M.M. : 70

CLASS-XI
PHYSICS

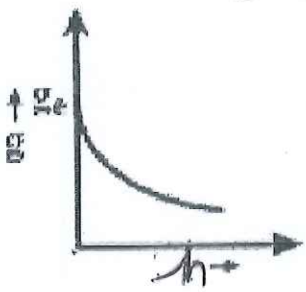
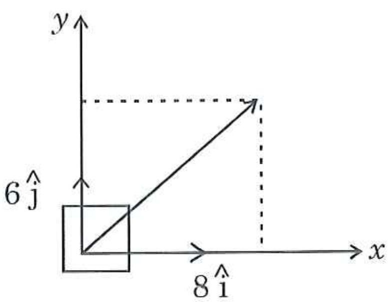
Marking Scheme/Hints to Solution

Note : Any other relevant answer, not given herein but given by the candidate be suitably rewarded.

S. No.	Value Points/Key Points	Marks Allotted to each value point/key point	Total Marks
	Section-A		
1.	(d)	1	1
2.	(c)	1	1
3.	(b)	1	1
4.	(b)	1	1
5.	(c)	1	1
6.	(a)	1	1
7.	(a)	1	1
8.	(a)	1	1
9.	(d)	1	1
10.	(b)	1	1
11.	(c)	1	1
12.	(c)	1	1
13.	(d)	1	1

14.	(c)	1	1
15.	(d)	1	1
16.	(c)	1	1
17.	(d)	1	1
18.	(a)	1	1

Section-B

19.	(a) Kepler's law of Area states the line joining a planet to the Sun sweeps out equal areas in equal interval of time.	1	
	(b) Position of sun at B	1	
	(OR)		
	(a) 	1	
	(b) Because all objects fall on ground with constant acceleration called acceleration due to gravity.	1	2
20.	(a) A number of forces, all acting at the same point are called concurrent forces.	½	
	(b) Free body diagram 	½	

	$a_x = F_x/m = 2\ m/s^2$	½	
	$a_y = F_y/m = 1.5\ m/s^2$	½	
	Net acceleration = $2.5\ m/s^2$		
	Alternative Solution		
	acceleration can be calculation on $F_{net}/m = 10/4 = 2.5\ m/s^2$	1	2
21.	When two or more waves superimpose each other with slightly different frequencies, then a sound of of periodically varying amplitude at a point is observed. This phenomenon is known as beats.	1	
	The persistence of hearing of sound is about 0.1 sec, so the ear cannot distinguish between sounds of frequency more than 10 Hz.	1	
	OR		
	The superposition principle states that when two or more waves superimpose/overlap, the resultant displacement at a point is equal to the algebraic vector sum of the displacements due to each wave at that point.	1	
	Difference (Choose any one)		
	Progressive waves :		
	1. Energy is transferred in the medium		
	2. Speed of motion is same. The system can oscillate with any arbitrary freq.	$\frac{1}{2}$	
	Stationary waves :		
	1. There is no transfer of energy in the medium.		
	2. The system cannot oscillate with any frequency.	$\frac{1}{2}$	
	(or any other relevant difference)		2

22.	(a) Characteristics		
	1. Acceleration is directly proportional to displacement.		
	2. Acceleration is directed opposite to displacement.	$\frac{1}{2}+\frac{1}{2}$	
	(b) The restoring force provided by the gravity.	1	2
23.	$V_{cm} = (M_1V_1 + M_2V_2)/(M_1 + M_2)$	½	
	$V_{cm} = 2\mathbf{k}$	½	
	$A_{cm} = d\ (V_{cm}/dt)$	½	
	$A_{cm} = 0$	½	2
24.	$V = 2gr^2\ (\rho_b - \rho_l)/9\eta$	½	
	Put all the given values in the above formula	½	
	$= 0.992\ kg\ m^{-1}\ s^{-1}$	1	2
25.	The vectors are perpendicular if their dot product is zero.		
	$\vec{P} . \vec{Q} = 0$	½	
	Put the values	½	
	$\lambda = +\ 3$	1	2
	Section-C		
26.	(i) $2\pi/\lambda = 80$		
	$= 7.85$ cm $= 0.078$ m	1	
	(ii) $2\pi/T = 3$		
	$T = 2.09$ s	1	
	(iii) $v = 1/T$		
	$= 0.48$ Hz	1	3

27.	V = volume/sec = $[L^3T^{-1}]$	½	
	$\frac{P}{l}$ = pressure gradient = $\frac{\left[ML^{-1}T^{-2}\right]}{[L]}$	½	
	$= [ML^{-2}T^{-2}]$		
	Now L.H.S. = V = $[L^3T^{-1}]$	½	
	R.H.S. = $\frac{\pi}{8} \times \frac{P}{l} \times \frac{r^4}{\eta} = \frac{\left(ML^{-2}T^{-2}\right)L^4}{\left(ML^{-1}T^{-1}\right)} = \left[L^3T^{-1}\right]$	1	
	As L.H.S. = R.H.S., dimensionally, therefore, the formula is correct.	½	3
28.	Mean free path is given by		
	$\lambda = \frac{1}{\sqrt{2}\ \pi d^2 n}$; $\quad PV = k_B NT$	1	
	T = 27°C = (27 + 273)K = 300 K		
	$\Rightarrow \frac{N}{V} = n = \frac{P}{k_B T}$	1	
	P = 1 atm = 1.013×10^5 N/m^2		
	d = 2r = 4.0×10^{-10} m		
	$\lambda = \frac{k_B T}{\sqrt{2}\pi d^2 P}$		
	$= \frac{1.38 \times 10^{-23} \times 300}{1.414 \times 3.14 \left(4.0 \times 10^{-10}\right)^2 \times 1.013 \times 10^5}$		
	$= 5.75 \times 10^{-8}$ m	1	3
	OR		

The law of equipartition of energy states that the total energy of the system possessed by a dynamic system residing in thermal equilibrium is equally divided among all degrees of freedom. 1 ½

$V_{rms} = (3RT/M)^{½}$

Now, rms velocity of H_2 molecules = rms velocity of O_2 molecule

$[(3R \times T)/2]^{½}) = [3R \times (47 + 273))/32]^{½}$

$T = (2 \times 320)/32$ 1

$= 20$ K ½

29. (a) False

Correct statement : The net acceleration of a particle in circular motion is always along the radius of the circle towards the centre. 1

(b) False

Correct statement : While leaving the circular path, the particle moves tangentially to the circular path. 1

(c) True

Because over a complete cycle, for an acceleration at any point of circular path, there is an equal and opposite acceleration vector at a point diametrically opposite to the first point, resulting in a null net acceleration vector. 1 3

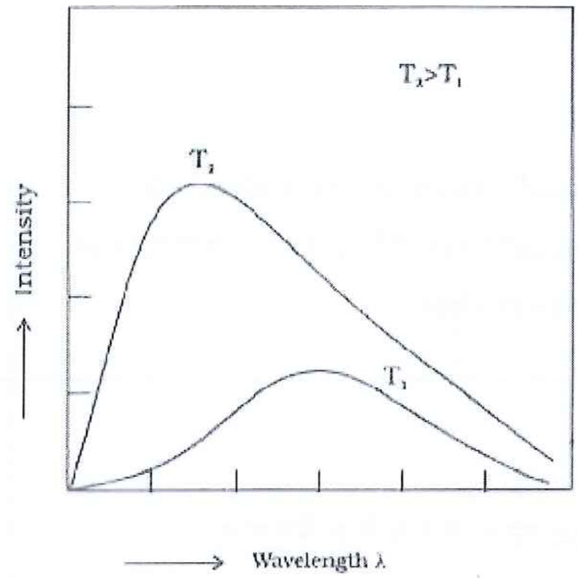
OR

(a) To avoid the risk of skidding as well as to reduce the wear and tear of the car tyres, the road surface at a bend is tilted inward, i.e., the outer side of the road is raised above its inner side. 1

	(b) v = 18 km/h		
	$= \frac{18 \times 1000}{60 \times 60} = 5$ m/s	½	
	$r = 3$ m, $\mu_s = 0.1$	½	
	On an unbanked road, frictional force alone can provide the centripetal force. Therefore condition for the cyclist not to slip is that		
	$\frac{mv^2}{r} \leq f_s \left(= \mu_s R\right)$	½	
	As $v^2 = 5^2 = 25$ and μ_s rg = 0.1 × 3 × 10 = 3		
	$\frac{v^2}{r} \leq \mu_s \frac{mg}{m}$		
	$V^2 \leq \mu_s rg$ (The cyclist will slip)	½	
30.	For 2 kg mass : $T_1 - 2g = 2a$	½	
	For 3 kg mass : $T_2 - T_1 = 3a$	½	
	For 4 kg mass : $4g - T_2 = 4a$		
	Adding all the equations	½	
	2g = 9a		
	→ a = 2g/9 = 2.18 m/s²	½	
	$T_1 = 2a + 2g = 22g/9$ = 23.96 N	½	
	$T_2 = 4g - 4a = 28g/9$ = 30.5 N	½	3

Section-D

31. (a) 1



Features :

(i) The black body radiation from a surface depends only on its temperature and not on its size, shape etc. 1+1

(ii) With increase in temperature, this wavelength of maximum intensity, keeps on decreasing.

(b) Wein's displacement law states that the product of wavelength corresponding to maximum intensity and the absolute temperature is constant. (λ_m T = constant) 1+1

Application

It helps us to understand the observed changes in colour, of a piece of iron, heated over a flame.

OR

(a) Diagram ½

Derivative (NCERT Article 10.4) 2

	(b) Pressure Energy / Volume; Potential Energy / volume; Kinetic energy / volume — ½ mark each	½ ½ ½	
	(c) (i) Streamline; (ii) Non-viscous; (iii) incompressible — Any two ½+½	½ ½	5
32.	(a) $V_1 = \left(\frac{M_1 - M_2}{M_1 + M_2}\right) U_1 + \left(\frac{2M_2}{M_1 + M_2}\right) U_2$	½	
	$V_2 = \left(\frac{M_2 - M_1}{M_1 + M_2}\right) U_2 + \left(\frac{2M_1}{M_1 + M_2}\right) U_1$	½	
	$M_1 = M_2 = m$		
	$V_1 = U_2$	½	
	$V_2 = U_1$	½	
	(b) $mv = (M + m)\,V$		
	Vel. of combination, $V = \frac{mv}{M + m} = 2.04$ m/s	1	
	$(M + m)gh = \frac{1}{2}(M + m)V^2$		
	$h = \frac{V^2}{2g} = 0.212$ m	1	
	amount of heat produced = Loss in K.E.		
	$= \frac{1}{2}mv^2 - \frac{1}{2}(M + m)V^2$		
	$= 28.54$ J	1	
	OR		

	(a) α, is the angle of projection		
	For vertically upward motion of a projectile		
	$y = (u\sin\alpha)t - \frac{1}{2}(gt)^2$		
	or $\frac{1}{2}gt^2 - (u\sin\alpha)\,t + y = 0$	1	
	This is a quadratic equation in t. Its roots are		
	$t_1 = \frac{u\sin\alpha - \sqrt{u^2\sin^2\alpha - 2gy}}{g}$	½	
	and $t_2 = \frac{u\sin\alpha + \sqrt{u^2\sin^2\alpha - 2gy}}{g}$	½	
	$\therefore\quad t_1 + t_2 = \frac{2u\sin\alpha}{g}$ = T (time of flight of the projectile)	1	
	(b) $R = \frac{u^2\sin 2\theta}{g}$		
	$3000 = \frac{u^2\sin 60°}{g} \Rightarrow \frac{u^2}{g} = 2000\sqrt{3}$	1	
	$R_{max} = \frac{u^2}{g} = 2000\sqrt{3}$ m = 3464 m = 3.46 km	½	
	target cannot be hit	½	5
33.	(a) As distance r increases, the gravitational potential energy increases	½	
	$U = \frac{-GMm}{r}$	½	

(b) Gravitational potential energy of a body

= Gravitational potential × mass of the body — 1

(c) $W(r) = -4\dfrac{Gm^2}{l} - 2\dfrac{Gm^2}{\sqrt{2}l}$ — 1

$U(r) = \dfrac{-2.Gm^2}{l}\left(2 + \dfrac{1}{\sqrt{2}}\right) = -5.41\dfrac{Gm^2}{l}$ — 1

The gravitational potential at the centre of the square

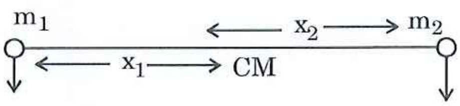
$\left(r = \sqrt{2}\,l/2\right)$ is

$V(r) = -4\sqrt{2}\dfrac{Gm}{l}$ — 1

OR

(a) (i) Torque — 1

(ii) Angular momentum — 1

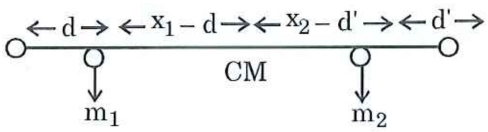
(b) 

— ½

By principle of Moments — ½

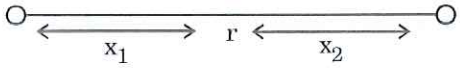
$gm_1x_1 = m_2gx_2$

$m_1x_1 = m_2x_2$ ....(1) — 1



$$\boxed{d' = \frac{m_1}{m_2}d}$$ — 1

Alternative Solution :



	$x_{cm} = \dfrac{m_1x_1 + m_2x_2}{m_1 + m_2}$	½	
	let mass m_1 moves through distance d towards CM		
	$x_{cm} = \dfrac{m_1(x_1 - d) + m_2(x_2 + d')}{m_1 + m_2}$	1	
	$\dfrac{m_1x_1 + m_2x_2}{m_1 + m_2} = \dfrac{m_1(x_1 - d) + m_2(x_2 - d')}{m_1 + m_2}$	½	
	$-m_1 d + m_2 d' = 0$		
	$\boxed{d' = \dfrac{m_1}{m_2} d}$ towards left	1	5
	Section-E		
34.	(a) Power	1	
	(b) Power = Force × velocity	1	
	(c) Fig. A : Action = W + W′		
	Fig. B : Action = W − W′	1+1	
	OR		
	(c) The man should adopt Fig. B method to lift the bucket without the floor yielding.	1	
	Reason : In Fig. B the force is applied by the man in the downward direction. This decreases the apparent weight of the man.	1	4
35.	(a) The thermodynamic quantities, heat and work, are not state variables.	$\frac{1}{2} + \frac{1}{2}$	

(b) In isochoric change, there is no change in volume. Therefore, whole of the heat energy supplied to the system will increase internal energy only.	1	
(c) Yes, it is possible to raise a gas's temperature without adding heat to it. During adiabatic compression, this is feasible. Work is done on the gas in compression, which is negative work. As a result, the gas's internal energy rises, and its temperature rises as well.	1+1	
OR		
(c) Heat supplied = 150 J/s	1	
Work done = 75 J/s		
By using first law of thermodynamics :		
$\Delta Q = \Delta U + \Delta W$		
$\Delta U = 150 - 75$		
= 75 J/s	1	4