SHRI KRISHNA ACADEMY

BOARD EXAM (10,+1,+2) ,NEET AND JEE COACHING CENTRE

SBM SCHOOL CAMPUS,TRICHY MAIN ROAD,NAMAKKAL

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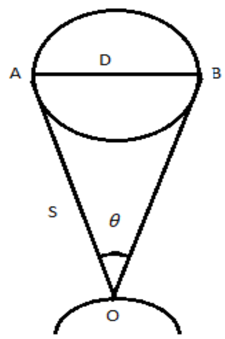
STD: XI

SUBJECT: PHYSICS **TENTATIVE ANSWER KEY** **MARKS : 70**

Q.N	SECTION - I		MARKS
	OPTION	ANSWER	
1	c)	velocity	1
2	a)	2.5 rad	1
3	b)		1
4	c)	zero	1
5	d)	13.81 ms^{-1}	1
6	d)	stress	1
7	d)	centripetal force acts towards centre and centrifugal force appears to act away from the centre in a circular motion	1
8	d)	angular velocity increases and moment of inertia decreases	1
9	a)	perihelion and aphelion	1
10	c)	adiabatic	1
11	d)		1
12	c)	acceleration = - k (x + a)	1
13	d)	sin (x + vt)	1
14	a) or b)	6.28 $radm^{-1}$	1
15	d)	longitudinal and transverse	1

<table>
<tr><th>Q.N</th><th>SECTION - II</th><th>MARKS</th></tr>
<tr><td>16</td><td>The principle of homogeneity of dimensions states that the dimensions of all the terms in a physical expression should be the same.</td><td>2</td></tr>
<tr><td>17</td><td>Velocity, $v = \frac{dx}{dt} = \frac{d}{dt}(2 - 5t + 6t^2)$
or $v = -5 + 12t$
For initial velocity, $t = 0$
$\therefore$ Initial velocity $= -5\text{ms}^{-1}$

The negative sign implies that at t = 0 the velocity of the particle is along negative x direction.</td><td>2</td></tr>
<tr><td>18</td><td>The force acting on an object is equal to the rate of change of its momentum.
$\vec{F} = \frac{\vec{dp}}{dt}$</td><td>2</td></tr>
<tr><td>19</td><td>The center of gravity of a body is the point at which the entire weight of the body acts irrespective of the position and orientation of the body.</td><td>2</td></tr>
<tr><td>20</td><td><table><tr><th>S.No.</th><th>Transverse waves</th><th>Longitudinal waves</th></tr><tr><td>1.</td><td>The direction of vibration of particles of the medium is perpendicular to the direction of propagation of waves.</td><td>The direction of vibration of particles of the medium is parallel to the direction of propagation of waves.</td></tr><tr><td>2.</td><td>The disturbances are in the form of crests and troughs.</td><td>The disturbances are in the form of compressions and rarefactions.</td></tr><tr><td>3.</td><td>Transverse waves are possible in elastic medium.</td><td>Longitudinal waves are possible in all types of media (solid, liquid and gas).</td></tr></table></td><td>2</td></tr>
<tr><td>21</td><td>If the earth has no tilt, then seasons of the earth may change and existence of life on the earth would be affected.</td><td>2</td></tr>
<tr><td>22</td><td>1. Brownian motion increases with increasing temperature.
2. Brownian motion decreases with bigger particle size, high viscosity and density of the liquid (or) gas.</td><td>2</td></tr>
</table>

23	Steel is more elastic than rubber. If an equal stress is applied to both steel and rubber, the steel produces less strain. So the Young's modulus is higher for steel than rubber. The object which has higher young's modulus is more elastic.	2
24	Since $T \propto \sqrt{l}$ Therefore, $T = \text{constant } \sqrt{l}$ $\frac{T_f}{T_i} = \sqrt{\frac{l + \frac{44}{100} l}{l}} = \sqrt{1.44} = 1.2$ Therefore, $T_f = 1.2\, T_i = T_i + 20\%\, T_i$	2
Q.N	**SECTION - III**	**MARKS**
25	$\lambda = \frac{1}{\sqrt{2}\pi n d^2}$ $n = \frac{N}{V} = \frac{P}{kT} = \frac{101.3 \times 10^3}{1.381 \times 10^{-23} \times 300}$ $= 2.449 \times 10^{25}\ molecues/m^3$ $\lambda = \frac{1}{\sqrt{2} \times \pi \times 2.449 \times 10^{25} \times (1.2 \times 10^{-10})^2}$ $= \frac{1}{15.65 \times 10^5}$ $\lambda = 0.63 \times 10^{-6} m$	3
26	Let AB = D be the diameter of the moon which is to be measured from the earth by an observer A. A telescope is focused on the moon and angle AOB is found. Since $\theta = \frac{Arc}{Radius} = \frac{D}{S}$ $D = S.\theta$ i.e., Linear diameter =Distance x Angular diameter 	3

27	Diagram + Explanation **Motion along horizontal direction** The particle has zero acceleration along x direction. So, the initial velocity u_x remains constant throughout the motion. $x = u_x t + \frac{1}{2}at^2.$ $x = u_x t$ **Motion along downward direction** Here u_y = 0 (initial velocity has no downward component), a = g (we choose the +ve y-axis in downward direction), and distance y at time t $y = u_y t + \frac{1}{2}at^2,$ $y = \frac{1}{2}gt^2$ $y = \frac{1}{2}g\frac{x^2}{u_x^{\,2}} = \left(\frac{g}{2u_x^{\,2}}\right)x^2$ $y = Kx^2$ where $K = \frac{g}{2u_x^2}$ is constant The above equation is the equation of a parabola	1 ½ 1 ½
28	$F = \frac{mv^2}{r} = \frac{60 \times 50 \times 50}{10} = 15{,}000$ N	3
29	Total energy is conserved in inelastic collision Total energy contains the kinetic energy term and also a term ΔQ, which includes all the losses that take place during collision. Note that loss in kinetic energy during collision is transformed to another form of energy like sound, thermal, etc.	1

	Further, if the two colliding bodies stick together after collision such collisions are known as completely inelastic collision or perfectly inelastic collision. Such a collision is found very often. For example when a clay putty is thrown on a moving vehicle, the clay putty (or Bubblegum) sticks to the moving vehicle and they move together with the same velocity.	2
30	**Law of orbits:** Each planet moves around the Sun in an elliptical orbit with the Sun at one of the foci. **Law of area:** The radial vector (line joining the Sun to a planet) sweeps equal areas in equal intervals of time. **Law of period:** The square of the time period of revolution of a planet around the Sun in its elliptical orbit is directly proportional to the cube of the semi-major axis of the ellipse.	3
31	(i) **The law of length :** For a given wire with tension T (which is fixed) and mass per unit length μ (fixed) the frequency varies inversely with the vibrating length. Therefore, $$f \propto \frac{1}{l} \Rightarrow f = \frac{C}{l}$$ $\Rightarrow l \times f = C$, where C is a constant (ii) **The law of tension:** For a given vibrating length l (fixed) and mass per unit length μ (fixed) the frequency varies directly with the square root of the tension T, $$f \propto \sqrt{T}$$ $\Rightarrow f = A\sqrt{T}$, where A is a constant	3

	(iii) **The law of mass:** For a given vibrating length l (fixed) and tension T (fixed) the frequency varies inversely with the square root of the mass per unit length μ, $$f \propto \frac{1}{\sqrt{\mu}}$$ $$\Rightarrow f = \frac{B}{\sqrt{\mu}}$$, where B is a constant	
32	DIAGRAM EXPLANATION COP EXPLANATION	½ 1 ½ 1
33	Since, the diameter of the pistons are given, we can calculate the radius of the piston $$r = \frac{D}{2}$$ Area of smaller piston, $A_1 = \pi\left(\frac{5}{2}\right)^2 = \pi(2.5)^2$ Area of larger piston, $A_2 = \pi\left(\frac{60}{2}\right)^2 = \pi(30)^2$ $$F_2 = \frac{A_2}{A_1} \times F_1 = (50N) \times \left(\frac{30}{2.5}\right)^2 = 7200\,N$$ This means, with the force of 50 N, the force of 7200 N can be lifted.	3

Q.N	SECTION - IV	MARKS
34 (a)	$T \propto m^a l^b g^c$ $T = k.\ m^a l^b g^c$ $[T^1] = [M^a] [L^b] [LT^{-2}]^c$ $[M^0L^0T^1] = [M^a L^{b+c} T^{-2c}]$ Comparing the powers of M, L and T on both sides, a=0, b+c=0, -2c=1 Solving for a,b and c a = 0, b = 1/2, and c = −1/2 From the above equation T = k. $m^0 \ell^{1/2} g^{-1/2}$ $T = k\left(\frac{\ell}{g}\right)^{1/2} = k\sqrt{\ell/g}$ k = 2π, hence $T = 2\pi\sqrt{\ell/g}$	1 1 2 1
34 (b)	Definition Diagram + explanation $I = \sum m(x+d)^2$ $I = \sum m(x^2 + d^2 + 2xd)$ $I = \sum(mx^2 + md^2 + 2dmx)$ $I = \sum mx^2 + \sum md^2 + 2d\sum mx$ $I_C = \sum mx^2$ The term, $\sum mx = 0$ because, x can take positive and negative values with respect to the axis AB. The summation $(\sum mx)$ will be zero. Thus, $I = I_C + \sum md^2 = I_C + (\sum m)d^2$ Here, $\sum m$ is the entire mass M of the object $(\sum m = M)$ $I = I_C + Md^2$	1 1 ½ 1 1 ½

35 (a)	SCALAR PRODUCT (ANY FIVE POINTS) VECTOR PRODUCT (ANY FIVE POINTS) Each point carries ½ mark	5
35 (b)	The minimum speed required by an object to escape Earth's gravitational field	1
	$E_i = \frac{1}{2} M v_i^2 - \frac{GMM_E}{R_E}$	½
	When the object reaches a height far away from Earth and hence treated as approaching infinity, the gravitational potential energy becomes zero *U (∞) = 0* and the kinetic energy becomes zero as well. $E_f = 0$	½
	According to law of conservation of energy $E_i = E_f$ $\frac{1}{2} M v_i^2 - \frac{GMM_E}{R_E} = 0$ $\frac{1}{2} M v_i^2 = \frac{GMM_E}{R_E}$ $\frac{1}{2} M v_e^2 = \frac{GMM_E}{R_E}$ $v_e^2 = \frac{GMM_E}{R_E} . \frac{2}{M}$ $v_e^2 = \frac{2GM_E}{R_E}$ $g = \frac{GM_E}{R_e^2},$ $v_e^2 = 2gR_E$	1
	$v_e = \sqrt{2gR_E}$ $v_e = 11.2 \text{ kms}^{-1}$	2

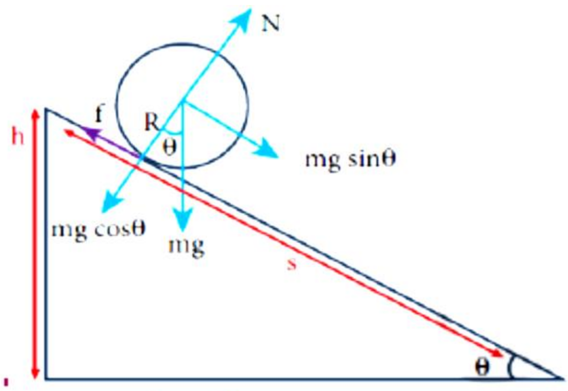
36 (a)	Newton's law of cooling states that the rate of loss of heat of a body is directly proportional to the difference in the temperature between that body and its surroundings diagram dQ = msdT $\frac{dQ}{dt} = \frac{msdT}{dt}$ $\frac{dQ}{dt} \propto -(T - T_s)$ $\frac{dQ}{dt} = -a(T - T_s)$ $-a(T - T_s) = ms\frac{dT}{dt}$ $\frac{dT}{T - T_s} = -\frac{a}{ms}dt$ $\int_0^{\infty} \frac{dT}{T - T_s} = -\int_0^t \frac{a}{ms}dt$ $\ln(T - T_s) = -\frac{a}{ms}t + b_1$ $T = T_s + b_2 e^{-\frac{a}{ms}t}$ $b_2 = e^{b_1} = \text{constant}$	1 ½ 1 1 1 ½
36 (b)	(i) $W = \int \vec{F} \cdot d\vec{r}$ $W = \int dW = \int \frac{dW}{dt} dt$ $\vec{v} = \frac{d\vec{r}}{dt};\ d\vec{r} = \vec{v}\,dt.$	

	$\int \vec{F}\cdot d\vec{r} = \int\left(\vec{F}\cdot\frac{d\vec{r}}{dt}\right)dt = \int\left(\vec{F}\cdot\vec{v}\right)dt \quad \left[\vec{v} = \frac{d\vec{r}}{dt}\right]$ $\int \frac{dW}{dt}dt = \int\left(\vec{F}\cdot\vec{v}\right)dt$ $\int\left(\frac{dW}{dt} - \vec{F}\cdot\vec{v}\right)dt = 0$ $\frac{dW}{dt} - \vec{F}\cdot\vec{v} = 0$ Or $\frac{dW}{dt} = \vec{F}\cdot\vec{v}$	2
	Relevant example	1
	ii) P = (resistive force + mass × acceleration) (velocity) $P = \vec{F}_{-tot}\vec{v} = (F_{resistive} + F)\vec{v}$ $P = \vec{F}_{tot}\cdot\vec{v} = (F_{resistive} + ma)\vec{v}$ = [500 + (1250 x 0.2)] x 30 = 22.5 Kw	2
37 (a)	According to Bernoulli's theorem, the sum of pressure energy, kinetic energy, and potential energy per unit mass of an incompressible, non-viscous fluid in a streamlined flow remains a constant	1
	Diagram and Explanation	1
	$W = F_A d = P_A V$ $E_{PA} = P_A V = P_A V \times \left(\frac{m}{m}\right) = m\frac{P_A}{\rho}$ Potential energy of the liquid at A, $PE_A = mg\,h_A$, Due to the flow of liquid, the kinetic energy of the liquid at A, $KE_A = \frac{1}{2}m\,v_A^2$	1

	$E_A = EP_A + KE_A + PE_A$ $E_A = m\frac{P_A}{\rho} + \frac{1}{2}mv_A^2 + mg\,h_A$ $E_B = m\frac{P_B}{\rho} + \frac{1}{2}mv_B^2 + mg\,h_B$ From the law of conservation of energy, EA = EB $m\frac{P_A}{\rho} + \frac{1}{2}mv_A^2 + mgh_A = m\frac{P_B}{\rho} + \frac{1}{2}mv_B^2 + mgh_B$ $\frac{P_A}{\rho} + \frac{1}{2}v_A^2 + gh_A = \frac{P_B}{\rho} + \frac{1}{2}v_B^2 + gh_B = \text{constant}$ Thus, the above equation can be written as $\frac{P}{\rho g} + \frac{1}{2}\frac{v^2}{g} + h = \text{constant}$	1 1
37 (b)	diagram for PE, KE AND TE **a. Expression for Potential Energy** For the simple harmonic motion, the force and the displacement are related by Hooke's law $\vec{F} = -k\vec{r}$ $F = -k\,x$ $F = -\frac{dU}{dx}$ $-\frac{dU}{dx} = -kx$ $dU = k\,x\,dx$	1

	$U(x)=\int_0^x k\,x'\,dx'=\frac{1}{2}k\left(x'\right)^2\Big\|_0^x=\frac{1}{2}kx^2$ $U\left(x\right)=\frac{1}{2}m\omega^2x^2$ $x = A\sin\omega t$ $U(\mathrm{t})=\frac{1}{2}m\omega^2A^2\sin^2\omega t$ **b. Expression for Kinetic Energy** Kinetic energy $KE=\frac{1}{2}mv_x^2=\frac{1}{2}m\left(\frac{dx}{dt}\right)^2$ $x = A\sin\omega t$ $v_x=\frac{dx}{dt}=A\omega\cos\omega t$ $=A\omega\sqrt{1-\left(\frac{x}{A}\right)^2}$ $v_x=\omega\sqrt{A^2-x^2}$ $KE=\frac{1}{2}mv_x^2=\frac{1}{2}m\omega^2\left(A^2-x^2\right)$ $KE=\frac{1}{2}m\omega^2A^2\cos^2\omega t$ **c. Expression for Total Energy** Total energy is the sum of kinetic energy and potential energy $E = KE + U$ $E=\frac{1}{2}m\omega^2(\mathrm{A}^2-x^2)+\frac{1}{2}m\omega^2x^2$ $E=\frac{1}{2}m\omega^2A^2=$ constant	1 1

	$E=\frac{1}{2}m\omega^2A^2\sin^2\omega t+\frac{1}{2}m\omega^2A^2\cos^2\omega t$ $=\frac{1}{2}m\omega^2A^2(\sin^2\omega t+\cos^2\omega t)$ $(\sin^2\omega t+\cos^2\omega t)=1$ $E=\frac{1}{2}m\omega^2A^2=\text{constant}$	2
38 (a)	**Newton's formula** Explanation $PV=\text{Constant}$ $PdV+VdP=0$ $P=-V\frac{dP}{dV}=B_T$ $v_T=\sqrt{\frac{B_T}{\rho}}=\sqrt{\frac{P}{\rho}}$ $v_T=\sqrt{\frac{(0.76\times13.6\times10^3\times9.8)}{1.293}}$ $=279.80\ \text{m s}^{-1}\approx280\ \text{ms}^{-1}$ (theoretical value) But the speed of sound in air at 0°C is experimentally observed as $332\ \text{m s}^{-1}$ which is close upto 16% more than theoretical value (Percentage error is $\frac{(332-280)}{332}\times100\%=15.6\%$). This error is not small **Laplace correction** Explanation $PV^{\gamma}=\text{constant}$	2 ½

	$V^{\gamma}\,dP + P\,(\gamma V^{\gamma-1}\,dV) = 0$ $\gamma P = -V\dfrac{dp}{dV} = B_A$ $v_A = \sqrt{\dfrac{B_A}{\rho}} = \sqrt{\dfrac{\gamma P}{\rho}} = \sqrt{\gamma}\,v_T$ Since air contains mainly, nitrogen, oxygen, hydrogen etc, (diatomic gas), we take γ = 1.47. Hence, speed of sound in air is $v_A = (\sqrt{1.4})(280\ \text{m s}^{-1}) = 331.30\ \text{m s}^{-1}$, which is very much closer to experimental data.	2 ½
38 (b)	Explanation  * $mg\sin\theta - f = ma$ * $Rf = I\alpha$ * $I = MK^2$ * $\alpha = \frac{a}{R}$ * $f = ma\left(\frac{K^2}{R^2}\right)$ * $a = \dfrac{g\sin\theta}{\left(1+\frac{K^2}{R^2}\right)}$	1 1 3