PT4/ANNUAL EXAMINATION, 2023-24

PHYSICS

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

Name of the student _____ Section ____ Date - 12.02.2024 (Monday)

GENERAL INSTRUCTIONS -

1. There are 33 questions in all. All questions are compulsory.
2. This question paper has five sections: Section A, Section B, Section C, Section D and Section E.
3. All the sections are compulsory.
4. Section A contains sixteen questions, twelve MCQ and four Assertion Reasoning based of 1 mark each, Section B contains five questions of two marks each, Section C contains seven questions of three marks each, Section D contains two case study based questions of four marks each and Section E contains three long answer questions of five marks each.
5. There is no overall choice. However, an internal choice has been provided in one question in Section B, one question in Section C, one question in each CBQ in Section D and all three questions in Section E. You have to attempt only one of the choices in such questions.
6. Use of calculators is not allowed.

SECTION - A

Q1. Which of the following pairs of physical quantities does not have the same dimensional formula? 1

(a) Work and torque (b) Angular momentum and Planck's constant

(c) Tension and surface tension (d) Impulse and linear momentum

Q2. The dimensional formula for universal gravitational constant is 1

(a) $[M^{-2} L^2 T^{-3}]$ (b) $[MLT^{-2}]$ (c) $[M^{-1} L^3 T^{-1}]$ (d) $[M^{-1} L^3 T^{-2}]$

Q3. Which of the following statement is false for a particle moving in a circle with a constant angular speed? 1

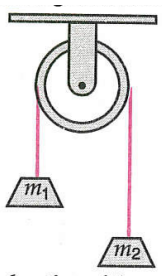
a) The velocity vector is tangent to the circle

b) The acceleration vector is tangent to the circle

c) The acceleration vector points to the centre of the circle

d) The velocity and acceleration vectors are perpendicular to each other.

Q4. Two masses m_1 = 5kg and M_2 = 4.8kg tied to a string are hanging over a light frictionless pulley. What is the acceleration of the masses, when left free to move?(Given: g= 9.8m/S^2) 1



a) 0.2m/S^2 b) 9.8m/S^2

c) 5m/S^2 d) 4.8m/S^2

Q5. A force vector applied on a mass is represented as $F = 6\hat{i} - 8\hat{j} + 10\hat{k}$ and acceleration with 1m/S^2. What will be the mass of the body? 1

a)10kg b)20kg c)$10\sqrt{2}$ kg d) $2\sqrt{10}$kg

Q6. A sphere of mass M and radius R is falling in a viscous fluid. The terminal velocity attained by the falling object will be proportional to 1

a) R^2 b)R c)1/R d)$1/R^2$

Q7. Dynamic lift is related to 1

a) Bernoulli's theorem c) Archimedes' principle

c) Equation of continuity d) Pascal's law

Q8. At which temperature, the centigrade and Fahrenheit scales are equal? 1

a) 40° b) -40° c)37° d) -80°

Q9. First law of thermodynamics corresponds to 1

a) Conservation of energy

b) Heat flow from hotter to cooler body

c) Law of conservation of angular momentum

d) Newton's law of cooling

Q10. An ant is walking on the horizontal surface. The number of degrees of freedom of ant will be: 1

a) 1 b) 2 c) 3 d) 6

Q11. The circular motion of the particle with constant speed is: 1

a) periodic but not simple harmonic b) simple harmonic but not periodic

c) periodic and simple harmonic d) neither periodic nor simple harmonic

Q12. The velocity of sound in any gas depends upon: 1

a) wavelength of sound only b) density and elasticity of gas

c) intensity of sound only d) amplitude and frequency of sound

For Question number 13 to 16, two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true and R is NOT the correct explanation of A.

c) A is true but R is false

d) A is false and R is also false

Q13. Assertion: K.E is conserved at every instant of elastic collision. 1

Reason: No deformation of matter occurs in elastic collision.

Q14. Assertion: Torque on a body can be zero even if there is a net force on it. 1

Reason: Torque and force on a body are always perpendicular.

Q15. Assertion: At the centre of earth a body has center of mass, but no center of gravity. 1

Reason: This is because g= 0 at the centre of earth.

Q16. Assertion: A body can have acceleration even if its velocity is zero at that instant of time. 1

Reason: The body will be momentarily at rest when it reverses. It's direction of motion.

SECTION - B

Q17. A Progressive wave is represented by y = A sin (ωt – kx) where *x* is distance and t is time. What are the dimensions of ω and k? 2

Q18. Find the angle between the vectors $\vec{A}= \hat{i}+2\hat{j}-\hat{k}$ and $\vec{B}= -\hat{i}+\hat{j}-2\hat{k}$. 2

Q19. If a body collides with the target body of equal mass at rest, show that the two bodies 2

move at right angles to each other after the collision.

Q20. How does acceleration due to gravity vary with depth? 2

OR

What will be the duration of the day, if earth suddenly shrinks to 1/64 of its original volume, mass remaining the same?

Q21. Eight rain drops of radius 1mm each falling down with terminal velocity of 5cm/sec coalesce to form a bigger drop. Find the terminal velocity of the bigger drop. 2

SECTION – C

Q22. The velocity of sound waves v through a medium may be assumed to depend on the density of the medium d and the modulus of elasticity E. Derive by the method of dimensions the formula for the velocity of sound. (Take the dimensional constant K=1) 3

Q23. A cricketer can throw a ball to a maximum horizontal distance of 100m. How much high above the ground can the cricketer throw the same ball? 3

Q24. On a two lane road, car A is travelling with the speed of36km/hr. Two cars B and C approach car A in opposite directions with a Speed of 54km/h each. At a certain instant, when distance AB is equal to AC, both being 1km, B decides to overtake A before C does. What minimum acceleration of car B is required to avoid an accident? 3

Q25. Define escape velocity. Obtain an expression for the escape velocity of a body from the surface of the earth. 3

Q26. Calculate the heat required to convert 3kg of ice at -12°c kept in a calorimeter to steam at 100°c at atmospheric pressure. 3

Given:

Specific heat capacity of ice= 2100 J/kg/K

Specific heat capacity of water= 4186 J/kg/K

Latent heat of fusion of ice= 3.35×10^5 J/kg

Latent heat of steam = 2.256×10^6 J/kg

Q27. Show that the average kinetic energy of a gas molecule is directly proportional to the temperature of the gas. Hence give the kinetic interpretation of temperature. 3

Q28. Show that for small oscillations the motion of a simple pendulum is simple harmonic. Derive an expression for its time period. 3

OR

Derive an expression for the time period of the horizontal oscillations of a massless loaded spring.

SECTION - D

Q29. The first law refers to the simple case when the net external force on a body is zero. The second law of motion refers to the general situation when there is a net external force acting on the body. It relates the net external force to the acceleration of the body. These qualitative observations lead to the second law of motion expressed by Newton as follows: 4

The rate of change of momentum of a body is directly proportional to the applied force and takes place in the direction in which the force acts. Thus, if under the action of a force F for time interval Δt, the velocity of a body of mass m changes from v to v + Δv i.e. its initial momentum

p = m v changes by **Δp = mΔv**. According to the Second Law

$$F \alpha \frac{\Delta P}{\Delta t} \quad \text{or} \quad F = k \frac{\Delta P}{\Delta t}$$

Where k is a constant of proportionality. Mathematically,

F = ma, the unit of force is **kg-m/s²** or Newton, which has the symbol N. Let us note at this stage some important points about the second law:

- In the second law, F = 0 implies a = 0. The second law is obviously consistent with the first law.
- The second law of motion is a vector law.
- The second law of motion given by is applicable to a single point particle as well as to the rigid body but internal forces are not considered in F.
- The second law of motion is a local relation which means that force F at a point in space (location of the particle) at a certain instant of time is related to an at that point at that instant. Answer the following questions.

i) Newton's second law of motion is applicable to which of the following?

a) Only rigid bodies

b) Only single point particles

c) Both single point particles and rigid bodies

d) Neither single point particles nor rigid bodies

ii) Which of the following statements is true regarding the second law of motion?

a) It is inconsistent with the first law of motion.

b) It only considers internal forces.

c) It is a vector law.

d) It is applicable to non-rigid bodies.

iii) If a car with a mass of 1000 kg is accelerating at 2 m/s^2, what is the net force acting on the car?

a) 500 N b) 1000 N c) 2000 N d) 5000 N

iv) Two masses of M and 4M are moving with equal kinetic energy. The ratio of their linear momenta is

(a) 1:8 (b)1:4 (c)1:2 (d) 4:1

30. Satellites in a circular orbits around the earth in the equatorial plane with T = 24 hours are called Geostationary Satellites. Clearly, since the earth rotates with the same period, the satellite would appear fixed from any point on earth. It takes very powerful rockets to throw up a satellite to such large heights above the earth but this has been done in view of the several benefits of much practical application. Weight of an object is the force with which the earth attracts it. We are conscious of our own weight when we stand on a surface, since the surface exerts a force opposite to our weight to keep us at rest. The same principle holds good when we measure the weight of an object by a Spring balance hung from a fixed point e.g. the ceiling. The object would fall down unless it is subject to a force opposite to gravity. This is exactly what the spring exerts on the object. This is because the spring is pulled down a little by the gravitational pull of the object and in turn the spring exerts a force on the object vertically upwards. 4

Now, imagine that the top end of the balance is no longer held fixed to the top ceiling of the room. Both ends of the spring as well as the object move with identical acceleration g. The spring is not stretched and does not exert any upward force on the object which is moving down with acceleration g due to gravity. The reading recorded in the spring balance is zero since the spring is not stretched at all. If the object were a human being, he or she will not feel his weight since there is no upward force on him. Thus, when an object is in free fall, it is weightless and this phenomenon is usually called the phenomenon of weightlessness. In a satellite around the earth, every part and parcel of the satellite has acceleration towards the centre of the earth which is exactly the value of earth's acceleration due to gravity at that position. Thus in the satellite everything inside it is in a state of free fall. This is just as if we were falling towards the earth from a height. Thus, in a manned satellite, people inside experience no gravity. Gravity for us defines the vertical direction and thus for them there are no horizontal or vertical directions, all directions are the same.

i) Weighing machine measures

a) Mass of the person b) Normal reaction exerted by machine on person

c) Both a and b d) None of these

ii) Time period of moon is

a) 27.3 days b) 20 days c) 85 days d) None of these

iii) Escape velocity from earth is given by

a) 20 km/s b) 11.2 km/s c) 2 km/s d) None of these

iv) Time period of geostationary satellite is

a) 24 hours b) 48 hours c) 72 hours d) None of these

SECTION - E

Q31. State Bernoulli's theorem. Derive expression for Bernoulli's equation for an incompressible, non viscous liquid flowing through a non-uniform tube. 5

OR

Derive an expression for the rise of liquid in a capillary tube and show that the height of the liquid column supported is inversely proportional to the radius of the tube.

Q32. i) Why Cp is greater than Cv? 5

ii) Using first law of thermodynamics, obtain Mayer's formula.

OR

i) Write conditions for adiabatic expansion.

ii) Derive expression for adiabatic work done during its expansion.

Q33. (i) Define SHM. 5

(ii) Find the expressions for displacement, velocity and acceleration of a particle in a SHM.

OR

i) Obtain an expression for beat frequency.

ii) The string of a violin emits a note of 400 Hz at its correct tension. The string is bit taut and produces 5 beats per second with a tuning fork of frequency 400 Hz. Find frequency of the note emitted by this taut string.