Work, Energy and Power JEE Main PYQ - 3

Total Time: 1 Hour : 15 Minute **Total Marks:** 120

Instructions

Instructions

1. Test will auto submit when the Time is up.
2. The Test comprises of multiple choice questions (MCQ) with one or more correct answers.
3. The clock in the top right corner will display the remaining time available for you to complete the examination.

Navigating & Answering a Question

1. The answer will be saved automatically upon clicking on an option amongst the given choices of answer.
2. To deselect your chosen answer, click on the clear response button.
3. The marking scheme will be displayed for each question on the top right corner of the test window.

Work, Energy and Power

1. Heat is given to an ideal gas in an isothermal process (+4, -1)
A Internal energy of the gas will decrease
B Internal energy of the gas will increase
C Internal energy of the gas will not change
D The gas will do positive work E The gas will do negative work
Choose the correct answer from the options given below:

a. C and D only

b. B and D only

c. A and E only

d. C and E only

---

2. **A stone of mass $1\,kg$ is tied to end of a massless string of length $1m$ If the breaking tension of the string is $400\,N$, then maximum linear velocity, the stone can have without breaking the string, while rotating in horizontal plane, is :** (+4, -1)

a. $40\,ms^{-1}$

b. $20\,ms^{-1}$

c. $400\,ms^{-1}$

d. $10\,ms^{-1}$

---

3. Find the amount of work done in rotating a dipole of dipole moment 3×10^{-3} from its position of stable equilibrium to the position of unstable equilibrium, in a uniform electric field of intensity 10^{4} $^{-1}$. (+4, -1)

a. (A) 50

b. (B) 60

c. (C) 80

d. (D) 70

---

4. The mass of a hydrogen molecule is $3.32 \times 10^{-27}\,kg$. If 10^{23} hydrogen molecules strike, per second,a fixed wall of area $2\,cm^2$ at an angle of 45° to the normal, and rebound elastically with a speed of $10^3\,m/s$, then the pressure on the wall is nearly : **(+4, -1)**

a. $2.35 \times 10^3\,N/m^2$

b. $4.70 \times 10^3\,N/m^2$

c. $2.35 \times 10^2\,N/m^2$

d. $4.70 \times 10^2\,N/m^2$

---

5. When a rubber -band is stretched by a distance x, it exerts a restoring force of magnitude $F = ax + bx^2$, where a and b are constants. The work done in stretching the unstretched rubber-band by L is : **(+4, -1)**

a. $aL^2 + bL^3$

b. $\frac{1}{2}(aL^2 + bL^3)$

c. $\frac{aL^2}{2} + \frac{bL^3}{3}$

d. $\frac{1}{2}\left(\frac{aL^2}{2} + \frac{bL^3}{3}\right)$

---

6. In a collinear collision, a particle with an initial speed v_0 strikes a stationary particle of the same mass. If the final total kinetic energy is 50% grater than the original kinetic energy, the magnitude of the relative velocity between the two particles, after collision, is - **(+4, -1)**

a. $\frac{v_0}{4}$

b. $\sqrt{2}v_0$

c. $\frac{v_0}{2}$

d. $\frac{v_0}{\sqrt{2}}$

7. An alpha-particle of mass m suffers 1-dimensional elastic coolision with a nucleus at rest of unknown mass. It is scattered directly backwards losing, 64% of its initial kinetic energy. The mass of the nucleus is : **(+4, -1)**

a. 4 m

b. 3.5 m

c. 2 m

d. 1.5 m

8. A uniform cable of mass $'M'$ and length $'L'$ is placed on a horizontal surface such that its $\left(\frac{1}{n}\right)^{th}$ part is hanging below the edge of the surface. To lift the hanging part of the cable upto the surface, the work done should be : **(+4, -1)**

a. $\frac{MgL}{n^2}$

b. $\frac{MgL}{2n^2}$

c. $\frac{2MgL}{n^2}$

d. $nMgL$

9. A spring whose unstretched length is l has a force constant k. The spring is cut into two pieces of unstretched lengths l_1 and l_2 where, $l_1 = nl_2$ and n is an integer. The ratio k_1/k_2 of the corresponding force constants, k_1 and k_2 will be : **(+4, -1)**

a. $\frac{1}{n^2}$

b. n^2

c. $\frac{1}{n}$

d. n

10. A spring of unstretched length ℓ has a mass m with one end fixed to a rigid support. Assuming spring to be made of a uniform wire, the kinetic energy possessed by it if it's free end is pulled with uniform velocity v is : **(+4, -1)**

a. $\frac{1}{2}mv^2$

b. mv^2

c. $\frac{1}{3}mv^2$

d. $\frac{1}{6}mv^2$

---

11. A projectile of mass M is fired so that the horizontal range is $4\,km$. At the highest point the projectile explodes in two parts of masses $M/4$ and $3M/4$ respectively and the heavier part starts falling down vertically with zero initial speed. The horizontal range (distance from point of firing) of the lighter part is : **(+4, -1)**

a. 16 km

b. 1 km

c. 10 km

d. 2 km

---

12. A point particle of mass m, moves along the uniformly rough track PQR as shown in the figure. The coefficient of friction, between the particle and the rough track equals μ. The particle is released, from rest, from the point P and it comes to rest at a point R. The energies, lost by the ball, over the parts, PQ and QR, of the track, are equal to each other, and no energy is lost when particle changes direction from PQ to QR. The values of the coefficient of friction μ and the distance $x(= QR)$, are, respectively close to : **(+4, -1)**

a. 0.2 and 6.5 m

b. 0.2 and 3.5 m

c. 0.29 and 3.5 m

d. 0.29 and 6.5 m

---

13. A piece of wood of mass $0.03\,kg$ is dropped from the top of a $100\,m$ height building. At the same time, a bullet of mass $0.02\,kg$ is fired vertically upward, with a velocity $100\ ms^{-1}$, from the ground. The bullet gets embedded in the wood. Then the maximum height to which the combined system reaches above the top of the building before falling below is : $(g = 10\,ms^{-2})$ **(+4, -1)**

a. 30 m

b. 10 m

c. 40 m

d. 20 m

---

14. A person trying to lose weight by burning at lifts a mass of $10\,kg$ upto a height of $1\,m$ 1000 times. Assume that the potential energy lost each time he lowers the mass is dissipated. How much fat will he use up considering the work done only when the weight is lifted up ? Fat supplies $3.8 \times 10^7\,J$ of energy per kg which is converted to mechanical energy with a 20% efficiency rate. Take $g = 9.8\,ms^{-2}$: **(+4, -1)**

a. $2.45 \times 10^{-3}\,kg$

b. $6.45 \times 10^{-3}\,kg$

c. $9.89 \times 10^{-3}\,kg$

d. $12.89 \times 10^{-3}\,kg$

---

15. A particle is moving in a circular path of radius a under the action of an attractive potential $U = -\frac{k}{2r^2}$. Its total energy is - **(+4, -1)**

a. $-\frac{k}{4a^2}$

b. $\frac{k}{2a^2}$

c. zero

d. $-\frac{3}{2}\frac{k}{a^2}$

---

16. A man (mass = $50\,kg$) and his son (mass = $20\,kg$) are standing on a frictionless surface facing each other. The man pushes his son so that he starts moving at a speed of $0.70\,ms^{-1}$ with respect to the man. The speed of the man with respect to the surface is : **(+4, -1)**

a. $0.20\,ms^{-1}$

b. $0.14\,ms^{-1}$

c. $0.47\,ms^{-1}$

d. $0.28\,ms^{-1}$

---

17. A force acts on a $2\,kg$ object so that its position is given as a function of time as $x = 3t^2 + 5$. What is the work done by this force in first 5 seconds ? **(+4, -1)**

a. 850 J

b. 900 J

c. 950 J

d. 875 J

---

18. Two particles A and B of equal mass M are moving with the same speed v as shown in the figure. They collide completely inelastically and move as a single particle C. The angle θ that the path of C makes with the $X-axis$ is given by : **(+4, -1)**

a. $\tan\theta = \frac{\sqrt{3}+\sqrt{2}}{1-\sqrt{2}}$

b. $\tan\theta = \frac{\sqrt{3}-\sqrt{2}}{1-\sqrt{2}}$

c. $\tan\theta = \frac{1-\sqrt{2}}{\sqrt{2}(1+\sqrt{3})}$

d. $\tan\theta = \frac{1-\sqrt{3}}{1+\sqrt{2}}$

19. A time dependent force $F = 6t$ acts on a particle of mass $1\,kg$. If the particle starts from rest, the work done by the force during the first $1\,sec.$ will be : **(+4, -1)**

a. 4.5 J

b. 22 J

c. 9 J

d. 18 J

20. A body of mass $m = 10^{-2}\,kg$ is moving in a medium and experiences a frictional force $F = -kv^2$. Its initial speed is $v_0 = 10\,ms^{-1}$. If, after $10\,s$, its energy is $\frac{1}{8}m{v_0}^2$, the value of k will be : **(+4, -1)**

a. $10^{-3} kg\,m^{-1}$

b. $10^{-3} kg\,s^{-1}$

c. $10^{-4} kg\,m^{-1}$

d. $10^{-1} kg\,m^{-1} s^{-1}$

21. A bullet looses $\left(\frac{1}{n}\right)^{th}$ of its velocity passing through one plank. The number of such planks that are required to stop the bullet can be : **(+4, -1)**

a. $\frac{n^2}{2n-1}$

b. $\frac{2n^2}{n-1}$

c. Infinite

d. n

22. Velocity-time graph for a body of mass $10\,kg$ is shown in figure. Work-done on the body in first two seconds of the motion is : **(+4, -1)**

a. 12000 J

b. -12000 J

c. -4500 J

d. -9300 J

---

23. A particle of mass M is moving in a circle of fixed radius R in such a way that its centripetal acceleration at time t is given by $n^2 R t^2$ where n is a constant. The power delivered to the particle by the force acting on it, is : (+4, -1)

a. $M n^2 R^2 t$

b. $M n R^2 t$

c. $M n R^2 t^2$

d. $\frac{1}{2} M n^2 R^2 t^2$

---

24. A body of mass m starts moving from rest along x-axis so that its velocity varies as $v = a\sqrt{s}$ where a is a constant and s is the distance covered by the body. The total work done by all the forces acting on the body in the first t seconds after the start of the motion is : (+4, -1)

a. $\frac{1}{8} m a^4 t^2$

b. $8 m a^4 t^2$

c. $4 m a^4 t^2$

d. $\frac{1}{4} m a^4 t^2$

---

25. A thin rod MN, free to rotate in the vertical plane about the fixed end N, is held horizontal. When the end M is released the speed of this end, when the rod makes an angle α with the horizontal, will be proportional to : (see figure) (+4, -1)

a. $\sqrt{\sin \alpha}$

b. $\sin \alpha$

c. $\sqrt{\cos\alpha}$

d. $\cos\alpha$

---

26. A proton of mass m collides elastically with a particle of unknown mass at rest. After the collision, the proton and the unknown particle are seen moving at an angle of 90° with respect to each other. The mass of unknown particle is : **(+4, -1)**

a. $\frac{m}{2}$

b. m

c. $\frac{m}{\sqrt{3}}$

d. $2m$

---

27. A block of mass m, lying on a smooth horizontal surface, is attached to a spring (of negligible mass) of spring constant k. The other end of the spring is fixed, as shown in the figure. The block is initally at rest in its equilibrium position. If now the block is pulled with a constant force F, the maximum speed of the block is : **(+4, -1)**

a. $\frac{\pi F}{\sqrt{mk}}$

b. $\frac{2F}{\sqrt{mk}}$

c. $\frac{F}{\sqrt{mk}}$

d. $\frac{F}{\pi\sqrt{mk}}$

---

28. Two particles of equal mass m have respective initial velocities $u\hat{i}$ and $u\left(\frac{\hat{i}+\hat{j}}{2}\right)$. They collide completely inelastically. The energy lost in the process is : **(+4, -1)**

a. $\frac{3}{4}mu^2$

b. $\sqrt{\frac{2}{3}}mu^2$

c. $\frac{1}{3}mu^2$

d. $\frac{1}{8}mu^2$

---

29. A 60 HP electric motor lifts an elevator having a maximum total load capacity of 2000 kg. If the frictional force on the elevator is 4000 N, the speed of the elevator at full load is close to : $(1\,HP = 746\,W,\ g = 10\,ms^{-2}\ )$ **(+4, -1)**

a. $1.5\,ms^{-1}$

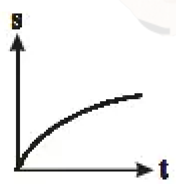
b. $1.7\,ms^{-1}$

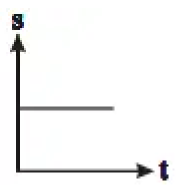
c. $2.0\,ms^{-1}$

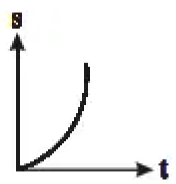
d. $1.9\,ms^{-1}$

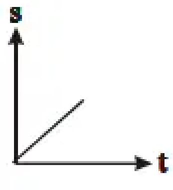
---

30. A particle is moving unidirectionally on a horizontal plane under the action of a constant power supplying energy source. The displacement (s) - time (t) graph that describes the motion of the particle is (graphs are drawn schematically and are not to scale) : **(+4, -1)**

a. 

b. 

c. 

d. 

Answers

1. **Answer: a**

Explanation:

Sol. $dQ = dU + dW$
$\Rightarrow dU = nC_V dT$
$dU = 0$ (for isothermal)
$\therefore U =$ constant
Also $dQ > 0$ (supplied)
Hence $dW > 0$

Concepts:

1. Work, Energy and Power:

Work:

- Work is correlated to force and the displacement over which it acts. When an object is replaced parallel to the force's line of action, it is thought to be doing work. It is a force-driven action that includes movement in the force's direction.
- The work done by the force is described to be the product of the elements of the force in the direction of the displacement and the magnitude of this displacement.

Energy:

- A body's energy is its potential to do tasks. Anything that has the capability to work is said to have energy. The unit of energy is the same as the unit of work, i.e., the Joule.
- There are two types of mechanical energy such as; Kinetic and potential energy.

Read More: Work and Energy

Power:

- Power is the rate at which energy is transferred, conveyed, or converted or the rate of doing work. Technologically, it is the amount of work done per unit of time.

The SI unit of power is Watt (W) which is joules per second (J/s). Sometimes the power of motor vehicles and other machines is demonstrated in terms of Horsepower (hp), which is roughly equal to 745.7 watts.

- Power is a scalar quantity, which gives us a quantity or amount of energy consumed per unit of time but with no manifestation of direction.

---

2. **Answer: b**

Explanation:

The correct answer is (B) : $20\ ms^{-1}$

Concepts:

1. Work, Energy and Power:

Work:

- Work is correlated to force and the displacement over which it acts. When an object is replaced parallel to the force's line of action, it is thought to be doing work. It is a force-driven action that includes movement in the force's direction.
- The work done by the force is described to be the product of the elements of the force in the direction of the displacement and the magnitude of this displacement.

Energy:

- A body's energy is its potential to do tasks. Anything that has the capability to work is said to have energy. The unit of energy is the same as the unit of work, i.e., the Joule.
- There are two types of mechanical energy such as; Kinetic and potential energy.

Read More: Work and Energy

Power:

- Power is the rate at which energy is transferred, conveyed, or converted or the rate of doing work. Technologically, it is the amount of work done per unit of time. The SI unit of power is Watt (W) which is joules per second (J/s).

Sometimes the power of motor vehicles and other machines is demonstrated in terms of Horsepower (hp), which is roughly equal to 745.7 watts.

- Power is a scalar quantity, which gives us a quantity or amount of energy consumed per unit of time but with no manifestation of direction.

---

3. **Answer: b**

Explanation:

Explanation:
Given that:Dipole Moment, = 3 × 10^{-3} Electric Field Intensity, = 10^4 $^{-1}$ We know that,In rotating the dipole from the position of stable equilibrium by an angle , the amount of work done is given by, = (1 − cos)For unstable equilibrium, = 180 = (1 − cos180) [cos180 = − 1] = 2 = 2 × 3 × 10^{-3} × 10^4 = 60 Hence, the correct option is (B).

---

4. **Answer: a**

Explanation:

$$P = \frac{F}{A} = \frac{2 \cdot nmv \cos\theta}{A} = \frac{2\times10^{23}\times3.32\times10^{-27}\times10^{3}}{\sqrt{2}\times2\times10^{-4}}\,N/m^2 = 2.35\times10^3\,N/m^2$$

Concepts:

1. **Work, Energy and Power:**

Work:

- Work is correlated to force and the displacement over which it acts. When an object is replaced parallel to the force's line of action, it is thought to be doing work. It is a force-driven action that includes movement in the force's direction.
- The work done by the force is described to be the product of the elements of the force in the direction of the displacement and the magnitude of this displacement.

Energy:

- A body's energy is its potential to do tasks. Anything that has the capability to work is said to have energy. The unit of energy is the same as the unit of work, i.e., the Joule.
- There are two types of mechanical energy such as; Kinetic and potential energy.

Read More: [Work and Energy]

Power:

- Power is the rate at which energy is transferred, conveyed, or converted or the rate of doing work. Technologically, it is the amount of work done per unit of time. The SI unit of power is Watt (W) which is joules per second (J/s). Sometimes the power of motor vehicles and other machines is demonstrated in terms of Horsepower (hp), which is roughly equal to 745.7 watts.
- Power is a scalar quantity, which gives us a quantity or amount of energy consumed per unit of time but with no manifestation of direction.

---

5. **Answer: c**

Explanation:

$$\int dW = \int F \cdot dl$$
$$W = \int_0^L ax dx + \int_0^L bx^2\, dx$$
$$= \frac{aL^2}{2} + \frac{bL^3}{3}$$

Concepts:

1. Work, Energy and Power:

Work:

- Work is correlated to force and the displacement over which it acts. When an object is replaced parallel to the force's line of action, it is thought to be doing work. It is a force-driven action that includes movement in the force's direction.
- The work done by the force is described to be the product of the elements of the force in the direction of the displacement and the magnitude of this displacement.

Energy:

- A body's energy is its potential to do tasks. Anything that has the capability to work is said to have energy. The unit of energy is the same as the unit of work, i.e., the Joule.
- There are two types of mechanical energy such as; Kinetic and potential energy.

Read More: [Work and Energy]

Power:

- Power is the rate at which energy is transferred, conveyed, or converted or the rate of doing work. Technologically, it is the amount of work done per unit of time. The SI unit of power is Watt (W) which is joules per second (J/s). Sometimes the power of motor vehicles and other machines is demonstrated in terms of Horsepower (hp), which is roughly equal to 745.7 watts.
- Power is a scalar quantity, which gives us a quantity or amount of energy consumed per unit of time but with no manifestation of direction.

---

6. Answer: b

Explanation:

It is a case of superelastic collision

$$mv_0 = mv_1 + mv_2 \quad \ldots.(i)$$
$$\Rightarrow v_1 + v_2 = v_0$$
$$\frac{1}{2}m\left(v_1^2 + v_2^2\right) = \frac{3}{2}\left(\frac{1}{2}mv_0^2\right)$$
$$\Rightarrow \left(v_1^2 + v_2^2\right) = \frac{3}{2}v_0^2 \quad \ldots(ii)$$
$$\Rightarrow \left(v_1 + v_2\right)^2 = v_1^2 + v_2^2 + 2v_1v_2$$
$$\Rightarrow v_0^2 = \frac{3v_0^2}{2} + 2v_1v_2$$
$$\Rightarrow 2v_1v_2 = -\frac{v_0^2}{2} \quad \ldots(iii)$$
$$\therefore \left(v_1 - v_2\right)^2 = \left(v_1 + v_2\right)^2 - 4v_1v_2 = v_0^2 + v_0^2$$
$$\Rightarrow v_1 - v_2 = \sqrt{2}v_0$$

Concepts:

1. Work, Energy and Power:

Work:

- Work is correlated to force and the displacement over which it acts. When an object is replaced parallel to the force's line of action, it is thought to be doing work. It is a force-driven action that includes movement in the force's direction.
- The work done by the force is described to be the product of the elements of the force in the direction of the displacement and the magnitude of this displacement.

Energy:

- A body's energy is its potential to do tasks. Anything that has the capability to work is said to have energy. The unit of energy is the same as the unit of work, i.e., the Joule.
- There are two types of mechanical energy such as; Kinetic and potential energy.

Read More: Work and Energy

Power:

- Power is the rate at which energy is transferred, conveyed, or converted or the rate of doing work. Technologically, it is the amount of work done per unit of time. The SI unit of power is Watt (W) which is joules per second (J/s). Sometimes the power of motor vehicles and other machines is demonstrated in terms of Horsepower (hp), which is roughly equal to 745.7 watts.
- Power is a scalar quantity, which gives us a quantity or amount of energy consumed per unit of time but with no manifestation of direction.

---

7. Answer: a

Explanation:

$mv_0 = mv_2 - mv_1$

$\frac{1}{2}mV_1^2 = 0.36 \times \frac{1}{2}mV_0^2$

$v_1 = 0.6v_0$

$\frac{1}{2}MV_2^2 = 0.64 \times \frac{1}{2}mV_0^2$

$V_2 = \sqrt{\frac{m}{M}} \times 0.8V_0$

$mV_0 = \sqrt{mM} \times 0.8V_0 - m \times 0.6V_0$

$\Rightarrow 1.6m = 0.8\sqrt{mM}$

$4m^2 = mM$

Concepts:

1. Work, Energy and Power:

Work:

- Work is correlated to force and the displacement over which it acts. When an object is replaced parallel to the force's line of action, it is thought to be doing work. It is a force-driven action that includes movement in the force's direction.
- The work done by the force is described to be the product of the elements of the force in the direction of the displacement and the magnitude of this displacement.

Energy:

- A body's energy is its potential to do tasks. Anything that has the capability to work is said to have energy. The unit of energy is the same as the unit of work, i.e., the Joule.
- There are two types of mechanical energy such as; Kinetic and potential energy.

Read More: [Work and Energy]

Power:

- Power is the rate at which energy is transferred, conveyed, or converted or the rate of doing work. Technologically, it is the amount of work done per unit of time. The SI unit of power is Watt (W) which is joules per second (J/s). Sometimes the power of motor vehicles and other machines is demonstrated in terms of Horsepower (hp), which is roughly equal to 745.7 watts.
- Power is a scalar quantity, which gives us a quantity or amount of energy consumed per unit of time but with no manifestation of direction.

---

8. Answer: b

Explanation:

Mass of the hanging part = $\frac{M}{n}$

$h_{COM} = \frac{L}{2n}$

work done W = mgh$_{COM} = \left(\frac{M}{n}\right)g\left(\frac{L}{2n}\right) = \frac{MgL}{2n^2}$

Option (2)

Concepts:

1. Work, Energy and Power:

Work:

- Work is correlated to force and the displacement over which it acts. When an object is replaced parallel to the force's line of action, it is thought to be doing work. It is a force-driven action that includes movement in the force's direction.
- The work done by the force is described to be the product of the elements of the force in the direction of the displacement and the magnitude of this displacement.

Energy:

- A body's energy is its potential to do tasks. Anything that has the capability to work is said to have energy. The unit of energy is the same as the unit of work, i.e., the Joule.
- There are two types of mechanical energy such as; Kinetic and potential energy.

Read More: [Work and Energy]

Power:

- Power is the rate at which energy is transferred, conveyed, or converted or the rate of doing work. Technologically, it is the amount of work done per unit of time. The SI unit of power is Watt (W) which is joules per second (J/s). Sometimes the power of motor vehicles and other machines is demonstrated in terms of Horsepower (hp), which is roughly equal to 745.7 watts.
- Power is a scalar quantity, which gives us a quantity or amount of energy consumed per unit of time but with no manifestation of direction.

---

9. **Answer: c**

Explanation:

$$k_1 = \frac{C}{\ell_1}$$
$$k_2 = \frac{C}{\ell_2}$$
$$\frac{k_1}{k_2} = \frac{C\ell_2}{\ell_1 C}\ell_2 = \frac{\ell_2}{n\ell_2} = \frac{1}{n}$$

Concepts:

1. Work, Energy and Power:

Work:

- Work is correlated to force and the displacement over which it acts. When an object is replaced parallel to the force's line of action, it is thought to be doing work. It is a force-driven action that includes movement in the force's direction.
- The work done by the force is described to be the product of the elements of the force in the direction of the displacement and the magnitude of this displacement.

Energy:

- A body's energy is its potential to do tasks. Anything that has the capability to work is said to have energy. The unit of energy is the same as the unit of work, i.e., the Joule.
- There are two types of mechanical energy such as; Kinetic and potential energy.

Read More: [Work and Energy]

Power:

- Power is the rate at which energy is transferred, conveyed, or converted or the rate of doing work. Technologically, it is the amount of work done per unit of time. The SI unit of power is Watt (W) which is joules per second (J/s). Sometimes the power of motor vehicles and other machines is demonstrated in terms of Horsepower (hp), which is roughly equal to 745.7 watts.
- Power is a scalar quantity, which gives us a quantity or amount of energy consumed per unit of time but with no manifestation of direction.

10. **Answer: d**

Explanation:

$$KE = \int \frac{1}{2} dm \left(\frac{v}{\ell} x\right)^2$$
$$= \frac{1}{2} \int \frac{m}{\ell} dx \frac{v^2}{\ell^2} x^2$$
$$= \frac{mv^2}{2\ell^2} \left(\frac{x^3}{3}\right)_0^\ell$$
$$= \frac{mv^2}{2\ell^3} \times \frac{\ell^3}{3}$$
$$= \frac{mv^2}{6}$$

Concepts:

1. **Work, Energy and Power:**

Work:

- Work is correlated to force and the displacement over which it acts. When an object is replaced parallel to the force's line of action, it is thought to be doing work. It is a force-driven action that includes movement in the force's direction.
- The work done by the force is described to be the product of the elements of the force in the direction of the displacement and the magnitude of this displacement.

Energy:

- A body's energy is its potential to do tasks. Anything that has the capability to work is said to have energy. The unit of energy is the same as the unit of work, i.e., the Joule.
- There are two types of mechanical energy such as; Kinetic and potential energy.

Read More: [Work and Energy]

Power:

- Power is the rate at which energy is transferred, conveyed, or converted or the rate of doing work. Technologically, it is the amount of work done per unit of time. The SI unit of power is Watt (W) which is joules per second (J/s).

Sometimes the power of motor vehicles and other machines is demonstrated in terms of Horsepower (hp), which is roughly equal to 745.7 watts.
- Power is a scalar quantity, which gives us a quantity or amount of energy consumed per unit of time but with no manifestation of direction.

---

11. Answer: c

Explanation:

The correct option is(C): 10 km

$$X_{COM} = \frac{m_1x_1+m_2x_2}{m_1+m_2}$$
$$R = \frac{\frac{M}{4}x+\frac{3M}{4}\times\frac{R}{2}}{M}$$

Horizontal range is given as

$$r_{\frac{M}{4}} = \frac{r}{2}+d = 2+8 = 10km$$
$$= 10Km$$

Concepts:

1. Work, Energy and Power:

Work:

- Work is correlated to force and the displacement over which it acts. When an object is replaced parallel to the force's line of action, it is thought to be doing work. It is a force-driven action that includes movement in the force's direction.
- The work done by the force is described to be the product of the elements of the force in the direction of the displacement and the magnitude of this displacement.

Energy:

- A body's energy is its potential to do tasks. Anything that has the capability to work is said to have energy. The unit of energy is the same as the unit of work, i.e., the Joule.
- There are two types of mechanical energy such as; Kinetic and potential energy.

Read More: [Work and Energy]

Power:

- Power is the rate at which energy is transferred, conveyed, or converted or the rate of doing work. Technologically, it is the amount of work done per unit of time. The SI unit of power is Watt (W) which is joules per second (J/s). Sometimes the power of motor vehicles and other machines is demonstrated in terms of Horsepower (hp), which is roughly equal to 745.7 watts.
- Power is a scalar quantity, which gives us a quantity or amount of energy consumed per unit of time but with no manifestation of direction.

---

12. **Answer: c**

Explanation:

From work energy theorem and given condition

$mgh - 2\,\mu mg\,\cos\theta \frac{h}{\sin\theta} = 0$

$\therefore \mu = \frac{1}{2\cot 30} = \frac{1}{2\sqrt{3}} = 0.29$

again $\frac{mgh}{2} = \mu\, mg\, .QR$

$\therefore QR = \frac{h}{2\mu} = \frac{2}{2\times 0.29} = 3.5\, m$

Concepts:

1. **Work, Energy and Power:**

Work:

- Work is correlated to force and the displacement over which it acts. When an object is replaced parallel to the force's line of action, it is thought to be doing work. It is a force-driven action that includes movement in the force's direction.
- The work done by the force is described to be the product of the elements of the force in the direction of the displacement and the magnitude of this displacement.

Energy:

- A body's energy is its potential to do tasks. Anything that has the capability to work is said to have energy. The unit of energy is the same as the unit of work, i.e., the Joule.

- There are two types of mechanical energy such as; Kinetic and potential energy.

Read More: Work and Energy

Power:

- Power is the rate at which energy is transferred, conveyed, or converted or the rate of doing work. Technologically, it is the amount of work done per unit of time. The SI unit of power is Watt (W) which is joules per second (J/s). Sometimes the power of motor vehicles and other machines is demonstrated in terms of Horsepower (hp), which is roughly equal to 745.7 watts.
- Power is a scalar quantity, which gives us a quantity or amount of energy consumed per unit of time but with no manifestation of direction.

---

13. Answer: c

Explanation:

Time taken for the particles to collide,
$t = \frac{d}{V_{rel}} = \frac{100}{100} = 1\,\text{sec}$
Speed of wood just before collision = $gt = 10\,m/s$ & speed of bullet just before collision $v - gt$
= $100 - 10 = 90\,m/s$
Now, conservation of linear momentum just before and after the collision -
$-(0.02)(1v) + (0.02)(9v) = (0.05)v$
$\Rightarrow\ 150\ =\ 5v$
$\Rightarrow\ v\ =\ 30\,m/s$
Max. height reached by body $h = \frac{v^2}{2g}$
$h = \frac{30\times30}{2\times10} = 45\,m$
$\therefore$ Height above tower = $40\,m$

Concepts:

1. Work, Energy and Power:

Work:

- Work is correlated to force and the displacement over which it acts. When an object is replaced parallel to the force's line of action, it is thought to be doing work. It is a force-driven action that includes movement in the force's direction.
- The work done by the force is described to be the product of the elements of the force in the direction of the displacement and the magnitude of this displacement.

Energy:

- A body's energy is its potential to do tasks. Anything that has the capability to work is said to have energy. The unit of energy is the same as the unit of work, i.e., the Joule.
- There are two types of mechanical energy such as; Kinetic and potential energy.

Read More: Work and Energy

Power:

- Power is the rate at which energy is transferred, conveyed, or converted or the rate of doing work. Technologically, it is the amount of work done per unit of time. The SI unit of power is Watt (W) which is joules per second (J/s). Sometimes the power of motor vehicles and other machines is demonstrated in terms of Horsepower (hp), which is roughly equal to 745.7 watts.
- Power is a scalar quantity, which gives us a quantity or amount of energy consumed per unit of time but with no manifestation of direction.

---

14. Answer: d

Explanation:

$$0.2 \times 3.8 \times 10^7 \times m = 10 \times g \times 1 \times 1000$$
$$m = \frac{10 \times 9.8 \times 1000}{0.2 \times 3.8 \times 10^7} = 1.289 \times 10^{-2}\,kg = 12.89 \times 10^{-3}\,kg$$

Concepts:

1. Work, Energy and Power:

Work:

- Work is correlated to force and the displacement over which it acts. When an object is replaced parallel to the force's line of action, it is thought to be doing work. It is a force-driven action that includes movement in the force's direction.
- The work done by the force is described to be the product of the elements of the force in the direction of the displacement and the magnitude of this displacement.

Energy:

- A body's energy is its potential to do tasks. Anything that has the capability to work is said to have energy. The unit of energy is the same as the unit of work, i.e., the Joule.
- There are two types of mechanical energy such as; Kinetic and potential energy.

Read More: Work and Energy

Power:

- Power is the rate at which energy is transferred, conveyed, or converted or the rate of doing work. Technologically, it is the amount of work done per unit of time. The SI unit of power is Watt (W) which is joules per second (J/s). Sometimes the power of motor vehicles and other machines is demonstrated in terms of Horsepower (hp), which is roughly equal to 745.7 watts.
- Power is a scalar quantity, which gives us a quantity or amount of energy consumed per unit of time but with no manifestation of direction.

---

15. **Answer: c**

Explanation:

$F = \frac{-dU}{dr} \quad \left[U = -\frac{k}{2r^2}\right]$

$\frac{mv^2}{r} = \frac{k}{r^3}$ [This force provides necessary centripetal force]

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

$\Rightarrow K.E = \frac{k}{2r^2}$

$\Rightarrow P.E = -\frac{k}{2r^2}$

Total energy $=$ Zero

Concepts:

1. Work, Energy and Power:

Work:

- Work is correlated to force and the displacement over which it acts. When an object is replaced parallel to the force's line of action, it is thought to be doing work. It is a force-driven action that includes movement in the force's direction.
- The work done by the force is described to be the product of the elements of the force in the direction of the displacement and the magnitude of this displacement.

Energy:

- A body's energy is its potential to do tasks. Anything that has the capability to work is said to have energy. The unit of energy is the same as the unit of work, i.e., the Joule.
- There are two types of mechanical energy such as; Kinetic and potential energy.

Read More: Work and Energy

Power:

- Power is the rate at which energy is transferred, conveyed, or converted or the rate of doing work. Technologically, it is the amount of work done per unit of time. The SI unit of power is Watt (W) which is joules per second (J/s). Sometimes the power of motor vehicles and other machines is demonstrated in terms of Horsepower (hp), which is roughly equal to 745.7 watts.
- Power is a scalar quantity, which gives us a quantity or amount of energy consumed per unit of time but with no manifestation of direction.

---

16. **Answer: a**

Explanation:

$\Rightarrow 0 = 50V_1 - 20V_2$ and $V_1 + V_2 = 0.7$

$\Rightarrow V_1 = 0.2$

Concepts:

1. Work, Energy and Power:

Work:

- Work is correlated to force and the displacement over which it acts. When an object is replaced parallel to the force's line of action, it is thought to be doing work. It is a force-driven action that includes movement in the force's direction.
- The work done by the force is described to be the product of the elements of the force in the direction of the displacement and the magnitude of this displacement.

Energy:

- A body's energy is its potential to do tasks. Anything that has the capability to work is said to have energy. The unit of energy is the same as the unit of work, i.e., the Joule.
- There are two types of mechanical energy such as; Kinetic and potential energy.

Read More: Work and Energy

Power:

- Power is the rate at which energy is transferred, conveyed, or converted or the rate of doing work. Technologically, it is the amount of work done per unit of time. The SI unit of power is Watt (W) which is joules per second (J/s). Sometimes the power of motor vehicles and other machines is demonstrated in terms of Horsepower (hp), which is roughly equal to 745.7 watts.
- Power is a scalar quantity, which gives us a quantity or amount of energy consumed per unit of time but with no manifestation of direction.

---

17. Answer: b

Explanation:

$x = 3t^2 + 5$

$v = \frac{dx}{dt}$

$v = 6t + 0$

at $t = 0\, v = 0$

$t = 5\, sec\;\; v = 30\, m/s$

W.D. = ΔKE

W.D. $= \frac{1}{2}mv^2 - 0 = \frac{1}{2}\,(2)\,(30)^2 = 900J$

Concepts:

1. Work, Energy and Power:

Work:

- Work is correlated to force and the displacement over which it acts. When an object is replaced parallel to the force's line of action, it is thought to be doing work. It is a force-driven action that includes movement in the force's direction.
- The work done by the force is described to be the product of the elements of the force in the direction of the displacement and the magnitude of this displacement.

Energy:

- A body's energy is its potential to do tasks. Anything that has the capability to work is said to have energy. The unit of energy is the same as the unit of work, i.e., the Joule.
- There are two types of mechanical energy such as; Kinetic and potential energy.

Read More: Work and Energy

Power:

- Power is the rate at which energy is transferred, conveyed, or converted or the rate of doing work. Technologically, it is the amount of work done per unit of time. The SI unit of power is Watt (W) which is joules per second (J/s). Sometimes the power of motor vehicles and other machines is demonstrated in terms of Horsepower (hp), which is roughly equal to 745.7 watts.

- Power is a scalar quantity, which gives us a quantity or amount of energy consumed per unit of time but with no manifestation of direction.

---

18. Answer: a

Explanation:

$$2\,mv'\,sin\,\theta = \frac{mv}{\sqrt{2}} + \frac{mv\sqrt{3}}{2}$$
$$3\,mv'\,cos\,\theta = \frac{mv}{2} - \frac{mv}{\sqrt{2}}$$
$$sin\,\theta = \frac{\frac{1}{\sqrt{2}}+\frac{\sqrt{3}}{2}}{\frac{1}{2}-\frac{1}{\sqrt{2}}}$$
$$= \frac{\sqrt{2}+\sqrt{3}}{1-\sqrt{2}}$$

The Correct Option is (A): $\tan\theta = \frac{\sqrt{3}+\sqrt{2}}{1-\sqrt{2}}$

Concepts:

1. **Work, Energy and Power:**

Work:

- Work is correlated to force and the displacement over which it acts. When an object is replaced parallel to the force's line of action, it is thought to be doing work. It is a force-driven action that includes movement in the force's direction.
- The work done by the force is described to be the product of the elements of the force in the direction of the displacement and the magnitude of this displacement.

Energy:

- A body's energy is its potential to do tasks. Anything that has the capability to work is said to have energy. The unit of energy is the same as the unit of work, i.e., the Joule.
- There are two types of mechanical energy such as; Kinetic and potential energy.

Read More: [Work and Energy]

Power:

- Power is the rate at which energy is transferred, conveyed, or converted or the rate of doing work. Technologically, it is the amount of work done per unit of time. The SI unit of power is Watt (W) which is joules per second (J/s). Sometimes the power of motor vehicles and other machines is demonstrated in terms of Horsepower (hp), which is roughly equal to 745.7 watts.
- Power is a scalar quantity, which gives us a quantity or amount of energy consumed per unit of time but with no manifestation of direction.

---

19. Answer: a

Explanation:

$6t = 1 \cdot \frac{dv}{dt}$

$\int\limits_{0}^{v} dv = \int 6t\, dt$

$v = 6\left[\frac{t^2}{2}\right]_0^1$

$= 3\, ms^{-1}$

$W = \Delta KE = \frac{1}{2} \times 1 \times 9 = 4.5\, J$

Concepts:

1. Work, Energy and Power:

Work:

- Work is correlated to force and the displacement over which it acts. When an object is replaced parallel to the force's line of action, it is thought to be doing work. It is a force-driven action that includes movement in the force's direction.
- The work done by the force is described to be the product of the elements of the force in the direction of the displacement and the magnitude of this displacement.

Energy:

- A body's energy is its potential to do tasks. Anything that has the capability to work is said to have energy. The unit of energy is the same as the unit of work, i.e., the Joule.
- There are two types of mechanical energy such as; Kinetic and potential energy.

Read More: Work and Energy

Power:

- Power is the rate at which energy is transferred, conveyed, or converted or the rate of doing work. Technologically, it is the amount of work done per unit of time. The SI unit of power is Watt (W) which is joules per second (J/s). Sometimes the power of motor vehicles and other machines is demonstrated in terms of Horsepower (hp), which is roughly equal to 745.7 watts.
- Power is a scalar quantity, which gives us a quantity or amount of energy consumed per unit of time but with no manifestation of direction.

---

20. Answer: c

Explanation:

$\frac{k_f}{k_i} = \frac{\frac{1}{8} m v_0^2}{\frac{1}{2} m v_0^2} = \frac{1}{4}$

$\frac{v_f}{v_i} = \frac{1}{2}$

$v_f = \frac{v_0}{2}$

$-k v^2 = \frac{m d v}{d t}$

$\int\limits_{v_{0}}^{\frac{v_{0}}{2}} \frac{d v}{v^{2}}=\int\limits_{0}^{t_{0}} \frac{-k d t}{m}$

$\left[-\frac{1}{v}\right]_{v_0}^{\frac{v_0}{2}} = \frac{-k}{m} t_0$

$\frac{1}{v_0} - \frac{2}{v_0} = -\frac{k}{m} t_0$

$-\frac{1}{v_0} = -\frac{k}{m} t_0$

$k = \frac{m}{v_0 t_0}$

$= \frac{10^{-2}}{10 \times 10}$

$= 10^{-4}\, kg\, m^{-1}$

Concepts:

1. Work, Energy and Power:

Work:

- Work is correlated to force and the displacement over which it acts. When an object is replaced parallel to the force's line of action, it is thought to be doing work. It is a force-driven action that includes movement in the force's direction.

- The work done by the force is described to be the product of the elements of the force in the direction of the displacement and the magnitude of this displacement.

Energy:

- A body's energy is its potential to do tasks. Anything that has the capability to work is said to have energy. The unit of energy is the same as the unit of work, i.e., the Joule.
- There are two types of mechanical energy such as; Kinetic and potential energy.

Read More: Work and Energy

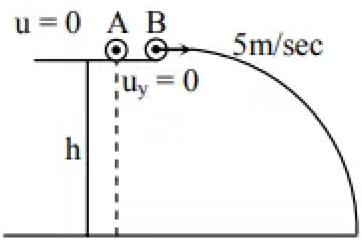
Power:

- Power is the rate at which energy is transferred, conveyed, or converted or the rate of doing work. Technologically, it is the amount of work done per unit of time. The SI unit of power is Watt (W) which is joules per second (J/s). Sometimes the power of motor vehicles and other machines is demonstrated in terms of Horsepower (hp), which is roughly equal to 745.7 watts.
- Power is a scalar quantity, which gives us a quantity or amount of energy consumed per unit of time but with no manifestation of direction.

---

21. Answer: a

Explanation:



$$\left(1-\frac{1}{n}\right)^2 V^2 = V^2 - 2as$$
$$2as = V^2\left(1-\left(\frac{n-1}{n}\right)^2\right) = V^2\left(\frac{2n-1}{n^2}\right)$$

$$O = V^2 - 2ans$$
$$n = \frac{V^2}{2as} = \frac{V^2}{V^2\left(\frac{2n-1}{n^2}\right)} = \frac{n^2}{2n-1}$$

Concepts:

1. Work, Energy and Power:

Work:

- Work is correlated to force and the displacement over which it acts. When an object is replaced parallel to the force's line of action, it is thought to be doing work. It is a force-driven action that includes movement in the force's direction.
- The work done by the force is described to be the product of the elements of the force in the direction of the displacement and the magnitude of this displacement.

Energy:

- A body's energy is its potential to do tasks. Anything that has the capability to work is said to have energy. The unit of energy is the same as the unit of work, i.e., the Joule.
- There are two types of mechanical energy such as; Kinetic and potential energy.

Read More: Work and Energy

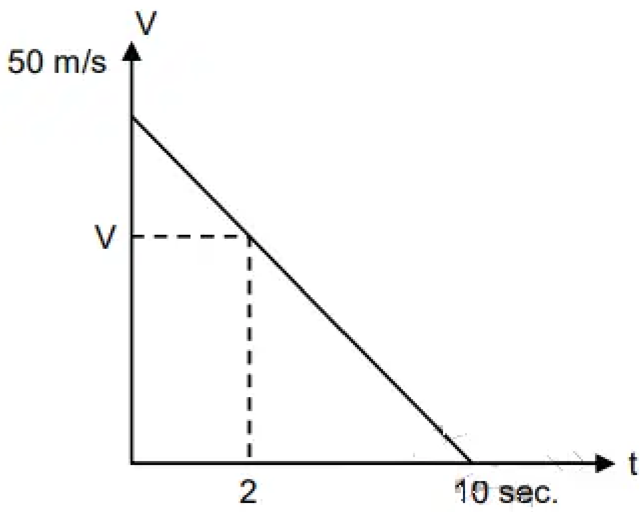
Power:

- Power is the rate at which energy is transferred, conveyed, or converted or the rate of doing work. Technologically, it is the amount of work done per unit of time. The SI unit of power is Watt (W) which is joules per second (J/s). Sometimes the power of motor vehicles and other machines is demonstrated in terms of Horsepower (hp), which is roughly equal to 745.7 watts.
- Power is a scalar quantity, which gives us a quantity or amount of energy consumed per unit of time but with no manifestation of direction.

---

22. Answer: c

Explanation:



Concepts:

1. Work, Energy and Power:

Work:

- Work is correlated to force and the displacement over which it acts. When an object is replaced parallel to the force's line of action, it is thought to be doing work. It is a force-driven action that includes movement in the force's direction.
- The work done by the force is described to be the product of the elements of the force in the direction of the displacement and the magnitude of this displacement.

Energy:

- A body's energy is its potential to do tasks. Anything that has the capability to work is said to have energy. The unit of energy is the same as the unit of work, i.e., the Joule.
- There are two types of mechanical energy such as; Kinetic and potential energy.

Read More: Work and Energy

Power:

- Power is the rate at which energy is transferred, conveyed, or converted or the rate of doing work. Technologically, it is the amount of work done per unit of time. The SI unit of power is Watt (W) which is joules per second (J/s). Sometimes the power of motor vehicles and other machines is demonstrated in terms of Horsepower (hp), which is roughly equal to 745.7 watts.
- Power is a scalar quantity, which gives us a quantity or amount of energy consumed per unit of time but with no manifestation of direction.

---

23. Answer: a

Explanation:

The correct option is(A): $M\,n^2R^2t$

$\frac{V^2}{R} = n^2\,Rt^2$
$\Rightarrow V^2 = n^2\,R^2\,t^2$
$\Rightarrow V = nRt$
$\Rightarrow \frac{dV}{dt} = nR$
$P = F_tV$
$= \frac{mdV}{dt}V$
$= mnR.nRt$
$P = n^2\,R^2\,t\,m$

Concepts:

1. Work, Energy and Power:

Work:

- Work is correlated to force and the displacement over which it acts. When an object is replaced parallel to the force's line of action, it is thought to be doing work. It is a force-driven action that includes movement in the force's direction.
- The work done by the force is described to be the product of the elements of the force in the direction of the displacement and the magnitude of this

displacement.

Energy:

- A body's energy is its potential to do tasks. Anything that has the capability to work is said to have energy. The unit of energy is the same as the unit of work, i.e., the Joule.
- There are two types of mechanical energy such as; Kinetic and potential energy.

Read More: Work and Energy

Power:

- Power is the rate at which energy is transferred, conveyed, or converted or the rate of doing work. Technologically, it is the amount of work done per unit of time. The SI unit of power is Watt (W) which is joules per second (J/s). Sometimes the power of motor vehicles and other machines is demonstrated in terms of Horsepower (hp), which is roughly equal to 745.7 watts.
- Power is a scalar quantity, which gives us a quantity or amount of energy consumed per unit of time but with no manifestation of direction.

---

24. Answer: a

Explanation:

Velocity of the body is given by
$v = a\sqrt{s}$
Differentiating w.r.t. t, we get
Acceleration, $a' = \frac{dv}{dt} = a\frac{1}{2}s^{-1/2} \cdot \frac{ds}{dt} = a\frac{1}{2\sqrt{s}} \cdot v \Rightarrow a' = \frac{a}{2\sqrt{s}} \cdot a\sqrt{s} = \frac{a^2}{2}$
Force on the body is $F = ma' = \frac{ma^2}{2}$
Distance covered by the body is given by
$s = ut + \frac{1}{2}a't^2$
$\Rightarrow s = \frac{1}{2} \cdot \frac{a^2}{2}t^2$
Work done =Force $\times$ Distance $= \frac{ma^2}{2} \cdot \frac{1}{2}\frac{a^2}{2}t^2 = \frac{1}{8}ma^4t^2$

Concepts:

1. Work, Energy and Power:

Work:

- Work is correlated to force and the displacement over which it acts. When an object is replaced parallel to the force's line of action, it is thought to be doing work. It is a force-driven action that includes movement in the force's direction.
- The work done by the force is described to be the product of the elements of the force in the direction of the displacement and the magnitude of this displacement.

Energy:

- A body's energy is its potential to do tasks. Anything that has the capability to work is said to have energy. The unit of energy is the same as the unit of work, i.e., the Joule.
- There are two types of mechanical energy such as; Kinetic and potential energy.

Read More: Work and Energy

Power:

- Power is the rate at which energy is transferred, conveyed, or converted or the rate of doing work. Technologically, it is the amount of work done per unit of time. The SI unit of power is Watt (W) which is joules per second (J/s). Sometimes the power of motor vehicles and other machines is demonstrated in terms of Horsepower (hp), which is roughly equal to 745.7 watts.
- Power is a scalar quantity, which gives us a quantity or amount of energy consumed per unit of time but with no manifestation of direction.

---

25. Answer: a

Explanation:

When the end M is released and rod makes angle α with horizontal, the displacement of centre of mass is $\frac{L}{2}\sin\alpha$. Now,
we know $mg\frac{L}{2}\sin\alpha = \frac{1}{2}I\omega^2$

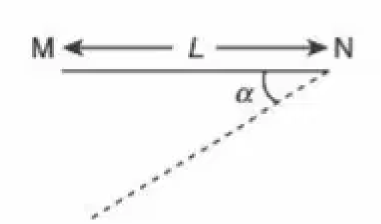
Here, $I = \frac{mL^2}{3}$; therefore,

$mg\frac{L}{2}\sin\alpha = \frac{1}{2}\frac{mL^2}{3}\omega^2$

$\Rightarrow \omega^2 = \frac{3g\sin\alpha}{L}$

$\Rightarrow \omega = \sqrt{\frac{3g\sin\alpha}{L}}$

$\Rightarrow \omega \propto \sqrt{\sin\alpha}$



Concepts:

1. Work, Energy and Power:

Work:

- Work is correlated to force and the displacement over which it acts. When an object is replaced parallel to the force's line of action, it is thought to be doing work. It is a force-driven action that includes movement in the force's direction.
- The work done by the force is described to be the product of the elements of the force in the direction of the displacement and the magnitude of this displacement.

Energy:

- A body's energy is its potential to do tasks. Anything that has the capability to work is said to have energy. The unit of energy is the same as the unit of work, i.e., the Joule.
- There are two types of mechanical energy such as; Kinetic and potential energy.

Read More: Work and Energy

Power:

- Power is the rate at which energy is transferred, conveyed, or converted or the rate of doing work. Technologically, it is the amount of work done per unit of time. The SI unit of power is Watt (W) which is joules per second (J/s). Sometimes the power of motor vehicles and other machines is demonstrated in terms of Horsepower (hp), which is roughly equal to 745.7 watts.

- Power is a scalar quantity, which gives us a quantity or amount of energy consumed per unit of time but with no manifestation of direction.

---

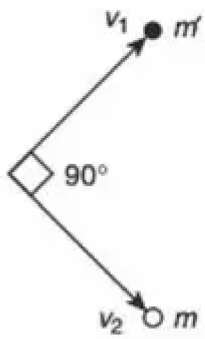
26. Answer: b

Explanation:

In figure (i) before collision, m' is mass of unknown particle; m is mass of proton; v_i is initial velocity.

(i) Before collision

Now, in figure (ii), v_1 is final velocity of unknown particle and v_2 is final velocity of proton.



(ii) After collision

By conservation of momentum, we have
Momentum before collision = Momentum after collision
Consider x -component, we have

$mv_1 + m'.0 = m'v_1 \cos 45^\circ + mv_2 \cos 45^\circ$
$mv_i = \frac{1}{\sqrt{2}}(m'v_1 + mv_2)$
Consider y -component, we have
$0 = m'v_1 \sin 45^\circ - mv_2 \sin 45^\circ$
$\frac{1}{\sqrt{2}}(m'v_i - mv_2) = 0$
$\Rightarrow m'v_1 = mv_2$
Substitute E (2) in E (1), we get
$mv_i = \frac{1}{\sqrt{2}}(mv_2 + mv_2) = \sqrt{2}mv_2$
$\Rightarrow v_i = \sqrt{2}v_2$
Using Eqs. (2) and (3) in (1), we get
$mv_i = \frac{1}{\sqrt{2}}(mv_2 + mv_2) = \sqrt{2}mv_2$
$\Rightarrow v_i = \sqrt{2}v_2$

Concepts:

1. Work, Energy and Power:

Work:

- Work is correlated to force and the displacement over which it acts. When an object is replaced parallel to the force's line of action, it is thought to be doing work. It is a force-driven action that includes movement in the force's direction.
- The work done by the force is described to be the product of the elements of the force in the direction of the displacement and the magnitude of this displacement.

Energy:

- A body's energy is its potential to do tasks. Anything that has the capability to work is said to have energy. The unit of energy is the same as the unit of work, i.e., the Joule.
- There are two types of mechanical energy such as; Kinetic and potential energy.

Read More: Work and Energy

Power:

- Power is the rate at which energy is transferred, conveyed, or converted or the rate of doing work. Technologically, it is the amount of work done per unit of time. The SI unit of power is Watt (W) which is joules per second (J/s). Sometimes the power of motor vehicles and other machines is demonstrated in terms of Horsepower (hp), which is roughly equal to 745.7 watts.
- Power is a scalar quantity, which gives us a quantity or amount of energy consumed per unit of time but with no manifestation of direction.

---

27. **Answer: c**

Explanation:

Maximum speed is at mean position (equilibrium). $F = kx$

$x = \frac{F}{k}$

$W_F + W_{sp} = \Delta KE$

$F\left(x\right) - \frac{1}{2}kx^2 = \frac{1}{2}mv^2 - 0$

$F\left(\frac{F}{k}\right) - \frac{1}{2}k\left(\frac{F}{k}\right)^2 = \frac{1}{2}mv^2$

$\Rightarrow v_{max} = \frac{F}{\sqrt{mk}}$

Concepts:

1. **Work, Energy and Power:**

Work:

- Work is correlated to force and the displacement over which it acts. When an object is replaced parallel to the force's line of action, it is thought to be doing work. It is a force-driven action that includes movement in the force's direction.
- The work done by the force is described to be the product of the elements of the force in the direction of the displacement and the magnitude of this displacement.

Energy:

- A body's energy is its potential to do tasks. Anything that has the capability to work is said to have energy. The unit of energy is the same as the unit of work, i.e., the Joule.

- There are two types of mechanical energy such as; Kinetic and potential energy.

Read More: Work and Energy

Power:

- Power is the rate at which energy is transferred, conveyed, or converted or the rate of doing work. Technologically, it is the amount of work done per unit of time. The SI unit of power is Watt (W) which is joules per second (J/s). Sometimes the power of motor vehicles and other machines is demonstrated in terms of Horsepower (hp), which is roughly equal to 745.7 watts.
- Power is a scalar quantity, which gives us a quantity or amount of energy consumed per unit of time but with no manifestation of direction.

---

28. Answer: d

Explanation:

From momentum conservation

$mu\hat{i} + mu\left(\frac{\hat{i}+\hat{j}}{2}\right) = (m+m)\bar{v}$

$\Rightarrow \bar{v} = \frac{3}{4}u\hat{i} + \frac{u}{4}\hat{j}$

$\Rightarrow |v| = \frac{u}{4}\sqrt{10}$

Final kinetic energy $= \frac{1}{2}2m\left(\frac{u}{4}\sqrt{10}\right)^2 = \frac{5}{8}mu^2$ Initial kinetic energy

$= \frac{1}{2}mu^2 + \frac{1}{2}m\left(\frac{u}{\sqrt{2}}\right)^2 = \frac{6}{8}mu^2$

Loss in $K.E. = k_i - k_f = \frac{1}{8}mu^2$

Concepts:

1. Work, Energy and Power:

Work:

- Work is correlated to force and the displacement over which it acts. When an object is replaced parallel to the force's line of action, it is thought to be doing work. It is a force-driven action that includes movement in the force's direction.
- The work done by the force is described to be the product of the elements of the force in the direction of the displacement and the magnitude of this

displacement.

Energy:

- A body's energy is its potential to do tasks. Anything that has the capability to work is said to have energy. The unit of energy is the same as the unit of work, i.e., the Joule.
- There are two types of mechanical energy such as; Kinetic and potential energy.

Read More: [Work and Energy]

Power:

- Power is the rate at which energy is transferred, conveyed, or converted or the rate of doing work. Technologically, it is the amount of work done per unit of time. The SI unit of power is Watt (W) which is joules per second (J/s). Sometimes the power of motor vehicles and other machines is demonstrated in terms of Horsepower (hp), which is roughly equal to 745.7 watts.
- Power is a scalar quantity, which gives us a quantity or amount of energy consumed per unit of time but with no manifestation of direction.

---

29. **Answer: d**

Explanation:

$4000?V + mg?V = P$

$\frac{60\times746}{4000+20000} = V$

$V = 1.86\,m/s. \approx 1.9\,m/s.$

Concepts:

1. **Work, Energy and Power:**

Work:

- Work is correlated to force and the displacement over which it acts. When an object is replaced parallel to the force's line of action, it is thought to be doing work. It is a force-driven action that includes movement in the force's direction.

- The work done by the force is described to be the product of the elements of the force in the direction of the displacement and the magnitude of this displacement.

Energy:

- A body's energy is its potential to do tasks. Anything that has the capability to work is said to have energy. The unit of energy is the same as the unit of work, i.e., the Joule.
- There are two types of mechanical energy such as; Kinetic and potential energy.

Read More: Work and Energy

Power:

- Power is the rate at which energy is transferred, conveyed, or converted or the rate of doing work. Technologically, it is the amount of work done per unit of time. The SI unit of power is Watt (W) which is joules per second (J/s). Sometimes the power of motor vehicles and other machines is demonstrated in terms of Horsepower (hp), which is roughly equal to 745.7 watts.
- Power is a scalar quantity, which gives us a quantity or amount of energy consumed per unit of time but with no manifestation of direction.

---

30. Answer: c

Explanation:

$$\frac{dK}{dE} = P = \cos t$$
$$\Rightarrow K = Pt = \frac{1}{2}mV^2$$
$$\therefore V = \sqrt{\frac{2Pt}{m}} = \frac{ds}{dt}$$
$$\therefore S = \sqrt{\frac{2P}{m}\frac{2}{3}t^{\frac{3}{2}}}$$

Concepts:

1. Work, Energy and Power:

Work:

- Work is correlated to force and the displacement over which it acts. When an object is replaced parallel to the force's line of action, it is thought to be doing work. It is a force-driven action that includes movement in the force's direction.
- The work done by the force is described to be the product of the elements of the force in the direction of the displacement and the magnitude of this displacement.

Energy:

- A body's energy is its potential to do tasks. Anything that has the capability to work is said to have energy. The unit of energy is the same as the unit of work, i.e., the Joule.
- There are two types of mechanical energy such as; Kinetic and potential energy.

Read More: Work and Energy

Power:

- Power is the rate at which energy is transferred, conveyed, or converted or the rate of doing work. Technologically, it is the amount of work done per unit of time. The SI unit of power is Watt (W) which is joules per second (J/s). Sometimes the power of motor vehicles and other machines is demonstrated in terms of Horsepower (hp), which is roughly equal to 745.7 watts.
- Power is a scalar quantity, which gives us a quantity or amount of energy consumed per unit of time but with no manifestation of direction.