SAMPLE PAPER CLASS XI PHYSICS

BLUEPRINT:

sr. no.	Name of chapter	VSAQ (1)	SA-I (2)	SA-II (3)	Value based (4)	LA(5)	Total 70
1	Physical world and measurement	1		3			
2	Kinematics		2	3,3		5	
3	Laws of motion	1	2	3			23
4	Work Energy and Power			3			
5	System of particle and Rotational motion	1		3		5	17
6	Gravitation		2	3			
7	Properties of bulk		2	3		5	
8	Thermodynamics	1		3			20
9	Behavior of perfect gasses and kinetic theory of gasses	1	2	3			
10	Oscillations and waves			3,3	4		10

SAMPLE PAPER

XI – PHYSICS

Time: Three Hours Maximum Marks: 70

General Instructions

(a) All questions are compulsory.

(b) There are 26 questions in total. Questions 1 to 5 carry one mark each, questions 6 to 10 carry two marks each, questions 11to 22 carry three marks each, questions 23 carry four marks and questions 24 to 26 carry five marks each.

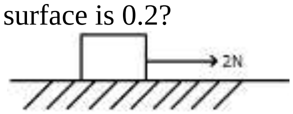
(c) There is no overall choice. However, an internal choice has been provided in one question of two marks, one question of three marks and all three questions of five marks each. You have to attempt onlyone of the given choices in such questions.

(d) Use of calculator is not permitted.

(e) You may use the following physical constants wherever necessary.

$e = 1.6 \text{ X } 10^{-19}$ C
$c = 3 \text{ X } 10^{8}$ m/s
$h = 6.6 \text{ X } 10^{-34}$ JS
$\mu_o = 4\pi \text{ X } 10^{-7}$ N/A^2
$k_B = 1.38 \text{ X } 10^{23}$ J/K
$N_A = 6.023 \text{ X } 10^{-23}$ /mole
$m_n = 1.6 \text{ X } 10^{-27}$ Kg

1. Write the dimensional formula of gravitational constant?
2. Name the instrument used to measure the speed of a vehicle?
3. What is the rotational analogue of mass of the body?
4. List the two essential conditions for isothermal process.
5. Give an example of heat pump.
6. Mention two ways in which static friction is a self-adjusting force. How much force of static friction is acting on the block of mass 2 kg shown in figure below if the coefficient of static friction between the block and the surface is 0.2?



7. A body of weight 64N on the surface of earth. What is the gravitational force on it due to the earth, at a height equal to the half of the radius of earth? Acceleration due to gravity on the surface of the earth is $10ms^{-1.}$
8. Define stress. A heavy wire is suspended from a roof and no weight is attached to its lower end. Is it under stress?
9. Define law of equipartition of energy with expression of energy. How it is related with kinetic energy of molecule.
10. Define and explain second's pendulum. Calculate its length.
11. Define centripetal acceleration. Derive an expression for centripetal acceleration and show its direction.
12. State law of conservation of momentum. Write S.I. units of momentum. Explain why a cricket player lowers his hand while catching a ball.
13. Derive an expression for work energy theorem for variable force.
14. State perpendicular axis theorem. What is the moment of inertia of a ring of mass 'm' and radius 'r' about an axis passing through its center and perpendicular to its plane? Also write formula for moment of inertia about an axis along its diameter.
15. Define escape velocity. Derive an expression for escape velocity.

16. Draw stress strain curve. Explain its various points.
17. Define Pascal's law. Give its application in hydraulic lift.
18. Draw block diagram of refrigerator. Explain its coefficient of performance.
19. Derive an expression for pressure exerted by an ideal gas.
20. A body oscillates with SHM according to the equation (in SI units), $x = 5 \cos [2\omega t + \pi/4]$. At $t = 1.5$ s, calculate the (a) displacement, (b) speed and (c) acceleration of the body.
21. What is absolute error? The temperature of two bodies measured by a thermometer are $t_1 = 20°C \pm 0.5°C$ and $t_2 = 50°C \pm 0.5°C$. What is the temperature difference and the error there in?
22. Write the relation for potential energy and kinetic energy of Simple harmonic oscillator. At what displacement the P.E and K.E of Simple Harmonic Oscillator is maximum?
23. In a simple harmonic motion, a particle moves to and fro repeatedly about its mean position, under a restoring force whose magnitude at any instant is directly proportional to the displacement from the mean position, and the force is directed toward the mean position

    In fact the SHM of a particle takes place under the condition of stable equilibrium. SHM is the most common form of motion in nature.

    Read the passage and answer the following questions:

    (i) Give at least two examples of SHM in nature.

    (ii) How the concept of SHM related to day to day life?
24. Derive equation of motion of a projectile. Also find

    (a) time of flight,

    (b) maximum height, and

    © horizontal range.

    Or

    Define parallelogram law of vector addition. Find the magnitude and direction of the resultant of two vectors A and B in terms of their magnitudes and angle θ between them.
25. Derive an expression for acceleration due to gravity below and above the surface of earth.

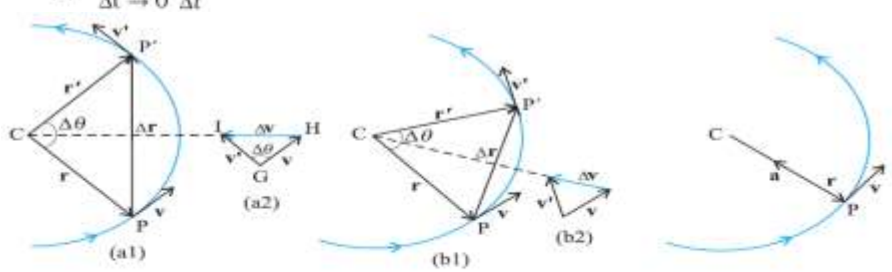
    Or

    The angular speed of a motor wheel is increased from 1200 rpm to 3120 rpm in 16 seconds. (i) What is its angular acceleration, assuming the acceleration to be uniform? (ii) How many revolutions does the engine make during this time?
26. State Bernoulli's theorem. Derive Bernoulli's equation.

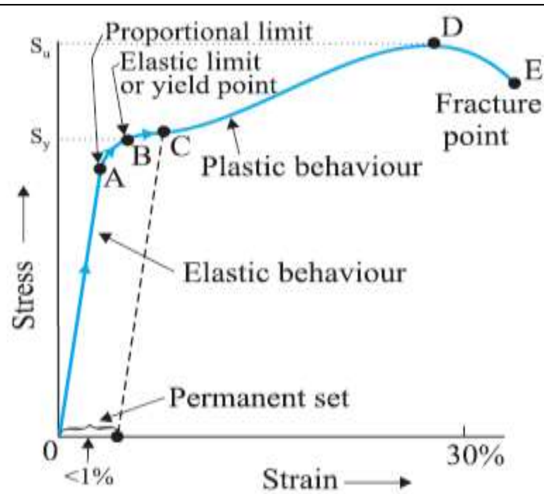
    Or

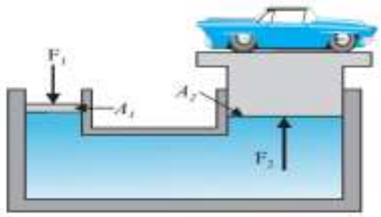
    Explain capillarity with illustration and deduce ascent formula

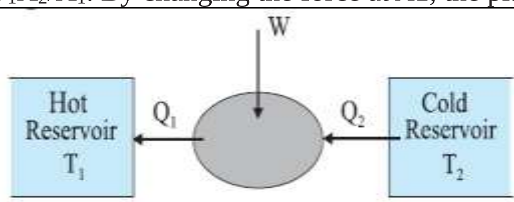
Model Answers and Marking scheme.

Sr. no.	Answer points	Marks
1	$[M^{-1}L^{3}T^{-2}]$	1
2	Speedometer	1
3	Moment of inertia	1
4	1. The walls of container must be perfectly conducting, to allow free exchange of heat between the gas and its surroundings. 2. The process of compression or expansion should be slow so as to provide time for exchange of heat.	1
5	Refrigrator	1
6	1. Friction adjusts its direction to be always opposite to applied force. 2. Friction adjusts its magnitude up to a certain limit, to be equal to the applied force. Fms = μsN = μsmg = 0.2 × 2 ×10 = 4N Since, applied force < Fms, the static friction acting = fs = 2 N.	½ ½ ½ ½
7	Mass of body m= $\frac{64}{g}$ = = $\frac{64}{10}$ = 6.4 kg g' = g$\frac{R^2}{(R+h)^2}$ = 10 x $\frac{4}{9}$ at a height h = mg' = 6.4 x 10 x $\frac{4}{9}$ N = 28.44 N	1 1
8	Stress: it is defines as the restoring force per unit area is known as stress. Yes, the wire is under stress as its own weight acts as load.	1 1
9	In equilibrium, the total energy is equally distributed in all possible energy modes, with each mode having an average energy equal to ½ k_BT. This is known as the law of equipartition of energy. $\frac{1}{2} mv^2_x + \frac{1}{2} mv^2_y + \frac{1}{2} mv^2_z = 3/2\ (k_Bt)$	1 1
10	Second pendulum is a pendulum whose time period is 2 s. L=$\frac{4x9.8}{4(3.14^2)}$ = 0.993 m= 99.3 cm	1
11	The acceleration possessed by an object moving in a circular motion is known as centripetal acceleration. a = v^2/R The magnitude of **a** is, by definition, given by $\lvert\mathbf{a}\rvert = \lim_{\Delta t \to 0} \frac{\lvert\Delta \mathbf{v}\rvert}{\Delta t}$ 	1 ½

	$\frac{\lvert\Delta \mathbf{v}\rvert}{v} = \frac{\lvert\Delta \mathbf{r}\rvert}{R}$ Or, $\lvert\Delta \mathbf{v}\rvert = v\frac{\lvert\Delta \mathbf{r}\rvert}{R}$ Therefore, $\lvert\mathbf{a}\rvert = \lim_{\Delta t \to 0}\frac{\lvert\Delta \mathbf{v}\rvert}{\Delta t} = \lim_{\Delta t \to 0}\frac{v\lvert\Delta \mathbf{r}\rvert}{R\Delta t} = \frac{v}{R}\lim_{\Delta t \to 0}\frac{\lvert\Delta \mathbf{r}\rvert}{\Delta t}$ If Δt is small, Δθ will also be small and then arc PP' can be approximately taken to be $\lvert\Delta \mathbf{r}\rvert$: $\lvert\Delta \mathbf{r}\rvert = v\Delta t$ $\frac{\lvert\Delta \mathbf{r}\rvert}{\Delta t} = v$ Or, $\lim_{\Delta t \to 0}\frac{\lvert\Delta \mathbf{r}\rvert}{\Delta t} = v$ Therefore, the centripetal acceleration a_c is : $= v^2/r$	½ 1
12	Law of conservation of momentum states that in an isolated system the total momentum of system remains constant. S.I units of momentum is Kgm/s By lowering his hands he increase the time of action hence decrease the rate of change of momentum thus less force acts on his hands	
13	$\frac{dK}{dt} = \frac{d}{dt}\left(\frac{1}{2}m v^2\right)$ $= m\frac{dv}{dt}v$ $= F v$ (from Newton's Second Law) $= F\frac{dx}{dt}$ Thus $dK = F dx$ Integrating from the initial position (x_i) to final position (x_f), we have $\int_{K_i}^{K_f} dK = \int_{x_i}^{x_f} F dx$ where, K_i and K_f are the initial and final kinetic energies corresponding to x_i and x_f. or $K_f - K_i = \int_{x_i}^{x_f} F dx$ From Eq. (6.7), it follows that $K_f - K_i = W$	½ ½ ½ ½ 1
14	the moment of inertia of a planar body (lamina) about an axis perpendicular to its plane is equal to the sum of its moments of inertia about two perpendicular axes concurrent with perpendicular axis and lying in the plane of the body. Moment of inertia about axis perpendicular to plane is mr^2 Diametric axis are symmetric therefor e using theorem of perpendicular axis $Ix + Iy = Iz$ $I_d + I_d = mr^2$ $I_d = ½\ mr^2$	1 1 1
15	Definition: minimum velocity required to get escape from earths gravitation pull	1 ½

	$E(\infty) = W_1 + \frac{mV_f^2}{2}$ If the object was thrown initially with a speed V_i from a point at a distance $(h+R_E)$ from the center of the earth (R_E = radius of the earth), its energy initially was $E(h+R_E) = \frac{1}{2}mV_i^2 - \frac{GmM_E}{(h+R_E)} + W_1$ By the principle of energy conservation Eqs. (8.26) and (8.27) must be equal. Hence $\frac{mV_i^2}{2} - \frac{GmM_E}{(h+R_E)} = \frac{mV_f^2}{2}$ The R.H.S. is a positive quantity with a minimum value zero hence so must be the L.H.S. Thus, an object can reach infinity as long as V_i is such that $\frac{mV_i^2}{2} - \frac{GmM_E}{(h+R_E)} \geq 0$ The minimum value of V_i corresponds to the $\frac{1}{2}m\left(V_i^2\right)_{min} = \frac{GmM_E}{h+R_E}$ If the object is thrown from the surface of the earth, h=0, and we get $(V_i)_{min} = \sqrt{\frac{2GM_E}{R_E}}$ Using the relation $g = GM_E / R_E^2$, we get $(V_i)_{min} = \sqrt{2gR_E}$	½ ½ ½
16	 In the region from A to B, stress and strain are not proportional. Nevertheless, the body still returns to its original dimension when the load is removed. The point B in the curve is known as yield point (also known as elastic limit) and the corresponding stress is known as yield strength (*Sy*) of the material. If the load is increased further, the stress	1 2

<table>
<tr><td></td><td>developed exceeds the yield strength and strain increases rapidly even for a small change in the stress. The portion of the curve between B and D shows this. When the load is removed, say at some point C between B and D, the body does not regain its original dimension. In this case, even when the stress is zero, the strain is not zero. The material is said to have a permanent set. The deformation is said to be plastic deformation. The point D on the graph is the ultimate tensile strength (*Su*) of the material.</td><td></td></tr>
<tr><td>17</td><td>The French scientist Blaise Pascal observed that the pressure in a fluid at rest is the same at all points if they are at the same height.
$\frac{F_b}{A_b} = \frac{F_c}{A_c} = \frac{F_a}{A_a}; \quad P_b = P_c = P_a$


In a hydraulic lift as shown in Fig. 10.6 two pistons are separated by the space filled with a liquid. A piston of small cross section *A*1 is used to exert a force *F*1 directly on the liquid. The pressure $P = F_1/A_1$ is transmitted throughout the liquid to the larger
cylinder attached with a larger piston of area *A*2, which results in an upward force of *P* × *A*2. Therefore, the piston is capable of supporting a large force (large weight of, say a car, or a truck, placed on the platform) *F*2 = *PA*2 = F_1A_2/A_1. By changing the force at *A*1, the platform can be lifted</td><td></td></tr>
<tr><td>18</td><td>

The coefficient of performance (α) of a refrigerator is given by
Q_2/W
where *Q*2 is the heat extracted from the cold reservoir and *W* is the work done on the
system–the refrigerant. (α□for heat pump is defined as *Q*1/*W*) Note that while □□by definition can never exceed 1, α□can be greater than 1. By energy conservation, the heat released to the hot reservoir is
*Q*1 = *W* + *Q*2
$\alpha = Q_2/Q_1\text{-}Q_2$</td><td>1
½
½
1</td></tr>
<tr><td>19</td><td>Consider a gas enclosed in a cube of side l. Take the axes to be parallel to the sides of the cube, A molecule with velocity (*vx, vy, vz*) hits the planar wall parallel to *yz*plane
of area *A* (= *l*2). Since the collision is elastic, the molecule rebounds with the same velocity; its *y* and *z* components of velocity do not change in the collision but the *x*-component reverses sign. That is, the velocity after collision is (-*vx, vy, vz*) . The change in momentum of the molecule is : –*mvx* – (*mvx*) = – 2*mvx* .</td><td>1</td></tr>
</table>

	By the principle of onservation of momentum, the momentum imparted to the wall in the collision = 2*mvx* . To calculate the force(and pressure) on the wall, we need to calculate momentum imparted to the wall per unit time. In a small time interval Δ*t*, a molecule with *x*-component of velocity *vx* will hit the wall if it is within the distance *vx* Δ*t* from the wall. That is, all molecules within the volume *Avx* □*t* only can hit the wall in time Δ*t*. But, on the average, half of these are moving towards the wall and the other half away from the wall. Thus the number of molecules with velocity (*vx*, *vy*, *vz*) hitting the wall in time Δ*t* is ½*A vx* Δ*t n* where *n* is the number of molecules per unit volume. The total momentum transferred to the wall by these molecules in time Δ*t* is : *Q* = (2*mvx*) (½ *n A vx* Δ*t*) The force on the wall is the rate of momentum transfer *Q*/Δ*t* and pressure is force per unit area : $P = Q/(A\Delta t) = n m vx^2$ Actually, all molecules in a gas do not have the same velocity; there is a distribution in Velocities. The above equation therefore, stands for pressure due to the group of molecules with speed *vx* in the *x*-direction and n stands for the number density of that group of molecules $P = (1/3)\, n m v^2$	½ ½ 1
20	(a) displacement = (5.0 m) cos [(2Ωs–1) ×1.5 s + π/4] = –3.535 m (b) , the speed of the body = – (5.0 m)(2πs–1) sin [(2πs–1) ×1.5 s + π/4] = – (5.0 m)(2πs–1) sin [(3π+ π4)] = 10π× 0.707 m s–1 = 22 m s–1 (c) the acceleration of the body = –(2πs–1)2 × displacement = – (2 πs–1)2 × (–3.535 m) = 140 m s–2	
21	Absolute error is the magnitude of difference between the value of individual measurement and the true value of the quantity. $\Delta t = t_2 - t_1$ = (50 ± 0.5) – (20 ± 0.5) = 30°C ± 1°C	1 1 1
22	The PE of particle executing SHM is given by $u=1/2mw^2y^2$ The KE of a particle executing SHM is given by $K= 1/2mw^2(a^2-y^2)$ U is maximum when y= a = amplitude of vibration. i.e the particle is passing from the extreme position and minimum when y = 0 i.e the particle is passing from the mean position.	1 1 1

	K is maximum when y =0 i.e particle is passing from mean position and K is minimum when y= a i. e. particle is passing from the extreme position.	
23	i) air molecules, strings of musical instrument . ii) In day to day life each one of us likes stability. We have to move out for carrying out our duties and assignments but our tendency is always to return to our central place of stable equilibrium. This is how the concept of SHM is related to our day to day life	1 2
24	Derivation of Equation of projectile (a) time of flight, (b) maximum height, and © Horizontal range. Or Definition diagram Magnitude of resultant Direction	2 1 1 1 1 1 2 1
25	Derivation for acceleration due to gravity above surface of earth Below surface of earth Or (i) We shall use $\omega = \omega_0 + \alpha t$ ω_0 = initial angular speed in rad/s $= 2\pi \times$ angular speed in rev/s $= \frac{2\pi \times \text{angular speed in rev/min}}{60 \text{ s/min}}$ $= \frac{2\pi \times 1200}{60}$ rad/s $= 40\pi$ rad/s Similarly ω = final angular speed in rad/s $= \frac{2\pi \times 3120}{60}$ rad/s $= 2\pi \times 52$ rad/s $= 104\pi$ rad/s The angular acceleration of the engine = 4π rad/s^2 (ii) The angular displacement in time t is given by $\theta = \omega_0 t + \frac{1}{2}\alpha t^2$ $= (40\pi \times 16 + \frac{1}{2} \times 4\pi \times 16^2)$ rad $= (640\pi + 512\pi)$ rad $= 1152\pi$ rad Number of revolutions = $\frac{1152\pi}{2\pi} = 576$	2 ½ 2 ½ ½ 1 ½ 1 ½ 1 ½

26	In a streamline flow of non-viscous fluid the sum of pressure energy, kinetic energy per unit mass and potential energy per unit mass is constant. $p/\rho + ½ v^2 + gh = constant$ derivation or Capillarity explanation Illustration Derivation	1 4 1 1 3