# PHYSICS - 1999

## PART - A

**Directions :** *Select the most appropriate alternative a, b, c & d in questions 1-25*

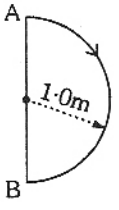
**1.** A closed compartment containing gas is moving with some acceleration in horizontal direction. Neglect effect of gravity. Then the pressure in the compartment is :

(A) same everywhere (B) lower in front side
(C) lower in rear side (D) lower in upper side.

**2.** The ratio of the speed of sound in nitrogen gas to that in helium gas at 300K is :

(A) $\sqrt{2/7}$ (B) $\sqrt{1/7}$
(C) $\sqrt{3}/5$ (D) $\sqrt{6}/5$

**3.** In 1·0S, a particle goes from point A to point B, moving in a semicircle (see figure). The magnitude of the average velocity is :

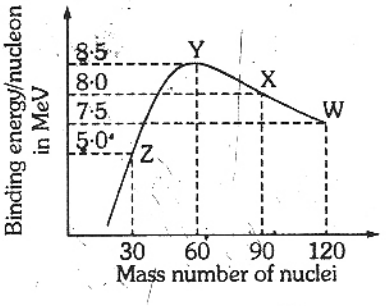



(A) 3·14 m/s (B) 2·0 m/s
(C) 1·0 m/s (D) zero

**4.** A charged particle is released from rest in a region of steady and uniform electric and magnetic fields which are parallel to each other. The particle will move in a :

(A) straight line (B) circle
(C) helix (D) cycloid

**5.** Binding energy per nucleon Vs mass number curve for nuclei is shown in figure. W, X, Y and Z are four nuclei indicated on the curve. The process that would release energy is :




(A) $Y \rightarrow 2Z$
(B) $W \rightarrow X + Z$
(C) $W \rightarrow 2Y$
(D) $X \rightarrow Y + Z$

**6.** Order of magnitude of density of uranium nucleus is ($m_p = 1.67 \times 10^{-27}$ kg) :

(A) $10^{20}$ kg/m$^3$ (B) $10^{17}$ kg/m$^3$
(C) $10^{14}$ kg/m$^3$ (D) $10^{11}$ kg/m$^3$

**7.** Two identical circular loops of metal wire are lying on a table without touching each other. Loop A carries a current which increases with time. In response, the loop B :

(A) remains stastionery
(B) is attracted by the loop A
(C) is repelled by the loop A
(D) rotates about its CM, with CM fixed.

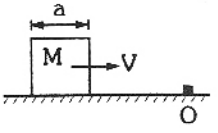
**8.** A spring of force constant K is cut into two pieces such that one piece is double the length of the other. Then the long piece will have a force constant of :

(A) 2/3 K (B) 3/2 K
(C) 3 K (D) 6 K

**9.** $^{22}Ne$ nucleus, after absorbing energy, decays into two $\alpha$-particles and an unknown nucleus. The unknown nucleus is :

(A) nitrogen (B) carbon
(C) boron (D) oxygen.

**10.** A cubical block of side a moving with velocity V on a horizontal smooth plane as shown. It hits a ridge at point O. The angular speed of the block after it hits O is :




(A) 3V/4a (B) 3V/2a
(C) $\sqrt{3}V/\sqrt{2}a$ (D) zero

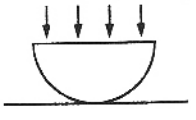
**11.** Yellow light is used in a single slit diffraction experiment with slit width of 0·6 mm. If yellow light is replaced by X-rays, then the observed pattern will reveal :

(A) that the central maximum is narrower
(B) more number of fringes
(C) less number of fringes
(D) no diffraction pattern

**12.** Two identical metal plates are given positive charges $Q_1$ and $Q_2$ $(< Q_1)$ respectively. If they are now brought close together to form a parallel plate capacitor with capacitance C, the potential difference between them is :

(A) $(Q_1 + Q_2)/2C$ (B) $(Q_1 + Q_2)/C$
(C) $(Q_1 - Q_2)/C$ (D) $(Q_1 - Q_2)/2C$

**13.** A thin slice is cut out of a glass cylinder along a plane parallel to its axis. The slice is placed on a flat plate as shown. The observed interference fringes from this combination shall be :

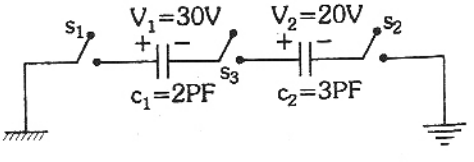


(A) straight
(B) circular
(C) equally spaced
(D) having fringe spacing which increases as we go outwards.

**14.** A coil of inductance 8.4 mH and resistance 6Ω is connected to a 12V battery. The current in the coil is 1.0A at approximately the time :

(A) 500 s (B) 20 s
(C) 35 ms (D) 1 ms

**15.** For the circuit shown, which of the following statements is true :




(A) With $S_1$ closed,
$V_1 = 15V, V_2 = 20V$
(B) With $S_3$ closed,
$V_1 = V_2 = 25V$
(C) With $S_1$ and $S_2$ closed, $V_1 = V_2 = 0$
(D) With $S_1$ and $S_3$ closed, $V_1 = 30V$, $V_2 = 20V$

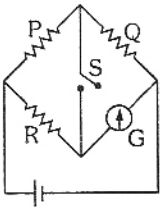
**16.** A concave lens of glass, refractive index 1.5 has both surfaces of same radius of curvature R. On immersion in a medium of refractive index 1.75, it will behave as a :

(A) Convergent lens of focal length 3.5 R
(B) Convergent lens of focal length 3.0 R
(C) divergent lens of focal length 3.5 R
(D) divergent lens of focal length 3.0 R

**17.** A gas mixture consists of 2 moles of oxygen and 4 moles of argon at temperature T. Neglecting all vibrational modes, the total internal energy of the system is :

(A) 4 RT (B) 15 RT
(C) 9 RT (D) 11 RT

**18.** In the circuit shown $P \neq R$, the reading of galvonometer is same with switch S open or closed. Then :




(A) $I_R = I_G$
(B) $I_P = I_G$
(C) $I_Q = I_G$
(D) $I_Q = I_R$

**19.** A smooth sphere A is moving on a frictionless horizontal plane with angular velocity $\omega$ and centre of mass velocity v. It collides elastically and head on with an identical sphere B at rest. Neglect friction everywhere. After the collision, their angular speeds are $\omega_A$ and $\omega_B$ respectively. Then :

(A) $\omega_A < \omega_B$ (B) $\omega_A = \omega_B$
(C) $\omega_A = \omega$ (D) $\omega_B = \omega$

**20.** In hydrogen spectrum the wavelength of $H_\alpha$ line is 656 nm; whereas in the spectrum of a distant galaxy $H_\alpha$ line wavelength is 706 nm. Estimated speed of galaxy with respect to earth is :

(A) $2 \times 10^8$ m/s (B) $2 \times 10^7$ m/s
(C) $2 \times 10^6$ m/s (D) $2 \times 10^5$ m/s

**21.** A particle free to move along the x-axis has potential energy given by $U(x) = K[1 - \exp(-x^2)]$ for $-\infty \leq x \leq +\infty$ where K is a positive constant of appropriate dimensions. Then :

(A) At points away from the origin, the particle is in unstable equilibrium
(B) For any finite non-zero value of x, there is a force directed away from the origin
(C) If its total mechanical energy is K/2, it has its minimum kinetic energy at the origin.
(D) For small displacements from x = 0, the motion is simple hormonic

**22.** A particle of mass M at rest decays into two particles of masses $m_1$ and $m_2$ having non-zero velocities. The ratio of the de-Broglie wavelengths of the particles $\lambda_1/\lambda_2$ is :

(A) $m_1/m_2$ (B) $m_2/m_1$
(C) 1.0 (D) $\sqrt{m_2}/\sqrt{m_1}$

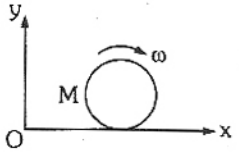
**23.** A circular loop of radius R, carrying current I, lies in x-y plane with its centre at the origin. The total magnetic flux through x-y plane is :

(A) directly proportional to I
(B) directly proportional to R
(C) directly proportional to $R^2$
(D) zero

**24.** Which of the following is a correct statement :

(A) Beta rays are same as cathode rays
(B) Gamma rays are high energy neutrons
(C) Alpha particles are singly ionized helium atoms
(D) Protons and neutrons have exactly the same mass.

**25.** A disc of mass M and radius R is rolling with angular speed $\omega$ on a horizontal plane as shown. The magnitude of angular momentum of the disc about the origin O is :




(A) $\left(\frac{1}{2}\right) MR^2\omega$
(B) $MR^2\omega$
(C) $\left(\frac{3}{2}\right) MR^2\omega$
(D) $2\ MR^2\omega$

**Directions** : *Question numbers 26–35 carry 3 marks each and may have more than one correct answers. All correct answers must be marked to get any credit in these questions.*

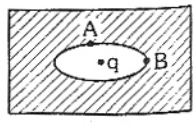
**26.** The coordinates of a particle moving in a plane are given by x (t) = a cos(pt) and y (t) = b sin (pt) where a, b (< a) and p are positive constants of appropriate dimensions. Then :

(A) the path of the particle is an ellipse
(B) the velocity and acceleration of the particle are normal to each other at $t = \pi/2p$
(C) the acceleration of the particle is always directed towards a focus
(D) the distance travelled by the particle in time interval t = 0 to $t = \pi/2p$ is a.

**27.** The half-life period of a radioactive element X is same as the mean life time of another radioactive element Y. Initially both of them have the same number of atoms. Then :

(A) X and Y have the same decay rate initially
(B) X and Y decay at the same rate always
(C) Y will decay at a faster rate than X
(D) X will decay at faster rate than Y

**28.** An elliptical cavity is carved within a perfect conductor. A positive charge q is placed at the centre of the cavity. The points A and B are on the cavity surface as shown in the figure. Then :




(A) electric field near A in the cavity = electric field near B in the cavity
(B) charge density at A = charge density at B
(C) potential at A = potential at B
(D) total electric field flux through the surface of the cavity is $q/\epsilon_0$.

**29.** Three simple harmonic motions in the same direction having the same amplitude and same period are superposed. If each differ in phase from the next by 45°, then :
(A) the resultant amplitude is $(1 + \sqrt{2})\, a$
(B) the phase of the resultant motion relative to the first is 90°
(C) the energy associated with the resulting motion is $(3 + 2\sqrt{2})$ times the energy associated with any single motion
(D) the resulting motion is not simple harmonic

**30.** As a wave propagates :
(A) the wave intensity remains constant for a plane wave
(B) the wave intensity decreases as the inverse of the distance from the source for a spherical wave
(C) the wave intensity decreases as the inverse square of the distance from the source for a spherical wave
(D) total intensity of the spherical wave over the spherical surface centered at the source remains constant at all times.

**31.** A bimetallic strip is formed out of two identical strips – one of copper and the other of brass. The coefficients of linear expansion of the two metals are $\alpha_C$ and $\alpha_B$. On heating, the temperature of the strip goes up by $\Delta T$ and the strip bends to form an arc of radius of curvature R. Then R is :
(A) proportional to $\Delta T$
(B) inversely proportional to $\Delta T$
(C) proportional to $|\alpha_B - \alpha_C|$
(D) inversely proportional to $|\alpha_B - \alpha_C|$

**32.** When a potential difference is applied across, the current passing through :
(A) an insulater at 0 K is zero
(B) a semiconductor at 0 K is zero
(C) a metal at 0 K is finite
(D) a p-n diode at 300 K is finite if it is reverse biased.

**33.** $Y(x, t) = \dfrac{0 \cdot 8}{[(4x + 5t)^2 + 5]}$ represents a moving pulse where x and y are in metres and t in second. Then :
(A) pulse is moving in positive x direction
(B) in 2s it will travel a distance of 2.5 m
(C) its maximum displacement is 0.16 m
(D) it is a symmetric pulse

**34.** In a wave motion $y = a \sin (Kx - \omega t)$, y can represent :
(A) electric field
(B) magnetic field
(C) displacement
(D) pressure.

**35.** Standing waves can be produced :
(A) on a string clamped at both ends
(B) on a string clamped at one end and free at the other
(C) when incident wave gets reflected from a wall
(D) when two identical waves with a phase difference of $\pi$ are moving in the same direction.

# ANSWERS

| | | | | | |
|---|---|---|---|---|---|
| **1.** B, | **2.** C, | **3.** B, | **4.** A, | **5.** C, | **6.** B, |
| **7.** C, | **8.** B, | **9.** B, | **10.** A, | **11.** D, | **12.** D, |
| **13.** A, | **14.** D, | **15.** D, | **16.** A, | **17.** D, | **18.** A, |
| **19.** C, | **20.** B, | **21.** D, | **22.** C, | **23.** D, | **24.** A, |
| **25.** C, | **26.** A, B, C, | **27.** C, | **28.** C, D, | **29.** A, C, | **30.** A, C, D, |
| **31.** B, D, | **32.** A, B, D, | **33.** B, C, D, | **34.** A, B, C, D, | | **35.** A, B, C. |

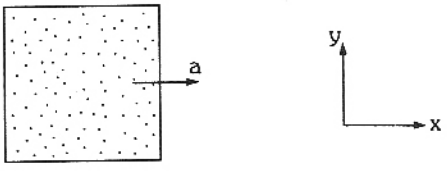
# SOLUTIONS

**1. (B)**

If a fluid (gas or liquid) is accelerated in positive x-direction, then pressure decreases in positive x-direction. Change in pressure has following differential equation—

$$\frac{dP}{dx} = -\rho a$$

where $\rho$ is the density of the fluid. Therefore, pressure is lower in front side.




**2. (C)**

Speed of sound in an ideal gas is given by

$$V = \sqrt{\frac{\gamma RT}{M}}$$

$$\therefore \quad V \propto \sqrt{\frac{\gamma}{M}} \qquad \text{[T is same for both the gases]}$$

$$\therefore \quad \frac{V_{N_2}}{V_{He}} = \sqrt{\frac{\gamma_{N_2}}{\gamma_{H_e}} \cdot \frac{M_{H_e}}{M_{N_2}}}$$

$$= \sqrt{\frac{(7/5)}{(5/3)}\left(\frac{4}{28}\right)}$$

$$= \sqrt{3}/5$$

$$\gamma_{N_2} = 7/5 \qquad \text{(Diatomic)}$$

$$\gamma_{He} = 5/3 \qquad \text{(Monoatomic)}$$

**3. (B)**

$$|\text{ average velocity }| = \left|\frac{\text{Displacement}}{\text{time}}\right| = \frac{AB}{\text{time}} = \frac{2}{1} = 2\text{m/s}$$

**4. (A)**

The charged particle will be accelerated parallel (if it is a positive charge) or antiparallel (if it is a negative charge) to the electric field, i.e., the charged particle will move parallel or antiparallel to electric and magnetic field. Therefore net magnetic force on it will be zero and its path will be a straight line.