CBSE Class 11 Physics Sample Paper Solution Set 4

Ans1. 4. (1)

Ans2. Pressure or energy per unit volume. (1)

Ans3. Greater torque will be applied if force arm is more as $\tau = rF\sin\theta$. (1)

Ans4. Kinetic energy is always positive, potential energy can be negative. (1)

Ans5. Yes, it is not an intrinsic property of the spring. It not only depends on the material in the spring but also the length and shape of the spring. (1)

Ans6. The statement is false. This is because when steel and rubber of same length and cross-sectional area are subjected to same load, then the extension produced in steel is much less than that of rubber. So the ratio of stress to strain or Young's modulus for steel is much greater than that of rubber. (1)

Ans7. rad/s. (1)

Ans8. (i) Impulse, $J = F\Delta t = P_2 - P_1$ (1/2)

For the same change in momentum if Δt is increased then F decreases. If the cricketer pulls back his hands, he increases Δt, and Force on his hand decreases and he does not hurt himself. (1/2)

Ans9. Horizontal Range = Maximum height

$$\frac{u^2 \sin 2}{g} = \frac{u^2 \quad {}^2}{2g}$$ (1)

$$\tan = 4$$

$$\theta = \tan^{-1} 4$$ (1)

OR

No. Even though the particle is moving with constant speed along the circle, it is accelerating as its velocity continuously changes. The acceleration vector is drawn towards the centre of the circle. So as the particle moves in uniform circular motion, the acceleration vector changes direction continuously and it is not a constant vector. I0 (2)

Ans10. Particle velocity is the velocity of the particles of the medium. (1)

Wave velocity is the speed at which the wave disturbance travels through the medium. (1)

Ans11.

Let $m_1 > m_2$

$P_1 = P_2$

$KE = \frac{P^2}{2m}$

$KE_1 = \frac{P_1^2}{2m_1}$ (1)

$KE_2 = \frac{P_2^{\ 2}}{2m_2}$

As $P_1 = P_2$ and $m_1 > m_2$

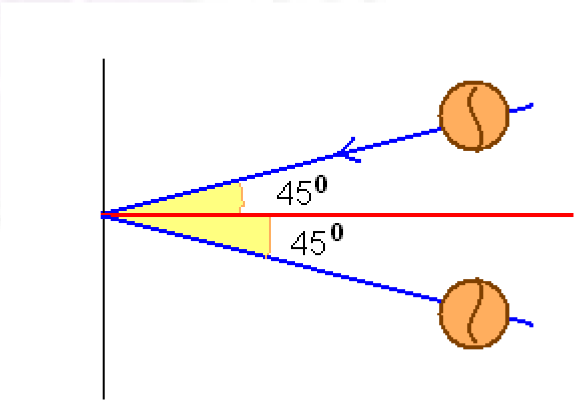
Therefore KE_2 will be greater than KE_1. (1)

Ans12. The law of equipartition of energy states that if a system is in equilibrium at absolute temperature T, the total energy is distributed equally in different energy modes of absorption, the energy in each mode being equal to $\frac{1}{2}k_B T$. (2)

Ans13. An expansion or contraction in which no heat enters or leaves the system is called an adiabatic process. In this the temperature of the system can change. (1)

In an isothermal process, the gas expands or is compressed at constant temperature. To maintain constant temperature heat can be transferred into or out of the system. (1)

Ans14.



Change in momentum $2mv\cos 45^o = \frac{10}{\sqrt{2}}V$.

Ans15. $\frac{1}{2}mv^2 = mgh$

Dimensions of LHS are $[M][LT^{-1}]^2 = [ML^2T^{-2}]$ (1)

Dimension of RHS are $[M][LT^{-2}][L]=[ML^2T^{-2}]$

Since the dimensions of quantity on LHS is equal to the dimensions of quantity on RHS. Thus the given expression is correct. (1)

Ans16. The position of a particle is given by

$$S(t)=5t\,\hat{i}+6t^2\,\hat{j}-10\hat{k}$$

$$v(t)=\frac{ds(t)}{dt}=5\hat{i}+12t\,\hat{j} \qquad (1/2)$$

$$a(t)=\frac{dv(t)}{dt}=12\,\hat{j} \qquad (1/2)$$

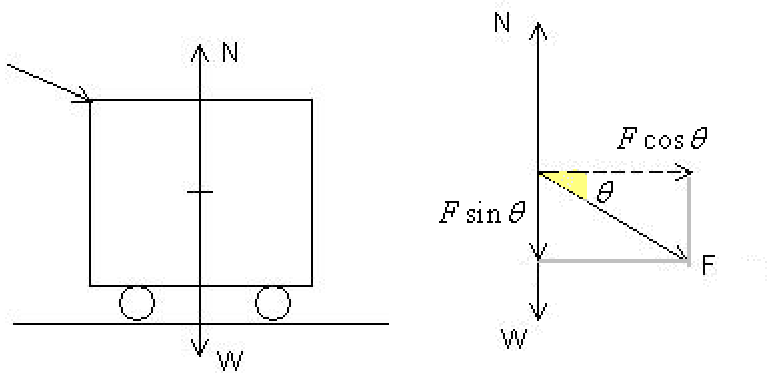
$$\vec{v}(t=1)=5\hat{i}+12\hat{j}$$

$$|\vec{v}|=\sqrt{5^2+12^2}=13m/s \qquad (1/2)$$

$$\vec{a}(t=1)=12j$$

$$|\vec{a}|=12\,m/s^2 \qquad (1/2)$$

Ans17. While pushing a greater force is required. This can be understood as follows.



Push the lawn mower

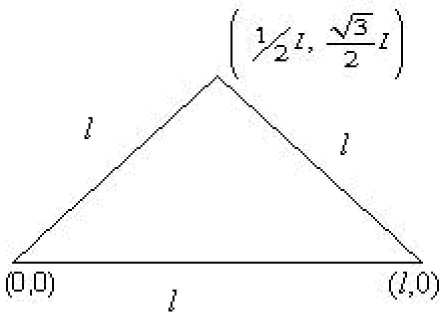
A component of the force applied is in the downward direction.
Force in horizontal direction is $F\cos\theta$.
Force in vertical direction is $N=F\sin\theta+W$.
This increases the frictional force as $f_{friction}=\mu N=\mu(F\sin\theta+W)$. (1)

A similar analysis for the pull of the lawn mower shows that
$f_{friction}=\mu N=\mu(W-F\sin\theta)$.
This shows that the frictional force is more for the case when the lawn mower is pushed rather than being pulled. (1)

Ans18.

$$\bar{x} = \frac{m_1x_1 + m_2x_2 + m_3x_3}{m_1 + m_2 + m_3}$$ (1)

$$= \frac{ml + m\,l/2}{3m} = \frac{l}{2}$$



$$\bar{Y} = \frac{m_1y_1 + m_2y_2 + m_3y_3}{m_1 + m_2 + m_3} = \frac{m\sqrt{3}\frac{l}{2}}{3m} = \frac{l}{2\sqrt{3}}$$ (1)

The coordinates of centre of mass are $\left(\frac{l}{2}, \frac{l}{2\sqrt{3}}\right)$.

Ans19. Kinetic energy of a satellite $= \frac{GMm}{2r} = E$ (1)

Potential energy of a satellite $= -\frac{GMm}{r} = -2E$ (1)

Total energy $= KE + PE$

$= E + (-2E) = -E$ (1)

Ans20. For an incompressible non- viscous fluid the sum of the pressure at any part plus the kinetic energy per unit volume plus the potential energy per unit volume there is always constant. (1.5)

The curved shape of an aerofoil causes a faster flow of air over its top surface than the lower one. From Bernoulli's principle, pressure of air below is greater than that above, and this produces the lift on the aerofoil. (1.5)

Ans21. (i) A body with large reflectivity is a poor absorber. Hence it is also a poor emitter. (1)

(ii) To convert water at 100^{o}c to steam at 100^{o}c the water needs to absorb the latent heat of vaporization. So it is more efficient to use steam rather than water because when steam at 100^{o}c is circulated it releases latent heat in addition to heat released due to change in temperature. (2)

Ans22. It is a reversible engine in which all input heat originates from a hot reservoir at temperature T_H and all heat rejected goes into a cold reservoir at T_C , It consists of two isothermal processes and two adiabatic processes. (2)

The efficiency of a Carnot engine is

$$\eta = 1 - \frac{T_C}{T_H} \quad (1)$$

Ans23. The volume of 1 mol of a gas is 22.4litres and 2 moles is 44.8 litres.

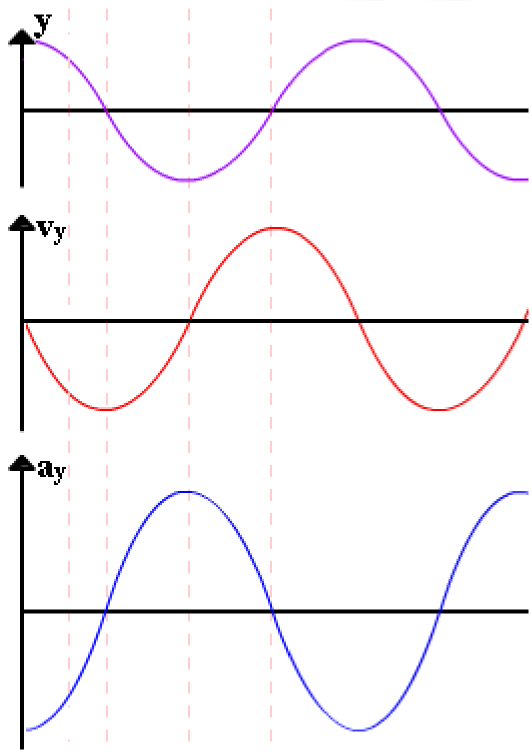
Since helium is mono atomic, its molar specific heat at constant volume $C_V = \frac{3}{2}R$ and molar specific heat at constant pressure $C_P = \frac{5}{2}R$. (2)

Here the volume is kept fixed so we will use C_V.

Heat required = no of moles x molar specific heat x rise in temperature

= 2 x 3/2R x 15=45R = 45 x 8.31 = 374J. (1)

Ans24.



(3)

Ans25. (i) Amplitude, $A = 5\times10^{-3} m$ (1)

$$ii) k = 80 \ ; \ k = \frac{2\pi}{\lambda} \text{ find } \lambda = \frac{\pi}{40} m \quad (1)$$

$$iii) \omega = 3 \ ; \ \omega = 2\pi f \text{ find } f = \frac{3}{2\pi} Hz \quad (1)$$

Ans26. Say, the work done in moving round a closed path, in a field, is zero. Then force in the field is called a conservative force. (1)

For a ball lifted to a height and brought back to original position, work done is zero. Hence gravitational force is conservative. (1)

For an object sliding up and down an inclined plane work done due to friction is not zero. Hence frictional force is non-conservative. (1)

Ans27.

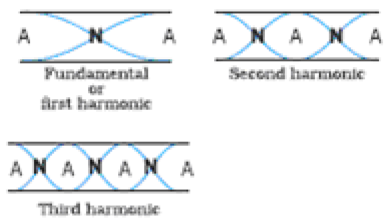
Bob A will not rise at all. (1)

In an elastic collision between two equal masses in which one is stationary, while the other is moving with some velocity, the stationary mass acquires the same velocity, while the moving mass immediately comes to rest after collision. In this case, a complete transfer of momentum takes place from the moving mass to the stationary mass. (1)

Hence, bob A of mass m, after colliding with bob B of equal mass, will come to rest, while bob B will move with the velocity of bob A at the instant of collision. (1)

Ans28.
Draw the different modes of vibration. (1)

As the ends are open antinodes are formed here.



(1)
Increase in tension increases the frequency. (1)

Let us look at two possibilities:

Say originally $f_A > f_B$ then on increasing the frequency of B the difference between frequencies of A and B would further increase. (1)

However on increasing the frequency of B the difference between A and B is decreasing. So this means that originally $f_A < f_B$.

$$f_A - f_B = 5Hz$$

Given $f_B = 500Hz$ (1)

$$f_A = 505Hz$$

OR

For each spring, spring constant is k

In series spring constant is $\frac{k}{2}$

In parallel spring constant is 2k. (1)

$$T_{\text{series}} = 2\pi\sqrt{\frac{m}{k/2}} = 2\pi\sqrt{\frac{2m}{k}} \quad (2)$$

$$T_{\text{Parallel}} = 2\pi\sqrt{\frac{m}{2k}} = 2\pi\sqrt{\frac{m}{2k}} \quad (2)$$

$$T_{\text{series}} = 2T_{Parallel}$$

Ans29.

(a) Mass of body A, m_A = 5 kg

Mass of body B, m_B = 10 kg

Applied force, F = 200 N

Coefficient of friction, μ_s = 0.15

The force of friction is given by the relation:

$f_s = \mu (m_A + m_B)g$

= 0.15 (5 + 10) × 10

= 1.5 × 15 = 22.5 N leftward

(1)

Net force acting on the partition = 200 – 22.5 = 177.5 N rightward

As per Newton's third law of motion, the reaction force of the partition will be in the direction opposite to the net applied force.

Hence, the reaction of the partition will be 177.5 N, in the leftward direction. (1)

(b) Force of friction on mass A:

$f_A = \mu m_A g$

= 0.15 × 5 × 10 = 7.5 N leftward

(1)

Net force exerted by mass A on mass B = 200 – 7.5 = 192.5 N rightward

As per Newton's third law of motion, an equal amount of reaction force will be exerted by mass B on mass A, i.e., 192.5 N acting leftward. (1)

When the wall is removed, the two bodies will move in the direction of the applied force. (1)

Ans30. A body thrown up in space and allowed to fall under the effect of gravity alone is called a projectile. (1)
Derive

$$H = \frac{u^2 \sin^2}{2g} \quad (1)$$

$$T = \frac{2u \sin}{g} \quad (1)$$

Given that speed of the ball, u = 40 m/s

Maximum height, h = 25 m

In projectile motion, the maximum height reached by a body projected at an angle θ, is given by the relation:

$$h = \frac{u^2 \sin^2 \theta}{2g}$$

$$25 = \frac{(40)^2 \sin^2 \theta}{2 \times 9.8}$$

$\sin^2 \theta = 0.30625$

$\sin \theta = 0.5534$

$\therefore \theta = \sin^{-1}(0.5534) = 33.60°$ (1)

Horizontal range, R

$$= \frac{u^2 \sin 2\theta}{g}$$

$$= \frac{(40)^2 \times \sin 2 \times 33.60}{9.8}$$

$$= \frac{1600 \times \sin 67.2}{9.8}$$

$$= \frac{1600 \times 0.922}{9.8} = 150.53 \text{ m}$$ (1)