**Class: XI**
**SESSION:2023-2024**
**MARKING SCHEME**
**HBSE SAMPLEQUESTIONPAPER(THEORY)**
**SUBJECT:PHYSICS**

| Q.no | | Marks |
|---|---|---|
| | SECTIONA | |
| 1 | (iii) 8h/9 | 1 |
| 2 | (ii) zero | 1 |
| 3 | (ii) 45 | 1 |
| 4 | (iii) 7200 N | 1 |
| 5 | (i)Opposing force | 1 |
| 6 | (iv) pascal | 1 |
| 7 | (i) 0 | 1 |
| 8 | (■)F | 1 |
| 9 | (■) B | 1 |
| 10 | (iii) zero | 1 |
| 11 | (iv) $10^7$ $Nm^{-2}$ | 1 |
| 12 | (■) Hook's ■w | 1 |
| 13 | (iv) 8Q | 1 |
| 14 | (■)J/kg | 1 |
| 15 | (a) | 1 |
| 16 | (d) | 1 |
| 17 | (d) | 1 |
| 18 | (b) | 1 |
| | SECTIONB | |
| 19 | $P = \frac{a^3b^2}{(\sqrt{c}d)}$ <br> $\frac{\Delta P}{P} = \frac{3\Delta a}{a} + \frac{2\Delta b}{b} + \frac{1}{2}\frac{\Delta c}{c} + \frac{\Delta d}{d}$ <br> $\left(\frac{\Delta P}{P}\times 100\right)\% = \left(3\times\frac{\Delta a}{a}\times 100 + 2\times\frac{\Delta b}{b}\times 100 + \frac{1}{2}\times\frac{\Delta c}{c}\times 100 + \frac{\Delta d}{d}\times 100\right)\%$ <br> = 3x1 +2x3 + ½ x 4 + 2 <br> = 3 + 6 +2 + 2 <br> = 13 % <br> Percentage error in $P$ = 13 % | ½ <br> ½ <br> ½ <br> ½ |

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| **20** | $\frac{\text{Given unit}}{\text{New unit}} = \left(\frac{M_1}{M_2}\right)^x \left(\frac{L_1}{L_2}\right)^y \left(\frac{T_1}{T_2}\right)^z$<br><br>Dimension formula of heat = $[M^1L^2T^{-2}]$<br><br>$\therefore x = 1, y = 2, z = 2$<br><br>Since $M_1 = 1\text{kg}, L_1 = 1\text{m}, T_1 = 1\text{s}$<br><br>and $M_2 = \alpha\,\text{kg}, L_2 = \beta\,\text{m}, T_2 = \gamma\,\text{s}$<br><br>As 1 calorie = 4.2 Joule<br><br>and 1 Joule = $1\text{kg}\ \text{m}^2\text{s}^{-2}$<br><br>$\Rightarrow \frac{\text{calorie}}{\text{New unit}} = 4.2\left(\frac{1\text{kg}}{\alpha\text{kg}}\right)^1 \left(\frac{1\text{m}}{\beta\text{m}}\right)^2 \left(\frac{1\text{s}}{\gamma\text{s}}\right)^{-2}$<br><br>$\therefore$ Calorie = $4.2\alpha^{-1}\beta^{-2}\gamma^2$ New unit | ½<br><br>½<br><br>½<br><br>½ |
| **21** | A conservative force exists when the work done by that force on an object is independent of the object's path. Instead, the work done by a conservative force depends only on the end points of the motion. An example of a conservative force is gravitational force, electrostatic force.<br><br>Or<br><br>Elastic potential energy is **energy stored as a result of applying a force to deform an elastic object**.<br><br>Elastic potential energy=$^{231}$½ 1/2 $kx^2$ | 2<br><br>1<br><br>1 |

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| **22** | A collision in which there is absolutely no loss Of kinetic energy is called elastic collision.<br>Characteristics: (any two)<br>1. The linear momentum is conserved.<br>2. Total energy of the system is conserved.<br>3. Kinetic energy is conserved.<br>4. Forces involved during elastic collisions must be conservative forces.<br>OR<br>**The ratio of relative velocity after collision to the relative velocity between two objects before their collision** is known as the coefficient of restitution. | 1<br>½<br>½<br>2 |
| **23** | Pascal's law is any pressure applied to a fluid inside a closed system will transmit that pressure equally in all directions throughout the fluid.<br>Hydraulic brake, Hydraulic jack | 1+1 |
| **24** | **As temperature levels change, so does the air pressure in your tyres. It's the same as when you drive at higher speeds for an extended period: the tyre warms, and the air within expands and increases pressure** | 2 |

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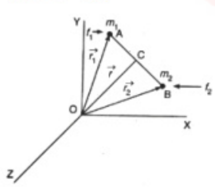
| **25** | Length of the steel wire, $l = 12\text{m}$<br>Mass of the steel wire, $m = 2.10\text{kg}$<br>Velocity of the transverse wave, $v = 343\text{m/s}$<br>Mass per unit length, $\mu = m/l = 2.10/12 = 0.175\text{kg m}^{-1}$<br>For Tension T, velocity of the transverse wave can be obtained using the relation:<br>$v = \sqrt{\frac{T}{\mu}}$<br>$\therefore T = v^2\mu$<br>$= (343)^2 \times 0.175 = 20588.575 \simeq 2.06 \times 10^4\text{N}.$ | 1<br><br>1 |
| | SECTIONC | |
| **26** | Let $AB = s$, time takemn to go form $A$ to $B$,<br>$t = \frac{s}{40}h$<br>and time taken to go form $B$ to $A$, $t_2 = \frac{s}{30}h$<br>$\therefore$ total time taken $=$<br>$t_1 + t_2 = \frac{S}{40} + \frac{s}{30} = \frac{(3+4)s}{120} = \frac{7s}{120}h$<br>Total distance travelled $= s + s = 2s$<br>$\therefore$ "Average speed" $= \frac{\text{total distance travelled}}{\text{total time taken}}$<br>$= \frac{2s}{7s/120} = \frac{120 \times 2}{7} = 34.3km/h$ | 1<br><br>1<br><br>1 |
| **27** | Consider a system of two particles of masses $m_1$ and $m_2$ located at A and B respectively.<br>$\vec{OA} = \vec{r_1}$<br>and $\vec{OB} = \vec{r_2}$<br><br>Let C be the position of centre of mass of the system of two particles. It would lie on the line joining A and B. Let $\vec{OC} = \vec{r}$ be the position vector of mass.<br>To evaluate $\vec{r}$, suppose $\vec{v_1}\&\vec{v_2}$ be the velocities of particles $m_1$ and $m_2$ respectively at any instant t<br>then, $v_1 = \frac{dr_1}{dt}$<br>and $v_2 = \frac{dr_2}{dt} \ldots\ldots(1)$<br>Let | 1 |

$f_1$ = external force on $m_1$

$f_2$ = external force on $m_2$

$F_{12}$ = internal force of $m_1$ due to $m_2$

$F_{21}$ = internal force on $m_2$ due to $m_1$ 1

**Linear momentum of particle $m_1$**

$$\vec{p_1} = m_1\vec{v_1}\ldots\ldots(2)$$

According to Newton's second law total force acting on this particle which is ($\vec{f_1} + \vec{F_{12}}$)

$$\frac{d\vec{p_1}}{dt} = \vec{f_1} + \vec{F}_{12}$$

Using (2), $\frac{d}{dt}(m_1\vec{v_1}) = \vec{f_1} + \vec{F_{12}}\ldots\ldots(3)$

$$\vec{f_1} + \vec{f_2} = \vec{f}\ldots\ldots(5)$$

where $\vec{f}$ = total external force on the system of two particles.

**Using (1),**

$$\frac{d}{dt}\left[m_1\frac{d\vec{r_1}}{dt} + m_2\frac{d\vec{r_2}}{dt}\right] = \vec{f}$$

Or $$\frac{d}{dt}\left[\frac{d}{dt}(m_1\vec{r_1} + m_2\vec{r_2})\right] = \vec{f}$$ 1

$$\frac{d^2}{dt^2}\vec{r}(m_1\vec{r_1} + m_2\vec{r_2}) = \vec{f}$$

Multiplying numerator and denominator of left side by ($m_1 + m_2$),

$$(m_1 + m_2)\frac{d^2}{dt^2}\vec{r}\,\frac{(m_1\vec{r_1} + m_2\vec{r_2})}{(m_1 + m_2)} = \vec{f} \qquad \ldots(6)$$

**Let us put**

$$\frac{m_1\vec{r_1} + m_2\vec{r_2}}{(m_1 + m_2)} = \vec{r} \qquad \ldots(7)$$

$$(m_1 + m_2)\frac{d^2}{dt^2}\vec{r} = \vec{f}\ldots\ldots(8)$$

This is the equation of motion of total mass ($m_1 + m_2$) supposed to be concentrated at a point whose position of vectors is $\vec{r}$ under the effect of total force $\vec{f}$.

**Now from (7),**

$$(m_1 + m_2)\vec{r} = m_1\vec{r_1} + m_2\vec{r_2}$$

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| | | 1.5<br><br>1.5 |
| 28 | **The moment of inertia of a rigid composite system is the sum of the moments of inertia of its component subsystems (all taken about the same axis).**<br>We know, kinetic energy $(E) = \frac{1}{2}mv^2$<br>As $v = \omega r$<br>So $E = \frac{1}{2}mr^2\omega^2 \Rightarrow E = \frac{1}{2}I\omega^2 \quad [\therefore I = mr^2]$<br>which is required relationship between kinetic energy of rotation and moment of inertia. | 1<br><br>2 |

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| **29** | Orbital velocity ($V_o$) : Velocity of a satellite moving in orbit is called orbital velocity ($V_o$).<br>Let a satellite of mass is revolving round the earth in a circular orbit at a height 'h' above the ground.<br>Radius of the orbit =R+h where R is radius of earth.<br>In orbit motion is " The centrifugal and centripetal forces acting on the satellite".<br>Centrifugal force $= \frac{mV^2}{r} = \frac{mV_0^2}{R+h}$........(1)<br>Centripetal force is the force acting towards the centre of the circle it is provided by gravitational force between the planet and satellite.<br>$\therefore F = \frac{GM}{(R+h)^2}$ ............. (2)<br>$(1) = (2) \frac{mV_0^2}{(R+h)} = \frac{GM}{(R+h)^2}$<br>$\therefore V_0^2 = \frac{GM}{R+h}$ or $V_o = \sqrt{\frac{GM}{R+h}}$<br>When $h < < R$ then orbital velocity.<br>$V_o = \sqrt{gR}$ is called orbital velocity. Its value is 7.92 km/sec.<br><br>OR<br>Escape velocity is the minimum velocity required by a body to be projected to overcome the gravitational pull of the earth.<br><br>Derivation of escape velocity | 1<br>1<br>1<br><br><br><br>1<br><br>2 |
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| **30** | An isothermal process is a thermodynamic process, in which the temperature of the system remains constant:<br>$\Delta T=0$.<br>Suppose 1 mole of gas is enclosed in isothermal container. Let $P_1, V_1, T$ be initial pressure, volumes and temperature. Let expand to volume $V_2$ & pressure reduces to $P_2$ & temperature remain constant. Then, work done is given by<br>$W = \int dW$<br>$W = \int_{V_1}^{V_2} P\,dV$<br>as $PV = RT$ (n = mole)<br>$P = \frac{RT}{V}$<br>$W = \int_{V_1}^{V_2} \frac{RT}{V} dV$<br>$W = RT \int_{V_1}^{V_2} \frac{dV}{V}$<br>$= RT [\text{In} V]_{V_1}^{V_2}$<br>$= RT [\text{In}V_2 - \text{In}V_1]$<br>$W = RT\,\text{In}\frac{V_2}{V_1}$<br>$\boxed{W = 2.303RT \log_{10}\frac{V_2}{V_1}}$ | 1<br><br>1<br><br>1 |

| | SECTION D | |
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| **31** | (i) Let H be the maximum height reached by the projectile in time $t_1$ For vertical motion,<br>The initial velocity = $u \sin\theta$<br>The final velocity = 0<br>Acceleration = $-g$<br>$\therefore$ using, $v^2 = u^2 + 2as$<br>$0 = u^2 \sin^2\theta - 2gH$<br>$2gH = u^2 \sin^2\theta$<br>$H = \frac{u^2 \sin^2\theta}{2g}$<br>(ii) Let $t_1$ be the time taken by the projectile to reach the maximum height H.<br>For vertical motion,<br>initial velocity = $u \sin\theta$<br>Final velocity at the maximum height = 0<br>Acceleration $a = -g$<br>Using the equation $v = u + at_1$<br>$0 = u \sin\theta - gt_1$<br>$gt_1 = u \sin\theta$<br>$t_1 = \frac{u \sin\theta}{g}$ | 1<br><br>1<br><br>1<br><br>1 |

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| | Let $t_2$ be the time of descent.<br>But $t_1 = t_2$<br>i.e. time of ascent= time of descent.<br>$\therefore$ Time of flight $T = t_1 + t_2 = 2t_1$<br>$\therefore\ T = \frac{2u\sin\theta}{g}$<br>(iii) Let R be the range of the projectile in a time T . This is covered by the projectile with a constant velocity $u\cos\theta$.<br>Range=horizontal component of velocity $\times$ Time of flight<br>i.e, $R = u\cos\theta.T$<br>$R = u\cos\theta.\frac{2u\sin\theta}{g}$<br>$R = \frac{u^2\sin 2\theta}{g}$<br>$\because 2\sin\theta\cdot\cos\theta = \sin 2\theta$ | |
| | OR<br>The parallelogram law of vector addition states that if two vectors are considered to be the two adjacent sides of a parallelogram with their tails meeting at the common point, then the diagonal of the parallelogram originating from the common point will be the resultant vector.<br><br>Derivation for resultant | 1<br><br>4 |
| **32** | Newton's second law of motion states that **"Force is equal to the rate of change of momentum. For a constant mass, force equals mass times acceleration.** | 2 |

Initial speed of the three-wheeler, u = 36km/h = 10m/s

Final speed of the three-wheeler, v = 0 m/s

Time, t = 4s

Mass of the three-wheeler, m = 400 kg

Mass of the driver, m' = 65kg

Total mass of the system, M = 400 + 65 = 465 kg

Using the first law of motion, the acceleration (a) of the three-wheeler car calculated as:

$v = u + at$ 1

$$a = \frac{(v-u)}{t} = \frac{(0-10)}{4} = -2.5 m/s^2$$

The negative sign indicates that the velocity of the three-wheeler is decrea with time. 1

Using Newton's second law of motion, the net force acting on the three-wheeler can be calculated as:

$F = Ma = 465 \times (-2.5) = -1162.5N$ 1

The negative sign indicates that the force is acting against the direction of motion of the three-wheeler.

OR

(i) Mass of the man, m = 70 kg

Acceleration, a = 0 1

Using Newton's second law of motion, we can write the equation of motion as:

R - mg = ma

Where, ma is the net force acting on the man.

As the lift is moving at a uniform speed, acceleration a = 0

∴ R = mg

= 70 × 10 = 700 N

∴ Reading on the weighing scale = $\frac{700}{g} = \frac{700}{10} = 70$ kg

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| | (ii) Mass of the man, m = 70 kg<br>Acceleration, a = 5m/s$^2$ downward<br>Using Newton's second law of motion, we can write the equation of motion as:<br>mg − R = ma,<br>∴ R = m(g − a)<br>= 70(10 − 5) = 70 × 5<br>= 350 N<br>∴ Reading on the weighing scale = $\frac{350}{g}$= $\frac{350}{10}$= 35 kg<br>(iii) Mass of the man, m = 70 kg<br>Acceleration, a = 5 m/s$^2$ upward<br>Using Newton's second law of motion, we can write the equation of motion as:<br>R − mg = ma<br>,R = m(g + a)<br>= 70(10 + 5) = 70 × 15<br>= 1050 N<br>∴ Readingontheweighingscale = $\frac{1050}{g}$= $\frac{1050}{10}$= 105 kg | 2<br><br><br><br><br><br><br><br><br><br><br>2 |
| 33. | Bernoulli's principle states that an increase in the speed of a fluid occurs simultaneously with a decrease in static pressure or a decrease in the fluid's potential energy.<br>To prove Bernoulli's theorem, consider a fluid of negligible viscosity moving with laminar flow, as shown in Figure.<br>Let the velocity, pressure and area of the fluid column be $p_1$, $v_1$ and $A_1$ at Q and $p_2$, $v_2$ and $A_2$ at R. Let the volume bounded by Q and R move to S and T where QS =$L_1$, and RT = $L_2$.<br><br><br>If the fluid is incompressible:<br>The work done by the pressure difference per unit volume = gain in kinetic energy per unit volume + gain in potential energy per unit volume. Now:<br>$A_1L_1 = A_2L_2$<br>Work done is given by:<br>$W = F \times d = p \times volume$<br>$\Rightarrow W_{net} = p_1 - p_2$<br>$\Rightarrow K.E = \frac{1}{2}mv^2 = \frac{1}{2}V\rho v^2 = \frac{1}{2}\rho v^2 (\because V = 1)$<br>$\Rightarrow K.E_{gained} = \frac{1}{2}\rho({v_2}^2 - {v_1}^2)$<br>$P_1 + \frac{1}{2}\rho {v_1}^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho {v_2}^2 + \rho g h_2$<br>$\therefore P + \frac{1}{2}\rho v^2 + \rho g h = const.$ | 1<br><br>1<br><br>2 |

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| | Bernoulli's Equation LIMITATION (ANY TWO)<br>[1] **the flow must be steady, i.e., the flow parameters (velocity, density, etc...) at any point cannot change with time** [2] the flow must be incompressible – even though pressure varies, the density must remain constant along with a streamline and [3] friction by viscous forces must be negligible.<br>OR<br>Terminal velocity is defined as the highest velocity attained by an object falling through a fluid<br><br>Derivation for terminal velocity | $\frac{1}{2}+\frac{1}{2}$<br><br>1<br><br>4 |

SECTION E

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| 34 | 1. $1.38 \times 10^{-23}$ joule per Kelvin.<br>2. P=1/3pv$^2$<br>3. The law of energy equipartition states that the total energy for every dynamic system in thermal equilibrium is evenly shared among the degrees of freedom.<br>Or<br>Degree of Freedom | 1<br>1<br>2 |
| 35 | 1. b) Longitudinal waves<br>2. c) Any medium even through vacuum<br>3. A longitudinal wave, the medium or the channel moves in the same direction with respect to the wave. Here, the movement of the particles is from left to right and forces other particles to vibrate. In a tansverse wave the medium or the channel moves perpendicular to the direction of the wave.<br>OR<br>Proof of V = $\nu\lambda$ | 1<br>1<br>2 |