m_1 d) m_1/m_2

27. A bread gives a boy of mass 40kg energy of 21kJ. If the efficiency is 28%, then the height that can be climbed by him using this energy is

a) 22.5m b) 15m c) 10m d) 5m

28. A ball of mass 2kg and another of mass 4kg are dropped together from a 60ft tall building. After a fall of 30ft each towards earth, their respective kinetic energies will be in the ratio of

a) $\sqrt{2}:1$ b) 1 : 4 c) 1 : 2 d) $1:\sqrt{2}$

29. A stone is tied to a string of length l and 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 velocity of string when horizontal (g being acceleration due to gravity) is

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

2006

30. If we throw a body upwards with velocity of $4ms^{-1}$, at what height does its kinetic energy reduce to half of the initial value? (Take $g=10^{-2}$)

a) 4m b) 2 m c) 1 m d) 0.4m

2005

31. A block of mass 10kg is moving in x-direction with a constant speed of $10ms^{-1}$. It is subjected to a retarding force $F=-0.1x\ Jm^{-1}$ during its travel from x = 20m to x = 30m. Its final kinetic energy will be

a) 475 J b) 450J c) 275J d) 250J

32. A projectile is fired at 30^0 with momentum p. Neglecting friction, the change in kinetic energy, when it returns back to the ground, will be

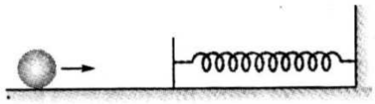
a) Zero b) 30% c) 60% d) 100%

33. A machine which is 75% efficient uses 12J of energy in lifting 1kg mass through a certain distance. The mass is then allowed to fall through the same distance. The velocity at the end of its fall is

a) $\sqrt{12}ms^{-1}$ b) $\sqrt{18}ms^{-1}$ c) $\sqrt{24}ms^{-1}$ d) $\sqrt{32}ms^{-1}$

2004

34. A mass of 0.5kg moving with a speed of $1.5ms^{-1}$ on a horizontal smooth surface collides with a nearly weightless spring of force constant $k = 50Nm^{-1}$. The maximum compression of the spring would be



a)0.15m b) 0.12m c) 1.5m d) 0.5m

35. A 30 g bullet travelling initially at $500ms^{-1}$ penetrates 12cm into wooden block. The average force exerted will be

a) 31250 N b) 41250 N c) 31750N d) 30450N

36. A thin uiform rod of mass m and length is hinged at the lower end to a level floor and strands vertically. It is now allowed to fall, and then its upper end will strike the floor with the velocity

a) $\sqrt{2gl}$ b) $\sqrt{5gl}$ c) $\sqrt{3gl}$ d) $\sqrt{mgl}$

37. A cylinder of mass 10kg rolling on a rough plane with a velocity of $10ms^{-1}$. If the coefficient of friction between the surface and cylinder is 0.5, then before stopping it will cover a distance of (take $g = 10ms^{-2}$)

a) 10m b) 7.5 m c) 5m d) 2.5m

Power

2010

38. A cyclist rides up a hill at a constant velocity. Determine the power developed by the cyclist if the length of the connecting rod of the pedal is r = 25cm, the time of revolution of the rod is t = 2s and the mean force exerted by his foot on the pedal is F = 15kg

a) 115.6 W b) 215.6 W c) 15.6 W d) 11.56 W

39. A body of mass 10kg moves with a velocity v of $2ms^{-1}$ along a circular path of radius 8m. The power produced by the body will be

a) $10Js^{-1}$ b) $98Js^{-1}$ c) $49Js^{-1}$ d) zero

2008

40. Water falls from a height of 60m at the rate of $15kgs^{-1}$ to operate a turbine. The losses due to frictional forces are 10% of energy. How much power is generated by the turbine? (Take $g = 10ms^{-2}$)

a) 8.1 kW b) 10.2 kW c) 12.3 kW d) 7.9 kW

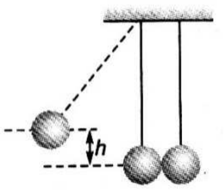
41. A motor is used to deliver water at a certain rate through a given horizontal pipe. To deliver n-times the water through the same pipe in the same time the power of the motor must be increased as follows

a) n-times b) $n^2 - times$ c) $n^3 - times$ d) $n^4 - times$

42. **A machine is delivering constant power to drive a body along a straight line. What is the relation between the distance travelled by the body against time?**

a) $s^2 \propto t^3$ b) $s^2 \propto t^{-3}$ c) $s^2 \propto t^2$ d) $s \propto t^3$

43. **A particle of mass m is moving in a circular path of constant radius r such that centripetal acceleration a_c varying with time is $a_c = k^2rt^2$, where k is a constant. What is the power delivered to the particle by the force acting on it?**



a) $2mkr^2t$ b) mkr^2t^2 c) mk^2r^2t d) mk^2rt^2

2006

44. **A body is initially at rest. It undergoes one-dimensional motion with constant acceleration. The power delivered to it at time t is proportional to**

a) $t^{1/2}$ b) t c) $t^{3/2}$ d) t^2

Key

1) **c**	2) **b**	3) **b**	4) **c**	5) **b**	6) **a**	7) **b**	8) **b**	9) **c**	10)**c**
11)**b**	12)**d**	13)**a**	14)**d**	15)**b**	16)**c**	17)**d**	18)**b**	19)**b**	20)**a**
21)**d**	22)**a**	23)**a**	24)**c**	25)**b**	26)**c**	27)**b**	28)**c**	29)**a**	30)**d**
31)**a**	32)**a**	33)**b**	34)**a**	35)**a**	36)**c**	37)**a**	38)**a**	39)**d**	40)**a**
41)**c**	42)**a**	43)**c**	44)**b**						

Hints

1. Work

1. Work done = Area under the graph $= 2\times(7-3)+\frac{1}{2}\times 2\times(12-7)$ = 13J

2. Impulse $|J|=|\Delta p|$ = Mv – (-Mv) = 2Mv

3. Total mass = 940 + 60 = 1000 kg

   T – mg = ma

   T – 1000 x 10 = 1000 x 1

   T = 11000N

4. Initial height of centre of gravity $=\frac{a}{2}$

   Final height of centre of gravity $=\frac{b}{2}$

   Work done = $mg\left[\frac{b}{2}-\frac{a}{2}\right]=mg\left[\frac{b-a}{2}\right]$

5. W = area of rectangle + area of triangle $=3\times 3\times\frac{1}{2}\times 3\times 3$ = 13 J

6. We have P x 40% $=\frac{W}{t}$

   $$\Rightarrow \frac{746}{4}\times\frac{40}{100}=\frac{W}{\left(2\pi\times\frac{600\times 2\pi}{60}\right)}$$

   $$\Rightarrow W = 7.46J$$

7. $h=\frac{u^2}{2g}=\frac{25}{2\times 9.8}$

   Work done by gravity force W = mgh $=0.1\times g\times\frac{25}{2\times 9.8}\cos 180^0$

   $$\therefore W=-0.1\times\frac{25}{2}=-1.25J$$

8. v = u + at

$\therefore$ 20 = 0 + a x 10

Or $a = 2ms^{-2}$

But, $s = ut + \frac{1}{2}at^2$

Or $s = 0 + \frac{1}{2} \times 2 \times 10 \times 10$ or s = 100 m

$\therefore$ Work done

W = F x s or W = ma x s = 50 x 2 x 100 $= 10^4 J$

9. Tension in the string is along the radius of circular path adopted by the bob, while displacement of the bob is along the circumference of the path. Hence, again F and s are at 90^0 and so W = 0

10. Acceleration of the particle

$a = \frac{dv}{dt} = \frac{d}{dt}(0.7c) = 0$ ($\because$ c=constant)

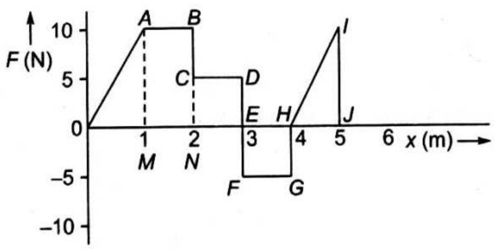
Hence force on the particle. Thus work done by a particle will be zero

11. Net work done

W = potential energy stored in the spring + loss of potential energy of mass

$= mg(h+d) - \frac{1}{2}kd^2$

12. Work done = force x displacement



= area of OAM + area of ABNM + area of CDEN – area of EFGH + area of HIJ

$= \frac{1}{2} \times 1 \times 10 + 1 \times 5 - 1 \times 5 + \frac{1}{2} \times 1 \times 10$ = 20J

2. Energy

13. The potential energy of a system increases if work is done by the system against a conservative force.

$-\Delta U = W_{conservative\ force}$

14. $m_A v_A = m_B v_B \Rightarrow 4v_A = 8\times 6 \Rightarrow v_A = 12 ms^{-1}$

Kinetic energy of the other mass $A = \frac{1}{2} m_A v_A^2 = \frac{1}{2}\times 4 \times (12)^2 = 288$ J

15. Angular velocity is given by

$\omega = 600\, rad / \min$

$= 20\pi\, rad / s$

$K = \frac{1}{2} I\omega^2 + \frac{1}{2} mv^2 = \frac{1}{2}\times\frac{1}{2} mr^2\omega^2 + \frac{1}{2} m(r\omega)^2 = \frac{1}{4}\times 4.8\times 1^2 \times (20\pi)^2 + \frac{1}{2}\times 4.8 \times (20\pi)^2 \times 1^2$

$= 1440\pi^2 J$

16. If v' is the final velocity of the wagon, then from the principle of conservation of linear momentum, $5\times 10^3 \times 1.(5\times 10^3 + 10^3)\times v'$

$v' = 1 ms^{-1}$

Change in KE $= \frac{1}{2}(6\times 10^3)\times 1^2 - \frac{1}{2}(5\times 10^3)\times (1.2)^2 = 1560$ J

17. Concept

18. $K = \frac{p^2}{2m} = \frac{P^2 t^2}{2m}$ as $F = P = \frac{p}{t}$

19. From conservation of linear momentum ,

$m_1 v_1 + m_2 v_2 = m_1 v_1 + m_2 v_2 \Rightarrow m_2 v_2 = \frac{3u}{2}$

From conservation of kinetic energy,

$$\frac{1}{2}m_1u_1^2+\frac{1}{2}m_2u_2^2=\frac{1}{2}m_1v_1^2+\frac{1}{2}m_2v_2^2$$

$$\Rightarrow m_2v_2^2=\frac{15u^2}{8}$$

$$m_2=1.2kg$$

20. From work-energy theorem

$$\frac{1}{2}mv^2=Fx\Rightarrow x=\frac{mv^2}{2F}$$

But when the makes turn, then

$$\frac{mv^2}{r}=F\Rightarrow r=\frac{mv^2}{F}$$

It is clear that $x=\frac{r}{2}$ i.e. by the same retarding force the car can be stopped in a less distance if the driver applies brakes. This retarding force is actually friction force

21. Kinetic energy of both α-particle and proton

= potential energy of two particles

$$=\frac{(2e)(e)}{4\pi\varepsilon_0 r}=\frac{2\times(1.6\times10^{-19})^2\times9\times10^9}{10^{-10}}=46.08\times10^{-19}$$

As initial momentum of two particles is zero, their final momentum must also be zero

$\therefore$ Numerical value of momentum of each particle = p

KE of proton $=\frac{p^2}{2m}=E(say)$

Kinetic energy of α-particle $=\frac{p^2}{2(4m)}=\frac{E}{4}$

Total kinetic energy $=E+\frac{E}{4}=46.08\times10^{-19}\,J$

$$\therefore E=\frac{4}{5}\times46\times10^{-19}\,J=36.8\times10^{-19}\,J$$

$\therefore$ KE of $\alpha-$ particle$=\frac{36.8\times10^{-19}}{4}=29.2\times10^{-19}J$

22. From energy conservation $\frac{1}{2}mv_{max}^2=mg(H_2-H_1)$

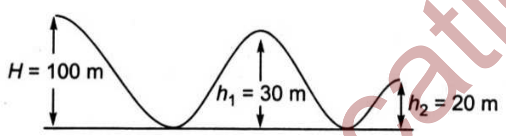
Here $H_1=$ minimum height of swing from earth's surface = 0.75m

$H_2=$ maximum height of swing from earth's surface = 2m

$\therefore \frac{1}{2}mv_{max}^2=mg(2-0.75)$

Or $v_{max}=\sqrt{2\times10\times125}=5ms^{-1}$

23. According to conservation of energy



Or $mg(H-h_2)=\frac{1}{2}mv^2$

Or $v=\sqrt{2g(100-20)}$

Or $v=\sqrt{2\times10\times80}=40ms^{-1}$

24. Kinetic energy $E_K=\frac{1}{2}mv^2$.............. (i)

Llinear momentum P = mv.............. (ii)

From eqs (i) and (ii), $E_K=\frac{m^2v^2}{2m}=\frac{p^2}{2m}$

$\therefore p=\sqrt{2mE_K}$

When $E_{K_1}=E_{K_2}$

$\frac{p_1^2}{2m_1}=\frac{p_2^2}{2m_2}$

Or $\frac{p_1}{p_2} = \sqrt{\frac{m_1}{m_2}}$ Or $\frac{p_2}{p_1} = \frac{1}{\sqrt{3}}$

25. Velocity at the time when knife edge strikes wooden floor is $\sqrt{2gh}$.

From work-energy theorem, we have

$$0 - \frac{1}{2}mv^2 = -Fs \Rightarrow F = Mg\frac{h}{s}$$

26. From conservation of linear momentum

$$p_{initial} = p_{final}$$

$$0 = m_1 v_1 - m_2 v_2$$

Or $\frac{v_1}{v_2} = \frac{m_2}{m_1}$ ………… (i)

Thus, ratio of kinetic energies

$$\frac{E_1}{E_2} = \frac{\frac{1}{2}m_1 v_1^2}{\frac{1}{2}m_2 v_2^2} = \frac{m_1}{m_2} \times \left(\frac{m_2}{m_1}\right)^2 = \frac{m_2}{m_1}$$

27. In order to climb a height h the boy utilizes potential energy = mgh

In order to climb he will use the efficient energy

Also $1kJ = 10^3 J$

Energy of one bread = 21kJ = $21 \times 10^3 J$

Energy consumed by boy $= \frac{28}{100} \times 21000 = 5880$ J ……… (i)

From law of conservation of energy,

$\therefore mgh = 40 \times 9.8 \times h$

Equations Eqs (i) and (ii) we have

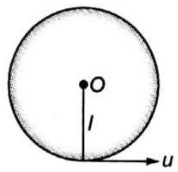
40 x 9.8 x h = 5880

$$\Rightarrow h = \frac{5880}{40 \times 9.8} = 15m$$

28. At a 30ft height, the velocity of both the masses will be equal ie, $v_1 = v_2 = v$

Thus, $\dfrac{K_1}{K_2} = \dfrac{\frac{1}{2}m_1v^2}{\frac{1}{2}m_2v^2} = \dfrac{m_1}{m_2} = \dfrac{2}{4} = \dfrac{1}{2}$

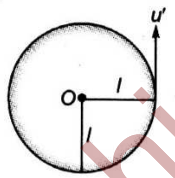
29. When stone is at its lowest position, it has only kinetic energy given by



$K = \frac{1}{2}mu^2$

At the horizontal position, it has energy

$E = U + K = \frac{1}{2}mu^2 + mgl$



According to conservation of energy

$\frac{1}{2}mu^2 = \frac{1}{2}mu^2 + mgl$

Or $\frac{1}{2}mu^2 = \frac{1}{2}mu^2 - mgl$

Or $u' = \sqrt{u^2 - 2gl}$

$|\Delta u| = |u| = \sqrt{u'^2 + u^2 + 2u'u\cos 90^0}$

$|\Delta u| = \sqrt{u'^2 + u^2}$

$= \sqrt{2(u^2 - gl)}$

30. Initial kinetic energy of the body $= \frac{1}{2}mv^2$

$=\frac{1}{2}m(4)^2 = 8m$

mgh = 4m

Or $h=\frac{4}{g}=\frac{4}{10}=0.4m$

31. According to work – energy theorem, work done = change in kinetic energy of the body

$\therefore W = K_f - K_i$

Or $F.dx = K_f - \frac{1}{2}mv_i^2$

Or $F.dx = K_f - \frac{1}{2}\times 10\times (10)^2$

Or $F.dx = K_f - 500$

Or $\int_{x=20}^{x=30} (-/=0.1)x\ dx = K_f - 500$

Or $-0.1\left[\frac{(30)^2}{2}-\frac{(20)^2}{2}\right] = K_f - 500$

Or $K_f - 500 = -0.1(450-200)$

Or $K_f - 500 = -25$

$\therefore K_f = 500 - 25 = 475J$

32. Concept

33. Potential energy $=\frac{75}{100}\times 12 = 9J$ ………….(i)

Now, KE of the mass at the end of fall

$KE=\frac{1}{2}mv^2$ ……………….(ii)

Applying law of conservation of energy,

$\frac{1}{2}mv^2 = 9$

$$v=\sqrt{\frac{2\times 9}{m}}=\sqrt{18}ms^{-1}$$

34. By the law of conservation of energy,

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

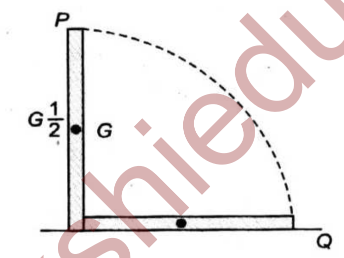
$$\therefore x^2=\frac{mv^2}{k}\Rightarrow x=\sqrt{\left(\frac{mv^2}{k}\right)}\Rightarrow x=\sqrt{\left(\frac{0.5\times 1.5\times 1.5}{50}\right)}$$

35. From kinetic energy relation

$$\frac{1}{2}mv^2=F.s$$

Or $F=\frac{mv^2}{2s}=\frac{30\times 10^{-3}\times (500)^2}{2\times 12\times 10^{-2}}=31250$ N

36. The kinetic energy at the point Q is given by



$$=\frac{1}{2}I\omega^2=\frac{1}{2}\frac{ml^2}{3}\frac{v^2}{l^2}$$

$$=\frac{1}{2}\times\frac{1}{3}mv^2$$

The potential energy at G= $\frac{1}{2}mgl$

From eqs (i) and (ii), we get $\frac{1}{2}\frac{mv^2}{3}=\frac{1}{2}mgl$

$$v=\sqrt{3gl}$$

37. A body of mass m moving with velocity v, possess kinetic energy given by

$K = \frac{1}{2}mv^2$ ....(i)

This kinetic energy is utilized in doing work against the frictionless forces

$W = \mu mgs$ .... (ii)

Where μ is coefficient of kinetic friction, m is mass, g is gravity and s is displacement.

Equating eqs (i) and (ii) we get

$\frac{1}{2}mv^2 = \mu mgs$

Where $\frac{1}{2}mv^2 = \frac{1}{2}\times 10 \times (10)^2 = 500kg - ms^{-1}$

Given $v = 10ms^{-}$, $\mu = 0.5m$, m = 10kg, $g = 10ms^{-2}$

$\Rightarrow s = \frac{\frac{1}{2}\times m \times (10)^2}{\mu mg} \quad = \frac{50}{0.5\times 10} = 10m$

3. Power

38. Linear velocity $v = r\omega = r\left(\frac{2\pi}{r}\right) = \frac{1}{4}\times\frac{2\pi}{2} = \frac{\pi}{4} ms^{-1}$

Power, $P = F\times v = 15\times 9.8\times\frac{\pi}{4}$ = 115.6W

39. Power is defined as the rate of change of energy in a system or the time rate of doing work

$\Rightarrow P = \frac{dE}{dt} = \frac{dW}{dt}$

Work=force x displacement = F x d

So $P = \frac{d}{dt}(F\times d) = \frac{d}{dt}\times 0 = 0$

40. Power generated by the turbine

$P_{generated} = P_{input}\times\frac{90}{100} = \frac{Mgh}{t}\times\frac{90}{100}$

Putting he given values

$\frac{M}{t} = 15kgs^{-1}$, $g = 10ms^{-2}$, h = 60m

$\therefore P_{generated} = (15\times 10\times 60)\times\frac{90}{100}$ =8.1kW

41. Mass flowing out per second $m = Av\rho$. …………… (i)

$\frac{P'}{P} = \frac{\frac{1}{2}A\rho v'^3}{\frac{1}{2}A\rho v^3}$ Or $\frac{P'}{P} = \left(\frac{v'}{v}\right)^3$

Now, $\frac{m'}{m} = \frac{A\rho v'}{A\rho v} = \frac{v'}{v}$

As $m' = nm, v' = nv$

$\therefore \frac{P'}{P} = n^3$

$\Rightarrow P' = n^3 P$

42. Power $= [ML^2T^{-3}] =$ constant

$\therefore \left[\dfrac{ML^2}{T^3}\right] = \text{constant}$

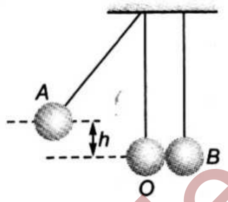
$\therefore [L^2] \propto [T^3] \;\; or \;\; s^2 \propto t^3$

43. Centripetal acceleration $a_c = \dfrac{v^2}{r} = k^2 r t^2$

$\Rightarrow v^2 = k^2 r^2 r^2$

$KE = \dfrac{1}{2} m v^2 = \dfrac{1}{2} m k^2 r^2 t^2$

According to work energy theorem, change in kinetic energy is equal to work done



$\therefore W = \dfrac{1}{2} m k^2 r^2 t^2$

Thus, power delivered to the particle

$P = \dfrac{dW}{dt} = m k^2 r^2 t$

44. Power delivered to the body

P = F.v = mav

Since, body undergoes one dimensional motion and is initially at rest, so

v = 0 + gt

$\therefore P = magt$ Or $P \propto t$