STUDENT ID | | | | | | | | | | | |

No. of pages - 24

(M)

COMMON ANNUAL SCHOOL EXAMINATION (2024-25)
CLASS : XI
SUBJECT: PHYSICS (042)

समय : 3 घंटे **अधिकतम अंक - 70**

Time Allowed : 3 hours **Maximum Marks : 70**

सामान्य निर्देश:

निम्नलिखित निर्देशों को सावधानीपूर्वक पढ़िए और उनका सख्ती से पालन कीजिए :

1. इस प्रश्न पत्र में कुल 33 प्रश्न हैं। सभी प्रश्न अनिवार्य हैं।
2. प्रश्न प्रश्न पत्र में पांच खंड हैं। क, ख, ग, घं एवं ङ।
3. खंड-क में प्रश्न संख्या 1 से 16 तक बहुविकल्पीय प्रश्न (MCQ) प्रकार के और प्रश्न हैं। प्रत्येक प्रश्न 1 अंक का है।
4. खंड-ख मं प्रश्न संख्या 17 से 21 तक अति लघु-उत्तरीय (VSA) प्रकार के पाँच प्रश्न हैं। प्रत्येक 2 अंकों का है।
5. खंड-ग में प्रश्न संख्या 22 से 28 तक लघु-उत्तरीय (SA) प्रकार के पाँच प्रश्न हैं। प्रत्येक 3 अंकों का है।
6. खंड-घ में प्रश्न संख्या 29 स 30 तक केस अध्ययन आधारित प्रश्न हैं। प्रत्येक प्रश्न 4 अंकों का है।
7. खंड-ङ में प्रश्न संख्या 31 से 33 तक दीर्घ-उत्तरीय (LA) प्रकार के प्रश्न हैं। प्रत्येक प्रश्न 5 अंकों का है।
8. प्रश्न पत्र में समग्र विकल्प नहीं दिया गया है। यद्यपि खंड-क के एक अतिरिक्त अन्य खंडों के कुछ प्रश्नों में आंतरिक विकल्प का प्रावधान दिया गया है।
9. कैलकूलेटर का उपयोग वर्जित है।

जहाँ आवश्यक हो, आप भौतिक नियतांकों के मानों का उपयोग कर सकते हैं :

$c = 3 \times 10^8$ m/s

$h = 6.63 \times 10^{-34}$ Js

$e = 1.6 \times 10^{-19}$ C

$\mu_o = 4\pi \times 10^{-7}$ TmA^{-1}

$\epsilon_o = 8.854 \times 10^{-12}$ C^2 N^{-1} M^{-2}

$\frac{1}{4\pi \epsilon_o} = 9 \times 10^9$ Nm^{2}C^{-2}

इलेक्ट्रॉन का द्रव्यमान $= 9.1 \times 10^{-31}$ kg

न्यूट्रान का द्रव्यमान $= 1.675 \times 10^{-27}$ kg

प्रोटॉन का द्रव्यमान $= 1.673 \times 10^{-27}$ kg

आवोग्रादों संख्या $= 6.023 \times 10^{23}$ per gram mole

बोल्ट्जमान नियतांक $= 1.38 \times 10^{-23}$ JK^{-1}

GENERAL INSTRUCTIONS:

Read the following questions very carefully and strictly follow them :

1. This question paper contains 33 questions. All questions are compulsory.
2. This question paper is divided into 5 sections - A, B, C, D and E.
3. In Section A – Question numbers 1 to 16 are Multiple Choice (MCQ) type questions. Each question carries 1 mark.
4. In Section B - Questions no. 17 to 21 are Very Short Answer (VSA) type questions. Each question carries 2 marks.
5. In Section C – Questions no. 22 to 28 are Short Answer (SA) type questions. Each question carries 3 marks.
6. In Section D – Questions no. 29 and 30 are Case Study-Based Questions. Each question carries 4 marks.
7. In Section E – Question no. 31 to 33 are Long Answer (A) type Questions. Each question carries 5 marks.
8. There is no overall choice given in the question paper. However, an internal choice has been proved in few question in all the sections except Section A.
9. Use of calculator is NOT allowed.

You may use the following values of physical constants where necessary.

$c = 3 \times 10^8$ m/s

$h = 6.63 \times 10^{-34}$ Js

$e = 1.6 \times 10^{-19}$ C

$\mu_o = 4\pi \times 10^{-7}$ TmA^{-1}

$\epsilon_o = 8.854 \times 10^{-12}$ C^2 N^{-1} M^{-2}

$\frac{1}{4\pi \epsilon_o} = 9 \times 10^9$ Nm^{2}C^{-2}

Mass of electron (m_e) $= 9.1 \times 10^{-31}$ kg

Mass of neutron $= 1.675 \times 10^{-27}$ kg

Mass of proton $= 1.673 \times 10^{-27}$ kg

Avogradro's number $= 6.023 \times 10^{23}$ per gram mole

Boltzman constant $= 1.38 \times 10^{-23}$ JK^{-1}

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SECTION-A

1. The dimension formula of universal gas constant is : 1

(a) $[ML^2T^{-2}K^{-1}mol^{-1}]$ (b) $[MLT^{-1}K^{-1}mol^{-1}]$

(c) $[ML^2T^{-1}K^{-1}mol^{-1}]$ (d) $[MLT^{-2}K^{-1}mol^{-1}]$

2. A ring of radius R and mass, rotating in its own plane around its centre with angular velocity w, its rotational kinetic energy is : 1

(a) $\frac{1}{2}MR\omega^2$ (b) $\frac{1}{2}MR^2\omega$

(c) $\frac{1}{2}MR^2\omega^2$ (d) $\frac{1}{2}M\omega^2$

3. As per the statement given by Kepler : all planets move in elliptical orbits with the sun situated at one of the foci of the ellipse. This statement is known as : 1

(a) Law of oribts (b) Law of areas

(c) Law of periods (d) Law of uniform motion

4. When brakes are applied to a moving vehicle, the distance it travels before stopping is called stopping distance. On doubling the initial velocity, the stopping becomes (for the same deceleration) : 1

(a) twice (b) four times

(c) eight-times (d) remain same

5. The relative viscosity of blood remains constant between : 1

(a) 0°C and 37°C (b) 38°C and 76°C

(c) 0°C and 100°C (d) for all temperatures

6. The given function of time $f(t) = \sin^2 \omega t$ is : 1

(a) periodic with a period, $T = 2\pi/\omega$

(b) periodic with a period, $T = \pi/\omega$

(c) periodic with a period, $T = \pi/\omega$ $T = \frac{\pi}{2\omega}$

(d) non-periodic

7. A wave travelling along a string is described by $y(x, t) = 0.005 \sin (80.0\ x - 3.0\ t)$, in which numerical constants are in si units. The wavelength of the wave is : 1

(a) 7.85 cm (b) 7.85 cm 78.5cm

(c) 78.5 m (d) 78.5 m

8. A bird flies prom (–2m, 3m, –4m) to (4m, –2m, –4m) in xyz coordinates. The bird's displacement is : 1

(a) $(2\hat{i} + \hat{j} - 8\hat{k})$m (b) $(6\hat{i} - 5\hat{j})$m

(c) $(2\hat{i} + \hat{j})$m (d) $(6\hat{i} + 5\hat{j} - 8\hat{k})$m

9. The force acting on a body of mass 2 kg is $(2\hat{i} + 2\hat{j} - \hat{k})$N. If the body is initially at rest, then the magnitude of velocity at the end of 4 seconds will be : 1

(a) 3 m/s (b) 4 m/s

(c) 6 m/s (d) 10 m/s

10. If momentum of a body is increased by 20%, then its kinetic energy increases by : 1

(a) 40% (b) 44%

(c) 36% (d) 52%

11. Two wires are made of the same material and have the same volume. The first wire has cross-sectional area A and the second wire has cross-sectional area 3A. If the length of the first wire is increased by $\Delta\ell$ on applying a force F, how much force is needed to stretch the second wire by the same amount? 1

(a) F (b) 4F

(c) 6F (d) 9F

12. The pressure of a gas is increased by 25% at constant temperature. The decrease in volume will be : 1

(a) 80% (b) 50%

(c) 25% (d) 20%

Question number 13 to 16 are Assertion (A) and Reason (R) type questions. Two statements are given,– One labelled Assertion (A) and the other labelled Reason (R). Select the correct answer from the codes (a), (b), (c) and (d) as given below :

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

(b) Both Assertion (A) and Reason (R) are true and (R) is the not correct explanation of Assertion (A).

(c) Assertion (A) is true and Reason (R) is false.

(d) Assertion (A) is false and Reason (R) is also false.

13. Assertion (A): Slope of momentum – time graph gives impulse.

Reason (R): Impulse is given by the rate of change of momentum with time. 1

14. Assertion (A): Torque is the time rate of change of a parameter, called angular momentum.

Reason (R): This is because in linear motion, force represents time rate of change of angular momentum. 1

15. Assertion (A): Steel is more elastic than rubber.

Reason (R): For the given force, more strain and produced in rubber than in steel. 1

16. Assertion (A): Snow is better insulator than ice.

Reason (R): Snow contains air packets and air is insulator of heat. 1

SECTION-B

17. A calorie is a unit of heat or energy and it equals about 4.2 J, where 1 J = 1 kg m^2 s^{-2}. Suppose we employ a system of units in which the unit of mass equals 10 kg, the unit of length equals 10 m the unit of time is 10 s. Find the magnitude of a calorie in the new system of units. 2

18. An electron and a proton are detected in a cosmic ray experiment. The first with kinetic energy 10 keV, and the second with 100 keV. Obtain the ratio of their speeds, if proton is roughly 1836 times heavier than the election. 2

19. Two buses P and Q are at positions 50 m and 150 m from the origin at time t = 0, they start moving in the same direction simultaneously with uniform speed 54 km/h and 36 km/h. Determine the time and position at which P overtaken Q. 2

OR

A person travels along a straight road for the first half distance with a velocity x and the second half distance with velocity y. Find the average velocity of the person for entire journey.

20. Derive an expression for the acceleration due to gravity of earth at a height 'h' above the surface of the earth. 2

21. The position of a particle is given by :

$\vec{r} = 3t\hat{i} - 2t^2\hat{j} + 5\hat{k}$, where t, is in second and the coefficients have the proper units for $\vec{r}$ to be in metre. Find magnitude and direction of acceleration. 2

SECTION-C

22. A particle of mass m oscillates in simple harmonic motion. The displacement x of the particle from origin varies with time as: $x(t) = A \cos(\omega t + \phi)$, where A, ω and ϕ are constants. Find the expression for total energy in simple harmonic motion. 3

23. (a) What do you mean by the radius of gyration of a body.

(b) Find the radius gyration of :

(i) a thin rod of length ℓ, w.r.t. an axis perpendicular to the rod and passing through its mid-point. The moment of inertia of this rod about the given axis is $\frac{1}{12}m\ell^2$, where m is mass of the rod. 3

(ii) a circular disc of radices r and mass m about its diameter. The moment of inertia of this circular disc about diameter is $\frac{1}{4}mr^2$. 3

24. A bird flies for 4 s with a velocity $v = (t - 1)$ m/s in a straight line. Calculate :

(a) acceleration at $t = 2$ s, is it uniform, or non uniform?

(b) the displacement of the bird in 4 s. 3

25. A particle moves in x – y plane as $x = 2\sin 4t$ and $y = 2(1 - \cos 4t)$. Find :

(a) magnitude of the velocity of the particle at $t = 2s$

(b) displacement of the particle in 4 seconds, when x and y are in metre. 3

OR

A projectile is thrown at an angle θ from ground with initial speed u. Find the expression for

(a) horizontal range.

(b) magnitude of velocity of the projectile at instant of time 't' magnitude of.

26. (a) State first law of thermodynamics

(b) If 320 J of work is done on a system and 70 cal of heat is extracted from the system. What is the increase / decrease in internal energy of the system? 3

27. (a) Two balls A and B are moving initially along the same straight line, After collision they continue to is move along the same straight line, if the collision is elastic and their masses are equal then show that their velocities are just interchanged.

(b) A body moving with some initial velocity collide with another body initially at rest. After the collision, the two bodies move together with a common velocity. Which type of collision is this? Is momentum conserved in this collision? 3

28. (a) Derive an expression for the speed given to a satellite required to put it in an orbit around the earth.

(b) A satellite is orbiting very close to the surface of planet. Find the orbital speed of the satellite of the radius of the planet is 1.6×10^6 m and acceleration due to gravity on that planet is 6.4 m/s^2. 3

SECTION-D

Question numbers 29 and 30 are case study-based questions. Read the following paragraphs and answer the questions that follow.

29. Consider an ideal gas is enclosed in a container. The molecules of the gas are in incessant random motion, colliding against one another and with the walls of the container. All collisions between molecules among themselves or between molecules and the walls are elastic. This implies that the total kinetic energy and total momentum both are conserved. The pressure exerted by the gas is directly related to the number of molecules and the mean of squared speed. The average kinetic energy of a molecule is proportional to the absolute temperature of the gas. 4

(i) The average kinetic energy of a gas molecule is related to the temperature as:

(a) αT (b) $\alpha \frac{1}{T}$

(c) $\alpha \sqrt{T}$ (d) Independent

(ii) When the temperature of the gas is increased, the pressure of the gas :

(a) increases (b) decreases

(c) remains same (d) first increases and then decreases

OR

If the pressure is increased, the average kinetic energy of a gas molecule :

(a) increases (b) decreases

(c) remains same (d) first decreases then increases

(iii) The temperature at which average kinetic energy of the gas molecules becomes almost zero is :

(a) 0°C (b) 273°C

(c) 0K (d) –273K

(iv) The internal energy of an ideal gas depends on :

(a) temperature only (b) pressure only

(c) volume only (d) temperature, pressure and volume

30. When a body falls through a its viscous medium, its velocity increases due to gravity. An opposing various drag which acts upwards also on increasing with velocity. Finally a stage is reached, when viscous force plus buoyant force becomes equal to force due to gravity. At this stage, there is no net force to accelerate the body. Now the body moves with constant velocity, called terminal velocity.

If a rain drop of radius r, density ρ falls through a viscous medium of density σ and coefficient of viscosity η, then the terminal velocity acquired by the rain drop is : 4

$$v_t = \frac{2r^2(\rho - \sigma)}{p\eta} g$$

(i) The terminal velocity of a rain drop with which it is falling is v, if the diameter of the drop is halved, then the new terminal velocity will be :

(a) v (b) v/2

(c) v/4 (d) 2v

(ii) If the radius of drop and coefficient of viscosity both are doubled, the new terminal velocity will be :

(a) same (b) doubled

(c) quadruple (d) halved

(iii) A rain drop is falling freely in a viscous medium. When net force on the rain drop becomes zero it will :

(a) move with constant velocity downwards

(b) move with constant velocity upwards

(c) move with constant velocity horizontally

(d) not move and become stops

(iv) The diameters of two rain drops are in the ratio 2:3. They fall through water, the ratio of their terminal velocities is :

(a) 2:3 (b) 4:9

(c) 3:2 (d) 1:1

OR

If n identical rain droplets falling through air with equal steady velocity v. They coalesce to force a bigger drop, the terminal velocity of big drop formed will be :

(a) nv (b) $n^{1/3}v$

(c) $n^{2/3}v$ (d) $n^{4/3}v$

SECTION-E

31. (a) State Bernoulli's principle and prove its equation.

(b) If the fluid is at rest, write Bernoulli's equation. 5

OR

(a) What do you mean by angle of contact? Write two factors on which it depends.

(b) Derive the expression of excess of pressure inside a soap bubble.

32. Explain mathematically the formation of standing waves. Discuss briefly the normal modes of vibration in a stretched string.

OR

A wave is expressed by the equation :

$y(x, t) = 0.5 \sin \pi (0.01\, x - 3t)$, where all quantities are in SI units. Find :

(a) wavelength and frequency of the wave

(b) speed of propagation

(c) particle velocity (at $x = 100$ m and $t = \frac{1}{6}$ s)

33. (a) The driver of a car travelling with a speed V suddenly notices a brick wall in front of him at a distance 'd'. Which is better for him to apply brakes or to make a circular turn of radius 'd' without applying brakes in order to just crashing into the wall? Justify your answer.

(b) A machine gun has amass of 25 kg. It fires 20 g bullets at the rate of 200 bullets per second at a speed of 300m/s. What force must be applied on the given to keep it in position? 5

OR

(a) State Newton's 2nd law of motion.

(b) Find the expression for potential energy of deformed (stretched or compressed) spring. Show that spring force is a conservative force.

(c) Why do blades of an electric fan continue to rotate for some tine, after the current is switched off?