MARKING SCHEME PHYSICS MODEL PAPER CLASS XI

Rubrics

SECTION –A

1. In scientific notation, (5 x 10^9) x (3 x 10^{24}) is expressed as:
A)1.5 x 10^{32} B)**1.5 x 10^{34}** C)15 x 10^{32} D)15 x 10^{34}
2.The Y-component of a force of magnitude 10N lying along X-axis is:
A)**0N** B)5N C)10N D)15N
3.The torque due to the gravitational force of the sun on the earth is:
A)mgd B)mgdcosθ C)mgdsinθ D)**Zero**
4.A body is displaced from a point (2,2) to a point (5,6), the magnitude of displacement is:
A)2m B)4m C)**5m** D)11m
5.The minimum number of forces of unequal magnitude required to keep a body in equilibrium is:
A) 2 B)**3** C)4 D)5
6.The velocity-time graph of a body moving with uniform velocity is:
A)**Parallel to X-axis** B)Parallel to Y-axis
C)Parabolic D)Hyperbolic
7. The gravitational pull of the earth on a unit mass of a body is:
A) **9.8N** B)9.8kg C)9.8m/s^2 D)9.8J
8. A body is thrown vertically upward, the work done by gravity on it is:
A)Maximum B)Zero C)Positive D)**Negative**
9. If the force and displacement of a body in the direction of force are halved, the work would change by factor:
A)2 B)$\frac{1}{2}$ C)4 **D)$\boldsymbol{\frac{1}{4}}$**
10.The angular speed of the Earth's daily rotation in rad/minute is:
A) $\frac{\pi}{120}$ B)$\frac{\pi}{180}$ C)$\frac{\pi}{270}$ **D)$\boldsymbol{\frac{\pi}{720}}$**
11.The minimum velocity required to put a satellite into orbit is called:
A)Escape velocity B)**Critical velocity** C)Terminal velocity D)Orbital velocity
12.When a satellite falls from high altitude to lower altitude its speed:

A)**Increases** B)Decreases C)Remains Same D)Becomes zero

13.The product of frequency and time period is equal to:

A)**1** B) -1 C)∞ D) 0

14.If 40 waves pass through a point in one second with a wavelength of 5cm, the wave speed is:

A)**2m/s** B)5m/s C)20m/s D) 40m/s
15.In a filter pump, when water flows out from the jet section, the pressure nearby:
A) Increases B) **Decreases**
C)Remains same D) Becomes zero

16.The principle of Young's Double Slits experiment is based on the division of:
A) Amplitude B)Frequency C) **Wavelength** D) Velocity
17.The quantity that remains constant during a heat engine cycle is:

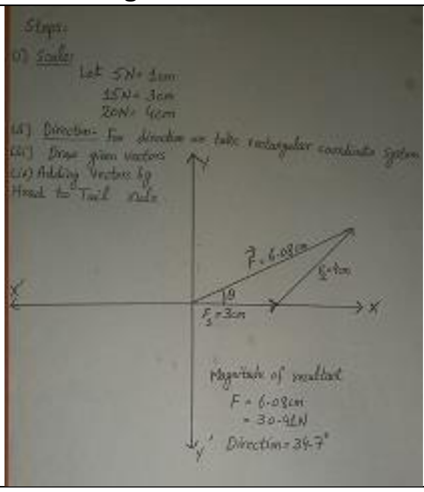
A) Heat B) Pressure C)Work done D) **Internal energy**

18.N/kg is equivalent to:

A)m/s B)$\mathbf{m/s^2}$ C)kgm/s D)kgm/s^2

Section-B

<table>
<tr><th>Item no</th><th>Question(Description)</th><th>Reference</th></tr>
<tr><td>i</td><td>i. Explain how does precision differ from accuracy in a measurement.</td><td>KPTBB
Grade XI
Page#11</td></tr>
<tr><td>Possible Answer</td><td>
<table>
<tr><th>Precision</th><th>Accuracy</th></tr>
<tr><td>In measurement, precision describes the degree of exactness with which a measurement is made and stated.
Precision depends on the instrument and technique used to make the measurement</td><td>In measurement, the accuracy describes the closeness of a measured value to the actual value of the measured quantity. The accuracy of a measurement depends upon the number of significant digits. The greater the number of significant digits in a measurement, the better is the accuracy and vice versa.</td></tr>
</table>
</td><td></td></tr>
<tr><td>Marking</td><td>2+2</td><td>4</td></tr>
<tr><td>ii</td><td>ii. Prove that (a) $\vec{F} = \frac{\Delta P}{\Delta t}$ (b) $\overrightarrow{a_c} = \frac{v^2}{r}$ are dimensionally homogeneous.</td><td>KPTBB
Grade XI
Page#28</td></tr>
<tr><td>Possible Answer</td><td>
<table>
<tr><td>(a) $\vec{F} = \frac{\Delta P}{\Delta t}$
ma = $\frac{m\Delta v}{\Delta t}$
Kgm/s^2= kg.$\frac{m/s}{s}$
Kgm/s^2=Kgm/s^2
[MLT^{-2}] = [MLT^{-2}]</td><td>(b) $\overrightarrow{a_c} = \frac{v^2}{r}$
m/s^2 = $\frac{(\text{m/s})^2}{m}$
m/s^2 = $\frac{(\text{m})^2}{ms^2}$
m/s^2 =m/s^2
[LT^{-2}] = [LT^{-2}]</td></tr>
</table>
</td><td></td></tr>
<tr><td>Marking</td><td>2+2</td><td>4</td></tr>
<tr><td>iii</td><td>iii. Explain the scalar product of two vectors and what it indicates about the relationship when the product is zero ,positive and negative.</td><td>KPTBB
Grade XI
Page#53</td></tr>
<tr><td>Possible Answer</td><td><u>Scalar Product:</u>
When a vector is multiplied by a vector and the product obtained is a scalar quantity, such type of vector multiplication is called scalar product.
Vector • Vector = Scalar
● When the product is zero vectors are perpendicular to each other, i.e. θ = 90°.
● When the product is positive vectors are either parallel to each other or lie at angle less than</td><td></td></tr>
</table>

	90°. ● When the product is negative, vectors are either antiparallel to each other, or lie at angle $90° < \theta \leq 180°$	
Marking	1+1+1+1	4
iv	Two forces of 15N and 20N are applied on an object at 60° to each other, find the resultant force using head to tail rule.	KPTBB Grade XI Page#40
Possible Answer		
Marking	1+1+1+1	4
v	Explain how the escape velocity relates to the gravitational constant (G) and radius (Re) of the earth.	KPTBB Grade XI Page#134,135
Possible Answer	**Escape velocity:** The minimum initial velocity, which a projectile must have at the Earth's surface in order to go out of Earth's gravitational field is known as escape velocity.(1) If a projectile is given an initial kinetic energy equal to $\frac{GM_e m}{R_e}$, it will just get out of gravitational field. The value of escape velocity can be computed by equating the initial kinetic energy with absolute potential energy at the surface of the earth. (1) $\frac{1}{2}\text{m}v_{esc}{}^2 = \frac{GM_e m}{R_e}$ $v_{esc} = \sqrt{\frac{2GM_e}{R_e}}$ (1) $v_{esc} = \sqrt{2GR_e}$ (1)	
Marking	1+1+1+1	4
vi	Differentiate conservative and non-conservative forces by giving two examples of each.	KPTBB Grade XI Page#122,123
Possible Answer	Coservative Force | Non-conservative Force	

<table>
<tr><td></td><td><table><tr><td>Conservative forces are those for which the work done is independent of the path taken and depends only on the initial and final positions.
The work done by conservative force along a closed path is zero.
Examples include gravitational force, electrostatic force, and spring force (elastic force).</td><td>Non-conservative forces are those for which the work done depends on the path taken.
The work done by conservative force along a closed path is not zero.
Examples include friction, air resistance, and contact forces like pushing or pulling.</td></tr></table></td><td></td></tr>
<tr><td>Marking</td><td>2+2</td><td>4</td></tr>
<tr><td>vii</td><td>If aerofoil lift the aeroplane upright position, how do the pilots make the aeroplane fly upside down?</td><td>KPTBB
Grade XI
Page#205</td></tr>
<tr><td>Possible Answer</td><td>According to Bernoulli's principle, the pressure difference above and below the wings generates lift due to varying air speeds; in inverted flight, pilots achieve lift by adjusting the angle of attack.(1)
By increasing this angle while upside down, they ensure the airflow creates sufficient pressure difference to lift the aircraft upward relative to its inverted position.(1)
The control surfaces, especially the elevator, are used to maintain this critical angle of attack, compensating for the inverted aerofoil shape.(1)
Thus, through precise adjustments and understanding of aerodynamics, pilots can sustain inverted flight by manipulating lift in accordance with Bernoulli's principle.(1)</td><td></td></tr>
<tr><td>Marking</td><td>1+1+1+1</td><td>4</td></tr>
<tr><td>viii</td><td>Define laminar flow and explain the transition of viscous fluid from laminar to turbulence condition.</td><td>KPTBB
Grade XI
Page#199</td></tr>
<tr><td>Possible Answer</td><td><u>Laminar flow:</u>
The flow is said to be streamline, steady, or laminar, if every particle of a fluid that passes through a particular point moves along exactly same velocity as followed by particles that have</td><td></td></tr>
</table>

	passed the point earlier. (1) In laminar flow, every particle of the fluid follows a smooth path such that the paths of different particles never cross each other.(1) Turbulent flow is irregular flow characterized by small whirlpool-like regions. Above a certain critical speed, fluid flow becomes turbulent.(1) In turbulent flow, the speed of the fluid at a point is continuously undergoing changes in both magnitude and direction. Turbulent flow tends to occur at higher velocities and low viscosity.(1)	
Marking	1+1+1+1	4
ix	Describe the effect of pressure and moisture on speed of sound in air.	KPTBB Grade XI Page#199
Possible Answer	**<u>Pressure:</u>** For one mole of an ideal gas having volume V and pressure P at temperature T, we can write General gas equation. $PV = RT.$ $V = \frac{RT}{P}$ (1) where R is a general gas constant. If m is the mass of the gas, then its density is $\rho=\frac{m}{V}$ Or $\rho=\frac{mP}{RT}$ Therefore speed of sound is $V=\sqrt{\frac{\gamma P}{\rho}}$ (1) $V=\sqrt{\frac{\gamma RT}{m}}$ Hence the speed of sound in air is independent of its pressure. (1) **<u>Moisture:</u>** The presence of moisture in the air reduces the resultant density of air. The net result is that speed of sound increases with humidity. Hence, the velocity of sound in damp air is greater than its value in dry air. (1)	
Marking	1+1+1+1	4
x	Differentiate between transverse and compressional waves by giving two examples	KPTBB Grade XI Page#255
Possible	**<u>Transverse waves:</u>**	

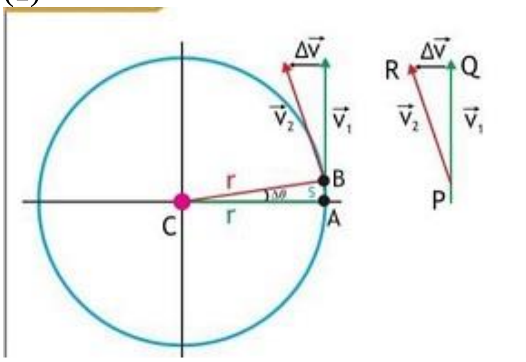
Answer	The waves in which the particles of medium vibrate along a line perpendicular to the direction of propagation of the waves are known as transverse waves. Transverse waves consist of crust and trough. **Examples**: (any two) water waves, light waves, radio waves, microwaves etc. **Compressional or longitudinal waves:** Those waves in which the particles of the medium vibrate about their mean position along the direction of propagation of the waves are called compressional or longitudinal waves. Longitudinal waves consist of compressions and rarefactions. **Examples**:(any two) Sound waves, Seismic P -waves	
Marking	1+1+1+1	4
Xi.	Describe two applications of Doppler effect to electromagnetic waves.	KPTBB Grade XI Page#290,291
Possible Answer	Doppler effect is not confined to sound waves but equally applicable to light waves. Application of Doppler effect are (1) **Speed and direction of the plane**: The reflection of radar waves from an aeroplane. The frequency of reflected waves is decreased if the plane is moving away from the source. The frequency of reflected waves is increased if the plane is moving towards the source. From this frequency shift, the speed and direction of the plane can be determined. (2) **Speed and Direction of Submarine**: When sound waves are reflected from a moving submarine, the frequency is changed. By this change in frequency, we can calculate the speed and direction of the submarine. The velocities of the earth satellites are also determined from the Doppler shift in the frequency of radio waves which they transmit.(2)	
Marking	2+2	4
Xii	Define interference of light and state the necessary conditions to observe it.	KPTBB Grade XI Page#290,291
Possible Answer	**Interference** : Interference is described as the effect produced by the superposition of waves from two coherent sources travelling in the same direction.(1) **Conditions to observe interference of light**.(Any	

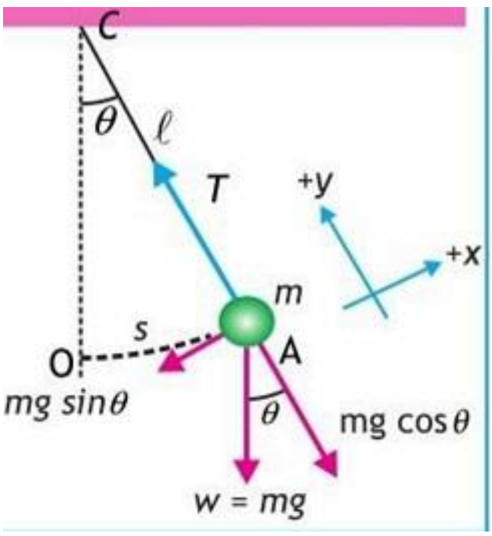
	three) (i) The light waves must come from two coherent sources. (ii) The amplitude of waves must be equal or nearly equal. (iii) The light waves should be perfectly monochromatic. (iv) The path difference of the waves from the two sources must be small. (v) The principle of linear superposition should be applicable.	
Marking	1+1+1+1	4
Xiii	Determine the angle at which first-order Bragg diffraction occurs for X-rays with a 4nm wavelength incident on a crystal with a 6nm lattice spacing.	KPTBB Grade XI Page#331
Possible Answer	**Given data:** Wavelength, λ = 4nm $= 4 \times 10^{-9}$m Lattice spacing, d = 6nm $= 6 \times 10^{-9}$m Order of the image=m=1 **To find**: Angle, θ = ? **Formula:** $2d\sin\theta = m\lambda$ $\sin\theta = \frac{m\lambda}{2d}$ **Soliution**: $\sin\theta = \frac{1\times 4 \times 10^{-9}}{2\times 6\times 10^{-9}}$ $\sin\theta = \frac{4}{12}$ $\sin\theta = 0.33$ $\theta = 19°$	
Marking	1+1+1+1	4

Section-C

Item no	Question(Description)	Reference
2.(a)	What is projectile motion? Describe the range of projectile and explain how the angle of projection influences the maximum range.	KPTBB Grade XI Page#105,107
Possible answer	**Projectile motion:** Projectile motion is the form of two-dimensional motion experienced by an object or particle that is thrown near the Earth's surface and moves along a	

	curved path under the action of gravity only. The path followed by a projectile is called its trajectory which is parabola.(1) **<u>Range:</u>** The horizontal distance from point of projection to point of impact is called range of projectile. Consider a projectile which is thrown with certain velocity v_o making an angle θ with the horizontal.(1) To find the maximum range, we will use second equation of motion along x-axis. $S_x = v_{ix}t + \frac{1}{2}a_x t^2$ Here v_{ix} = $v_o\cos\theta$, S_x =R, a_x =0, t = $\frac{2v_o sin\theta}{g}$ (1) Putting values $R = v_o\cos\theta(\frac{2v_o sin\theta}{g}) + \frac{1}{2} \times 0 \times (\frac{2v_o sin\theta}{g})^2$ $R = v_o\cos\theta(\frac{2v_o sin\theta}{g})$ R = $\frac{v_o^2}{g}(2sin\theta\cos\theta)$ $2sin\theta\cos\theta = sin2\theta$ R = $\frac{v_o^2}{g}sin2\theta$ (1) **<u>Maximum range angle:</u>** Since the maximum value for the sin of any angle is 1, so the factor 2θ will be maximum if it is equal to 1 as well. $sin2\theta_{max}$ =1 Or $2\theta_{max}$ = $Sin^{-1}1$ Since $Sin^{-1}1$= 90° $2\theta_{max}$ =90° θ_{max} =45° (1)	
Marking	1+1+1+1+1	5
2.(b)	Calculate the horizontal range of a ball thrown at 40 m/s at an angle of 30° to the horizontal.	KPTBB Grade XI Page#109
Possible answer	**<u>Given data:</u>** v_o = 40m/s θ = 30° g = 9.8m/s^2 **<u>To find</u>**: R = ? **<u>Formula:</u>** R = $\frac{v_o^2}{g}sin2\theta$ **<u>Soliution</u>**: R = $\frac{(40)^2}{9.8}sin2(30°)$ R =141.7m	

Marking	1+1+1+1	4
3.(a)	Describe centripetal acceleration and prove that $a_c = \frac{v^2}{r}$.	KPTBB Grade XI Page#155,156
Possible answer	**<u>Centripetal acceleration:</u>** Acceleration produced in a body directed towards the centre of circular path is called centripetal acceleration. (1)  (1) consider a body of mass m moving in a circle of radius r with uniform speed $\vec{v}$. C is centre of circle. At point A at time t_1, velocity of body is $\vec{v}_1$ and at point 'B' at time t_2, velocity of body is $\vec{v}_2$. Let us now draw a triangle PQR such that PQ is equal and parallel to $\vec{v}_1$ and PR is equal and parallel to $\vec{v}_2$. As speed is uniform hence, $\vec{v}_1 = \vec{v}_2 = \vec{v}$ in magnitude but they differ in direction. By vector diagram, $\vec{v} = \vec{v}_2 - \vec{v}_1$ is the change in velocity of body in time interval $\Delta t = t_2 - t_1$. When time Δt is small the change $\Delta\vec{v}$ is also small in that case arc $\overline{AB}$ is approximately equal to cord AB. On comparison, we see that ΔACB and ΔPQR are isosceles triangles, so these are similar. Geometrically, $\frac{arc\ AB}{\overline{Ac}} = \frac{\overline{QR}}{\overline{PQ}}$ Or, $\frac{\hat{E}}{r} = \frac{\Delta\ddot{O}}{v}$ (2) **Condition** When θ is very small, or when $\Delta t = t_2 - t_1$ is very small, point 'B' will by very near to point 'A' and then: $S = vt$ Then the above equation becomes $\frac{v\Delta t}{r} = \frac{\Delta v}{v}$ (provided that Δt is very very small) Or $\frac{\Delta v}{\Delta t} = \frac{v^2}{r}$ Or $\lim_{\Delta t \to 0} \frac{\Delta v}{\Delta t} = a_{inst}$ Or $a_{inst} = \frac{v^2}{r}$ This acceleration is also called centripetal acceleration. Thus $a_c = \frac{v^2}{r}$ (1)	
Marking	1+1+2+1	5
3.(b)	Find the centripetal acceleration of the Moon as it orbits the Earth in a circle of radius 382,400 km and a period of 27.3 days	KPTBB Grade XI Page#155,156

Possible answer	**Given data:** r = 382,400km = 3.824 x 10^8m T = 27.3 days = 2,359,680 sec **To find**: a_c = ? **Formula:** $a_c = \frac{v^2}{r}$ **Solution**: v = $\frac{2\pi r}{T}$ v= 1018m/s $a_c = \frac{(1018)^2}{3.824 \times 10^8}$ = 2.7 $\times 10^{-3}$ m/s^2	
Marking	1+1+1+1	4
4.(a)	Show that a simple pendulum executes simple harmonic motion.	KPTBB Grade XI Page#231
Possible answer	**Simple Pendulum**: A simple pendulum consists of a small heavy mass ‘m’ suspended by a light string of length ‘l’, fixed with its upper end. (1 mark) When such a pendulum is displaced from its mean position ‘O’ it starts oscillating to and fro about the mean position. Let the bob of pendulum of mass ‘m’ having weight ‘w’ is displaced from mean position O towards A, where ‘w’ acts vertically in downward direction, l is length of pendulum, which is the sum of the length of string and the radius ‘r’ of the metallic bob. T is tension in string, we have resolved ‘w’ into its component as: (1 mark)	

	$T = mg\cos\theta$ $F_{applied} = -F_{restoring}$ (i) $F_{restoring} = -mg\sin\theta$ (ii) $ma = -mg\sin\theta$ ($F_{applied} = ma$) $a = -g\sin\theta$ (iii) (1 mark) It means that 'a' depends upon $\sin\theta$. When 'θ' is very small, $\sin\theta \approx \theta$ and equation (iii) becomes $a = -g\theta$ (iv) But when 'θ' is very small, point 'O' will be very near to 'A' and arc OA ≈ x is a straight line and then ΔAOC will be a right angle triangle. (1 mark) And $x/l = \sin\theta \approx \theta$, then eq (iv) becomes, $a = -g\frac{x}{l}$ Or $a = -(\frac{g}{l})\ x$ During the motion, 'g' and 'l' remain constant and so we put $\frac{g}{l} = \omega^2 =$ constant. Hence a = constant (-x) $a \propto -x$ This is the equation of S.H.M, so motion of simple pendulum is S.H.M. (1 mark)	
Marking	1+1+1+1+1	5
4.(b)	Calculate the length of a pendulum with a period of 2 seconds at the surface of moon . ($g_m = 1.63\ m/s^2$).	KPTBB Grade XI Page#231
Possible answer	**Given data:** T = 2 sec $g = 1.63 m/s^2$ **To find**: l = ? **Formula:** $T = 2\pi\sqrt{\frac{l}{g}}$ $l = \frac{T^2 g}{4\pi^2}$ **Soliution**: $l = \frac{(2)^2 \times 1.63}{4(3.14)^2}$ l = 0.165m	
Marking	1+1+1+1	4
5.(a)	Prove that for an ideal gas, Cp - Cv = R .	KPTBB Grade XI Page#362
Possible answer	When gas is heated at constant volume, there is no work done by the gas against the surrounding. The heat received is converted entirely into the internal energy in	

	the form of molecular kinetic energy, thus raising the temperature.(1 mark) On the other hand, when the gas is heated at constant pressure, the gas will expand on being heated. It does work against the surrounding. Hence, heat must be supplied to change the internal energy of the gas and to perform external work. Since the change of internal energy is the same in both cases, the specific heat at constant pressure, Cp, is greater than the specific heat at constant volume, Cv i.e.,Cp> Cv because external work is also performed when the gas expands at constant pressure.(1 mark) If ΔQ_v is the amount of heat supplied and ΔT is the rise in temperature, then by the definition of the constant volume molar specific heat we have. $\Delta Q_v = nC_v\Delta T$ (i) The pressure of the gas increases during the process, but no work is done, because the volume is kept constant. $\Delta W_v = 0$ From the first law of thermodynamics: $\Delta Q_v = \Delta U + \Delta W_v$ $\Delta Q_v = \Delta U + 0$ $\Delta Q_v = \Delta U$ (ii) Comparing (i) and (ii) we get $\Delta U = nC_v\Delta T$ (iii) (1 mark) If ΔQ_p is the heat supplied and ΔT is the rise in temperature, then $\Delta Q_p = nC_p\Delta T$ (iv) The work done by the gas against the constant external pressure is given by $\Delta W = \text{Force} \times \text{distance}$ $\Delta W_p = F\Delta Y$ $\Delta W_p = PA\Delta Y = P\Delta V$ (v) For an ideaal gas, the general gas equation is $P\Delta V = nR\Delta T$ Therefore $\Delta W_p = P\Delta V = nR\Delta T$ (vi) (1 mark) From first law of thermodynamics $\Delta Q_p = \Delta U + \Delta W_p$ (vii) Substituting the expressions for ΔQ_p, ΔU and ΔW_p we get $nC_p\Delta T = nC_v\Delta T + nR\Delta T$ On simplifying we get Cp - Cv = R (1 mark)	
Marking	1+1+1+1+1	5
5.(b)	Determine the change in internal energy of the system given that 37,200J of heat is supplied to the system and it performs 5,000 J of work.	KPTBB Grade XI Page#263
Possible	**Given data:**	

answer	ΔQ = 37200J ΔW = 5000J **<u>To find</u>**: ΔU = ? **<u>Formula:</u>** $\Delta Q = \Delta U + \Delta W$ $\Delta U = \Delta Q - \Delta W$ **<u>Soliution</u>**: $\Delta U = 372000 - 5000$ ΔU = 32,200J	
Marking	1+1+1+1	4