PHYSICS

Time : 3 hrs. **Class XI** **M.M. : 70**

Date -

General Instructions –

- All the questions are compulsory.
- There are **26** questions in total. Question Nos. **1 to 5** carry **1** mark each. Question Nos. **6 to 10** carry **2** marks each. Question Nos. **11 to 22** carry **3** marks each, question No. **23** is value based question and carries **4** marks and question Nos. **24 to 26** carry **5** marks each.
- There is no overall choice. However, an internal choice has been provided in one question of 2 marks, one question of 3 marks and all three questions of five marks each. You have to attempt only one of the given choices in such questions.
- Use of calculator is not permitted.
- You may use log book if necessary.
- **Please check that this question paper contains 03 printed pages.**

Q.1 The distance travelled by a body is directly proportional to time. Is any external force acting on it?

Q.2 How does the kinetic energy of a body change if its momentum is doubled?

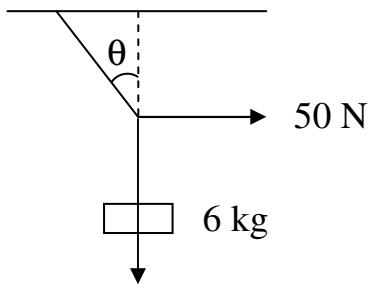
Q.3 Where does a body weigh more? At the sea level or on the mountains?

Q.4 Which fall faster – big raindrops or small rain drops and why?

Q.5 The length of a second's pendulum on the surface of earth is 1m. What will be the length of a second's pendulum on the surface of moon?

Q.6 What is the angle made by vector $\vec{A} = 2\hat{i} + 2\hat{j}$ with x-axis?

Q.7 A mass of 6kg is suspended by a rope of length 2m from a ceiling. A force of 50N in the horizontal direction is applied at the mid point of the rope as shown in the figure. What is the angle the rope makes with the vertical in equilibrium? Take g = 10 m/s^2. Neglect mass of the rope.



Q.8 Proper inflation of tyres of vehicles saves fuel. Why?

Q.9 State the work energy theorem. Prove it for a variable force acting on a body.

Q.10 A diver jumping from a spring board exhibits somersaults in air before touching the water surface, why?

OR

Define radius of gyration of a body rotating about an axis. Derive an expression for it.

Q.11 a) Two resistors of resistances R_1=100 ± 3 ohm and R_2= 200 ± 4 ohm are connected in series. Find the equivalent resistance.

b) The percentage errors in the measurement of mass and speed are 2% and 3% respectively. How much will be the maximum error in the estimate of kinetic energy obtained by measuring mass and speed?

Q.12 a) Show that for a projectile the angle between the velocity and the x-axis as a function of time is given by $\theta(t) = \tan^{-1}\frac{(u_y - gt)}{u_x}$.

b) Show that the projection angle θ for a projectile launched from the origin is given by : $\theta = \tan^{-1}\frac{(4H)}{R}$ where the symbols have their usual meaning.

Q.13 Show that two identical particles move at right angles to each other after elastic collision in two dimensions.

Q.14 Derive an expression for the centre of mass of a two particle system.

Q.15 Obtain the expression for the linear acceleration of a cylinder of radius 'R' rolling down an inclined plane. Also find the frictional force acting between the cylinder and the plane.

Q.16 Define escape velocity. Obtain an expression for the escape velocity of a body from the surface of the earth.

OR

Define gravitational potential energy of a body. Derive an expression for the gravitational potential energy of a body of mass 'm' located at distance 'r' from the centre of the earth (r>R).

Q.17 a) What is elastic potential energy?

b) Derive an expression for the elastic potential energy stored in a stretched wire under stress.

c) Prove that elastic energy density is equal to ½×stress×strain.

Q.18 A sphere of aluminium of 0.047 kg is placed for sufficient time in a vessel containing boiling water, so that the sphere is at 100^0C. It is then immediately transferred to 0.14kg copper calorimeter containing 0.25 kg of water at 20^0C. The temperature of water rises and attains a steady state at 23^0C. Calculate the specific heat capacity of aluminium. (given specific heat of copper = 0.386×10^3 J $kg^{-1}K^{-1}$)

Q.19 a) State Newton's law of cooling.

b) If a hot body at temperature θ is placed in a surrounding at temperature θ_0, deduce the relation : $\theta = \theta_0 + Ce^{-kt}$.

c) Represent Newton's law of cooling graphically.

Q.20 Define an adiabatic process. Show analytically that work done by one mole of an ideal gas during adiabatic expansion from temperature T_1 to T_2 is given by $W = \frac{R(T_1 - T_2)}{r-1}$.

Q.21 A particle executes simple harmonic motion between x = -A and x = +A. The time taken for it to go from 0 to A/2 is T_1 and to go from A/2 to A is T_2. Then, how are T_1 and T_2 related?

Q.22 The earthquakes generate sound waves inside the earth. Unlike a gas, the earth can experience both transverse (S) and longitudinal (P) sound waves. Typically the speed of S wave is about 4.0 km/sec, and that of P wave is 8.0 km/sec. A seismograph records P and S waves from an earthquake. The first P wave arrives 4 min before the first S wave. Assuming the waves travel in straight line, at what distance does the earthquake occur?

Q.23 Deepa and Shilpa were two students of class XI. Once they were discussing the law of gravitation with each other. Deepa asked Shilpa that a person sitting in a satellite feels weightlessness but a person standing on the moon has weight though moon is also a satellite of the earth. Both could not find suitable answer for this problem. They went to their physics teacher and sought answer for this question. The teacher explained the reason behind this nicely.

a) What are the values being displayed by Deepa and Shilpa?

b) What can be the possible answer for their problem?

Q.24 a) A liquid is in a streamline flow through a pipe of non-uniform cross-section. Prove that the sum of its kinetic energy, pressure energy and potential energy per unit volume remains constant throughout the flow.

b) State the law related to it.

c) The terminal velocity of a copper ball of radius 2.0 mm falling through a tank of oil at 20^0C is 6.5 cm/sec. Compute the viscosity of the oil at 20^0C. Density of oil = 1.5×10^3 kg/m^3, density of copper = 8.9×10^3 kg/m$^{3.}$

OR

a) Derive an expression for the height to which the liquid rises in a capillary tube of radius 'r'.

b) Mercury has an angle of contact equal to 140^0 with soda lime glass. A narrow tube of radius 1.00 mm made of thin glass is dipped in a trough containing mercury. By what amount does the mercury dip down in the tube relative to the liquid surface outside? Surface tension of mercury at the temperature of experiment is 0.465 N/m. Density of mercury = 13.6×10^3 kg/m^3.

Q.25 a) What is simple harmonic motion?

b) Derive expression for the instantaneous velocity of a particle executing SHM. When is the above particle velocity (i) maximum and (ii) minimum.

c) Show that the acceleration of a particle in SHM is proportional to its displacement from the mean position.

OR

Describe analytically the various modes of vibration in the case of a closed organ pipe of length L.

Q.26 a) Why $C_p > C_v$?

b) Show that $C_p - C_v = R/J$, where the symbols have their usual meanings.

OR

i) Discuss the four steps of a Carnot cycle.

ii) Show that the efficiency of a Carnot engine is given by $\eta = 1 - \frac{T_2}{T_1}$ ($T_2 < T_1$) where T_1 and T_2 are the temperature of source and sink respectively.