

# JEE Main 2019 Paper 1 (B.E./B.Tech) 8 April 2019 Shift 1 Question Paper



Conducted by the National Testing Agency (NTA)

**Time Allowed: 3 Hours**

**Paper 1: B.E./B.Tech.**

**Maximum Marks: 360**

## General Instructions

- (i) This paper is **Paper 1 (B.E./B.Tech.)** of **JEE (Main) 2019 - Session 2**, conducted by the National Testing Agency (NTA) in Computer Based Test (CBT) mode on 8 April 2019, Shift 1. The total duration is **3 hours**.
- (ii) The paper has **90 questions** and a maximum of **360 marks**: Mathematics, Physics and Chemistry carry 30 questions (120 marks) each, in that order.
- (iii) Each subject has **30 multiple choice questions** (MCQs), with four options each. Select the most appropriate answer.
- (iv) **All questions are compulsory**. Use only the constants given in the question while calculating.
- (v) **Marking scheme**: **+4** for a correct answer, **-1** for an incorrect answer, and **0** for an unanswered or marked-for-review question.
- (vi) All calculations and rough work are to be done on the rough sheets only. Calculators, log tables, slide rules and electronic gadgets are not allowed.

1.

$$\int \frac{\sin \frac{5x}{2}}{\sin \frac{x}{2}} dx$$

is equal to

(where c is a constant of integration)

- (A)  $2x + \sin x + 2\sin 2x + c$  (B)  $x + 2\sin x + \sin 2x + c$   
 (C)  $x + 2\sin x + 2\sin 2x + c$  (D)  $2x + \sin x + \sin 2x + c$

2. The mean and variance of seven observations are 8 and 16, respectively. If 5 of the observations are 2, 4, 10, 12, 14, then the product of the remaining two observations is :

- (A) 40 (B) 48  
 (C) 49 (D) 45

3. The greatest value of  $c \in \mathbb{R}$  for which the system of linear equations

$$x - cy - cz = 0$$

$$cx - y + cz = 0$$

$$cx + cy - z = 0$$

has a non-trivial solution, is :

- (A) -1 (B) 0  
 (C)  $1/2$  (D) 2

4. The sum of all natural numbers 'n' such that  $100 < n < 200$  and H.C.F. (91, n) > 1 is :

- (A) 3221 (B) 3121  
 (C) 3203 (D) 3303

5. The sum of the squares of the lengths of the chords intercepted on the circle,  $x^2 + y^2 = 16$ , by the lines,  $x + y = n$ ,  $n \in \mathbb{N}$ , where  $\mathbb{N}$  is the set of all natural numbers, is :

- (A) 210 (B) 160  
 (C) 320 (D) 105

6. A point on the straight line,  $3x + 5y = 15$  which is equidistant from the coordinate axes will lie only in :

- (A) 1<sup>st</sup> and 2<sup>nd</sup> quadrants (B) 4<sup>th</sup> quadrant  
 (C) 1<sup>st</sup> and 2<sup>nd</sup> and 4<sup>th</sup> quadrants (D) 1<sup>st</sup> quadrant

7. If  $\cos(\alpha + \beta) = 3/5$ ,  $\sin(\alpha - \beta) = 5/13$  and  $0 < \alpha, \beta < \frac{\pi}{4}$ , then  $\tan(2\alpha)$  is equal to :

- (A)  $21/16$  (B)  $63/52$   
 (C)  $33/52$  (D)  $63/16$

8. Let  $y = y(x)$  be the solution of the differential equation,

$$(x^2 + 1)^2 \frac{dy}{dx} + 2x(x^2 + 1)y = 1$$

such that  $y(0) = 0$ . If  $\sqrt{a}y(1) = \frac{\pi}{32}$ , then the value of 'a' is :

- (A)  $\frac{1}{2}$   
 (B)  $\frac{1}{16}$   
 (C) 1  
 (D)  $\frac{1}{4}$

9. The sum of the solutions of the equation

$$|\sqrt{x} - 2| + \sqrt{x} (\sqrt{x} - 4) + 2 = 0$$

( $x > 0$ ) is equal to:

- (A) 9 (B) 12  
 (C) 4 (D) 10

10. If

$$f(x) = \log_e \left( \frac{1-x}{1+x} \right)$$

,

$$|x| < 1$$

then

$$f\left(\frac{2x}{1+x^2}\right)$$

is equal to

- (A)  $2f(x^2)$  (B)  $2f(x)$   
(C)  $(f(x))^2$  (D)  $-2f(x)$

11. Let  $f : [0, 2] \rightarrow \mathbb{R}$  be a twice differentiable function such that  $f''(x) > 0$ , for all  $x \in (0, 2)$ . If  $\phi(x) = f(x) + f(2-x)$ , then  $\phi$  is :

- (A) decreasing on  $(0, 2)$  (B) decreasing on  $(0, 1)$  and increasing on  $(1, 2)$   
(C) increasing on  $(0, 2)$  (D) increasing on  $(0, 1)$  and decreasing on  $(1, 2)$

12. Let  $O(0, 0)$  and  $A(0, 1)$  be two fixed points. Then the locus of a point  $P$  such that the perimeter of  $\triangle AOP$  is 4, is :

- (A)  $9x^2 + 8y^2 - 8y = \frac{16}{18}$  (B)  $8x^2 - 9y^2 + 9y = \frac{18}{16}$   
(C)  $8x^2 + 9y^2 - 9y = \frac{18}{16}$  (D)  $9x^2 - 8y^2 + 8y = \frac{16}{18}$

13.

$$\lim_{x \rightarrow 0} \frac{\sin^2 x}{\sqrt{2} - \sqrt{1 + \cos x}}$$

equals:

- (A)  $\sqrt{2}$   
(B)  $2\sqrt{2}$   
(C) 4  
(D)  $4\sqrt{2}$

14. If  $\alpha$  and  $\beta$  be the roots of the equation  $x^2 - 2x + 2 = 0$ , then the least value of  $n$  for which

$$\left(\frac{\alpha}{\beta}\right)^n = 1$$

is :

- (A) 2 (B) 5  
(C) 4 (D) 3

15. The length of the perpendicular from the point  $(2, -1, 4)$  on the straight line,

$$\frac{x+3}{10}$$

=

$$\frac{y-2}{-7}$$

$= \frac{z}{1}$  is :

- (A) less than 2 (B) greater than 4  
(C) greater than 2 but less than 3 (D) greater than 3 but less than 4

16. Let  $A$  and  $B$  be two non-null events such that  $A \subset B$ . Then, which of the following statements is always correct?

- (A)  $P(A|B) = 1$  (B)  $P(A|B) = P(B) - P(A)$   
(C)  $P(A|B) \leq P(A)$  (D)  $P(A|B) \geq P(A)$

17. All possible numbers are formed using the digits 1, 1, 2, 2, 2, 2, 3, 4, 4 taken all at a time. The number of such numbers in which the odd digits occupy even places is :

- (A) 175 (B) 162  
(C) 160 (D) 180

18. Let

$$A = \begin{pmatrix} \cos \alpha & -\sin \alpha \\ \sin \alpha & \cos \alpha \end{pmatrix}$$

, ( $\alpha \in \mathbb{R}$ )  
such that

$$A^{32} = \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$$

then a value of  $\alpha$  is

(A) 0

(B)  $\frac{\pi}{16}$

(C)  $\frac{\pi}{32}$

(D)  $\frac{\pi}{64}$

19. The area (in sq. units) of the region

$A = \{ (x, y) \in \mathbb{R} \times \mathbb{R} \mid 0 \leq x \leq 3, 0 \leq y \leq 4, y \leq x^2 + 3x \}$  is :

(A)  $\frac{59}{6}$

(B)  $\frac{26}{3}$

(C) 8

(D)  $\frac{53}{6}$

20. If

$$\alpha = \cos^{-1}\left(\frac{3}{5}\right)$$

,

$$\beta = \tan^{-1}\left(\frac{1}{3}\right)$$

where

$$0 < \alpha, \beta < \frac{\pi}{2}$$

, then  $\alpha - \beta$  is equal to :

(A)  $\tan^{-1}\left(\frac{9}{14}\right)$

(B)  $\sin^{-1}\left(\frac{9}{5\sqrt{10}}\right)$

(C)  $\cos^{-1}\left(\frac{9}{5\sqrt{10}}\right)$

(D)  $\tan^{-1}\left(\frac{9}{5\sqrt{10}}\right)$

21. If  $S_1$  and  $S_2$  are respectively the sets of local minimum and local maximum points of the function,

$f(x) = 9x^4 + 12x^3 - 36x^2 + 25$ ,  $x \in \mathbb{R}$ , then :

(A)  $S_1 = \{-1\}$ ;  $S_2 = \{0, 2\}$  (B)  $S_1 = \{-2\}$ ;  $S_2 = \{0, 1\}$

(C)  $S_1 = \{-2, 0\}$ ;  $S_2 = \{1\}$  (D)  $S_1 = \{-2, 1\}$ ;  $S_2 = \{0\}$

22. If

$$f(x) = \frac{2 - x \cos x}{2 + x \cos x}$$

and  $g(x) = \log_e x$ , ( $x > 0$ ) then the value of integral

$$\int_{-\frac{\pi}{4}}^{\frac{\pi}{4}} g(f(x)) dx$$

is

(A)  $\log_e 3$

(B)  $\log_e 2$

(C)  $\log_e 1$

(D)  $\log_e e$

23. If

$$2y = \left( \cot^{-1} \left( \frac{\sqrt{3} \cos x + \sin x}{\cos x - \sqrt{3} \sin x} \right) \right)^2$$

,  
 $x \in$

$$\left( 0, \frac{\pi}{2} \right)$$

then

$$\frac{dy}{dx}$$

is equal to:

(A)  $2x - \frac{\pi}{3}$

(B)  $\frac{\pi}{6} - x$

(C)  $\frac{\pi}{3} - x$

(D)  $x - \frac{\pi}{6}$

24. The magnitude of the projection of the vector

$$\frac{\hat{i}}{2} + \frac{\hat{j}}{3} + \frac{\hat{k}}{6}$$

on the vector perpendicular to the plane containing the vectors  $\hat{i} + \hat{j} + \hat{k}$  and

$$\frac{\hat{i}}{2} + \frac{\hat{j}}{3} + \frac{\hat{k}}{6}$$

, is :

- (A)  $\frac{\sqrt{3}}{2}$   
 (B)  $\sqrt{6}$   
 (C)  $\sqrt{\frac{3}{2}}$   
 (D)  $3\sqrt{6}$

25. The shortest distance between the line  $y = x$  and the curve  $y^2 = x - 2$  is :

- (A)  $\frac{7}{4\sqrt{2}}$   
 (B)  $\frac{7}{8}$   
 (C)  $\frac{11}{4\sqrt{2}}$   
 (D) 2

26. The sum of the co-efficients of all even degree terms in  $x$  in the expansion of  $(x + \sqrt{x^3 - 1})^6 + (x - \sqrt{x^3 - 1})^6$ , ( $x > 1$ ) is equal to:

- (A) 32 (B) 26  
 (C) 29 (D) 24

27. The sum of the series

$$2 \cdot {}^{20}C_0 + 5 \cdot {}^{20}C_1 + 8 \cdot {}^{20}C_2 + 11 \cdot {}^{20}C_3 + \dots + 62 \cdot {}^{20}C_{20}$$

is equal to :

- (A)  $2^{25}$  (B)  $2^{24}$   
 (C)  $2^{26}$  (D)  $2^{23}$

28. The contrapositive of the statement "If you are born in India, then you are a citizen of India", is :

- (A) If you are not a citizen of India, then you are not born in India. (B) If you are born in India, then you are not a citizen of India.  
 (C) If you are a citizen of India, then you are born in India. (D) If you are not born in India, then you are not a citizen of India.

29. The equation of a plane containing the line of intersection of the planes  $2x - y - 4 = 0$  and  $y + 2z - 4 = 0$  and passing through the point (1, 1, 0) is :

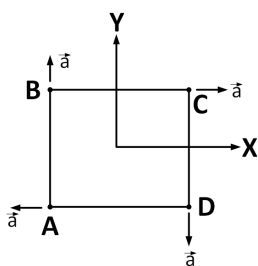
- (A)  $x - 3y - 2z = -2$  (B)  $2x - z = 2$   
 (C)  $x - y - z = 0$  (D)  $x + 3y + z = 4$

30. If the tangents on the ellipse  $4x^2 + y^2 = 8$  at the points (1, 2) and (a, b) are perpendicular to each other, then  $a^2$  is equal to :

- (A)  $\frac{2}{17}$   
 (B)  $\frac{64}{17}$   
 (C)  $\frac{128}{17}$   
 (D)  $\frac{4}{17}$

## Physics - Multiple Choice Questions

**31.** Four particles A, B, C and D with masses  $m_A = m$ ,  $m_B = 2m$ ,  $m_C = 3m$  and  $m_D = 4m$  are at the corners of a square. They have accelerations of equal magnitude with directions as shown. The acceleration of the centre of mass of the particles is :

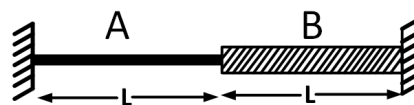


- (A)  $\frac{a}{5}(\hat{i} + \hat{j})$   
 (B)  $\frac{a}{5}(\hat{i} - \hat{j})$   
 (C)  $a(\hat{i} + \hat{j})$   
 (D) Zero

**32.** A thermally insulated vessel contains 150g of water at  $0^\circ\text{C}$ . Then the air from the vessel is pumped out adiabatically. A fraction of water turns into ice and the rest evaporates at  $0^\circ\text{C}$  itself. The mass of evaporated water will be closest to : (Latent heat of vaporization of water =  $2.10 \times 10^6 \text{ J kg}^{-1}$  and Latent heat of Fusion of water =  $3.36 \times 10^5 \text{ J kg}^{-1}$ )

- (A) 35 g                      (B) 130 g  
 (C) 20 g                      (D) 150 g

**33.**



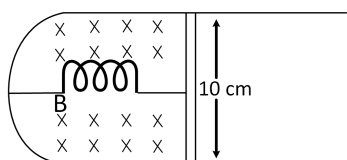
A wire of length  $2L$ , is made by joining two wires A and B of same length but different radii  $r$  and  $2r$  and made of the same material. It is vibrating at a frequency such that the joint of the two wires forms a node. If the number of antinodes in wire A is  $p$  and that in B is  $q$  then the ratio  $p : q$  is :

- (A) 3 : 5                      (B) 4 : 9  
 (C) 1 : 2                      (D) 1 : 4

**34.** A thin circular plate of mass  $M$  and radius  $R$  has its density varying as  $\rho(r) = \rho_0 r$  with  $\rho_0$  as constant and  $r$  is the distance from its centre. The moment of Inertia of the circular plate about an axis perpendicular to the plate and passing through its edge is  $I = aMR^2$ . The value of the coefficient  $a$  is :

- (A)  $\frac{1}{2}$   
 (B)  $\frac{3}{2}$   
 (C)  $\frac{8}{5}$   
 (D)  $\frac{3}{5}$

**35.** A thin strip 10 cm long is on a U shaped wire of negligible resistance and it is connected to a spring of spring constant  $0.5 \text{ Nm}^{-1}$  (see figure). The assembly is kept in a uniform magnetic field of 0.1 T. If the strip is pulled from its equilibrium position and released, the number of oscillation it performs before its amplitude decreases by a factor of  $e$  is  $N$ . If the mass of the strip is 50 grams, its resistance 10W and air drag negligible,  $N$  will be close to :



- (A) 50000                      (B) 1000  
(C) 5000                      (D) 10000

**36.** Two particles move at right angle to each other. Their de-Broglie wavelengths are  $\lambda_1$  and  $\lambda_2$  respectively. The particles suffer perfectly inelastic collision. The de-Broglie wavelength  $\lambda_2$  of the final particle, is given by :

- (A)  $\lambda = \frac{\lambda_1 + \lambda_2}{2}$   
(B)  $\frac{1}{\lambda^2} = \frac{1}{\lambda_1^2} + \frac{1}{\lambda_2^2}$   
(C)  $\lambda = \sqrt{\lambda_1 \lambda_2}$   
(D)  $\frac{2}{\lambda} = \frac{1}{\lambda_1} + \frac{1}{\lambda_2}$

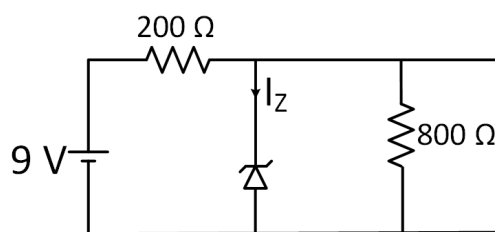
**37.** The bob of a simple pendulum has mass 2g and a charge of  $5.0 \mu\text{C}$ . It is at rest in a uniform horizontal electric field of intensity 2000 V/m. At equilibrium, the angle that the pendulum makes with the vertical is : (take  $g = 10 \text{ m/s}^2$ )

- (A)  $\tan^{-1}(5.0)$                       (B)  $\tan^{-1}(2.0)$   
(C)  $\tan^{-1}(0.5)$                       (D)  $\tan^{-1}(0.2)$

**38.** If  $10^{22}$  gas molecules each of mass  $10^{-26} \text{ kg}$  collide with a surface (perpendicular to it) elastically per second over an area  $1 \text{ m}^2$  with a speed  $10^4 \text{ m/s}$ , the pressure exerted by the gas molecules will be of the order of :

- (A)  $10^8 \text{ N/m}^2$                       (B)  $10^{16} \text{ N/m}^2$   
(C)  $10^4 \text{ N/m}^2$                       (D)  $2 \text{ N/m}^2$

**39.** The reverse breakdown voltage of a Zener diode is 5.6 V in the given circuit. The current  $I_Z$  through the Zener is :



- (A) 7 mA                      (B) 17 mA  
(C) 15mA                      (D) 10 mA

**40.** An alternating voltage  $v(t) = 220 \sin 100 \pi t$  volt is applied to a purely resistance load of  $50 \Omega$ . The time taken for the current to rise from half of the peak value to the peak value is :

- (A) 5 ms                      (B) 2.2 ms  
(C) 3.3 ms                      (D) 7.2 ms

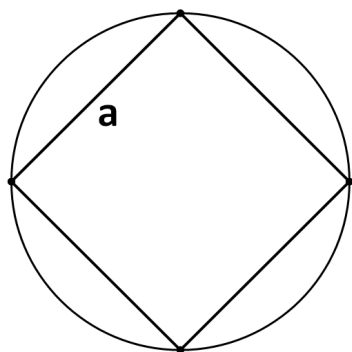
**41.** In an interference experiment the ratio of amplitudes of coherent waves is

$$\frac{a_1}{a_2} = \frac{1}{3}$$

. The ratio of maximum and minimum intensities of fringes will be :

- (A) 2                      (B) 4  
(C) 18                      (D) 9

42. Four identical particles of mass  $M$  are located at the corners of a square of side 'a'. What should be their speed if each of them revolves under the influence of other's gravitational field in a circular orbit circumscribing the square?



- (A)  $1.21\sqrt{\frac{GM}{a}}$   
 (B)  $1.16\sqrt{\frac{GM}{a}}$   
 (C)  $1.41\sqrt{\frac{GM}{a}}$   
 (D)  $1.35\sqrt{\frac{GM}{a}}$

43. A circular coil having  $N$  turns and radius  $r$  carries a current  $I$ . It is held in the  $XZ$  plane in a magnetic field  $B\hat{i}$ . The torque on the coil due to the magnetic field is :

- (A)  $\frac{Br^2I}{\pi N}$   
 (B)  $B\pi r^2IN$   
 (C) Zero  
 (D)  $\frac{B\pi r^2I}{N}$

44. A steel wire having a radius of 2.0 mm, carrying a load of 4 kg, is hanging from a ceiling. Given that  $g = 3.1 \text{ p ms}^{-2}$ , what will be the tensile stress that would be developed in the wire ?

- (A)  $3.1 \times 10^6 \text{ Nm}^{-2}$  (B)  $6.2 \times 10^6 \text{ Nm}^{-2}$   
 (C)  $4.8 \times 10^6 \text{ Nm}^{-2}$  (D)  $5.2 \times 10^6 \text{ Nm}^{-2}$

45. Radiation coming from transitions  $n = 2$  to  $n = 1$  of hydrogen atoms fall on  $\text{He}^+$  ions in  $n = 1$  and  $n = 2$  states. The possible transition of helium ions as they absorb energy from the radiation is :

- (A)  $n = 1 \rightarrow n = 4$  (B)  $n = 2 \rightarrow n = 5$   
 (C)  $n = 2 \rightarrow n = 4$  (D)  $n = 2 \rightarrow n = 3$

46. Ship A is sailing towards north-east with velocity

$$\vec{v} = 30\hat{i} + 50\hat{j}$$

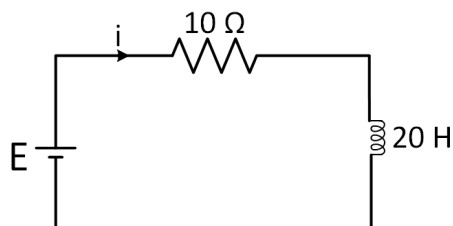
km/hr where  $\hat{i}$  points east and  $\hat{j}$ , north. Ship B is at a distance of 80 km east and 150 km north of Ship A and is sailing towards west at 10 km/hr. A will be at minimum distance from B in :

- (A) 2.2 hrs (B) 4.2 hrs  
 (C) 2.6 hrs (D) 3.2 hrs

47. Water from a pipe is coming at a rate of 100 litres per minute. If the radius of the pipe is 5 cm, the Reynolds number for the flow is of the order of : (density of water =  $1000 \text{ kg/m}^3$ , coefficient of viscosity of water =  $1 \text{ mPas}$ )

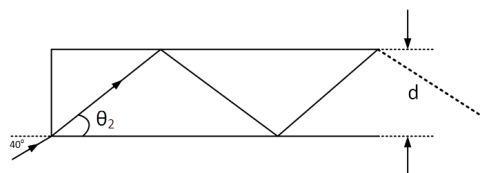
- (A)  $10^6$  (B)  $10^4$   
 (C)  $10^3$  (D)  $10^2$

48. A 20 Henry inductor coil is connected to a 10 ohm resistance in series as shown in figure. The time at which rate of dissipation of energy (joule's heat) across resistance is equal to the rate at which magnetic energy is stored in the inductor is :



- (A)  $\frac{2}{\ln 2}$   
 (B)  $\ln 2$   
 (C)  $2\ln 2$   
 (D)  $\frac{1}{2}\ln 2$

49. In figure, the optical fiber is  $l = 2\text{m}$  long and has a diameter of  $d = 20\text{ }\mu\text{m}$ . If a ray of light is incident on one end of the fiber at angle  $\theta_1 = 40^\circ$ , the number of reflection it makes before emerging from the other end is close to: (refractive index of fibre is 1.31 and  $\sin 40^\circ = 0.64$ )



- (A) 57000 (B) 55000  
(C) 66000 (D) 45000

50. Voltage rating of a parallel plate capacitor is 500V. Its dielectric can withstand a maximum electric field of  $10^6\text{ V/m}$ . The plate area is  $10^{-4}\text{ m}^2$ . What is the dielectric constant is the capacitance is 15 pF? (given  $\epsilon_0 = 8.86 \times 10^{-12}\text{ C}^2/\text{Nm}^2$ )

- (A) 8.5 (B) 4.5  
(C) 3.8 (D) 6.2

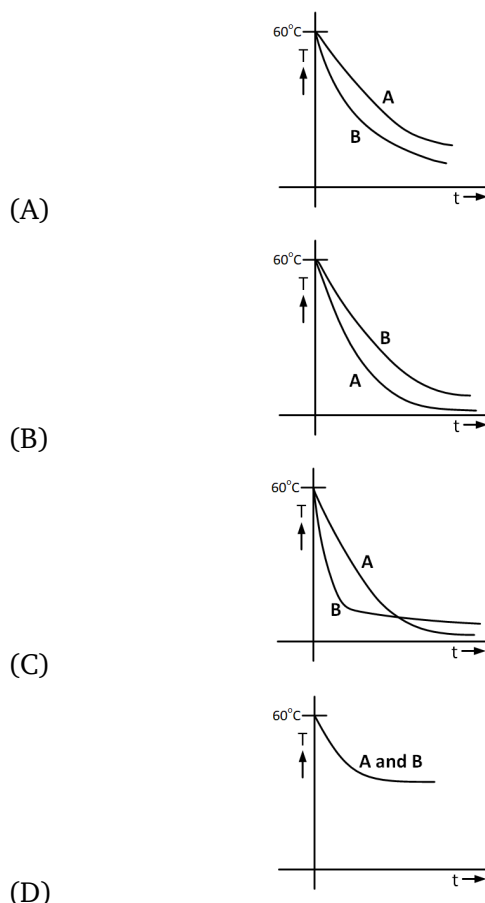
51. An upright object is placed at a distance of 40 cm in front of a convergent lens of focal length 20 cm. A convergent mirror of focal length 10 cm is placed at a distance of 60 cm on the other side of the lens. The position and size of the final image will be :

- (A) 20 cm from the convergent mirror, same size as the object (B) 40 cm from the convergent mirror, same size as the object  
(C) 40 cm from the convergent lens, same size as the object (D) 20 cm from the convergent mirror, twice the size of the object

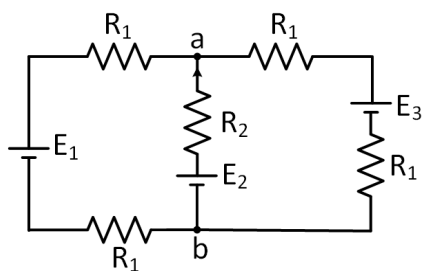
52. A plane electromagnetic wave travels in free space along the x-direction. The electric field component of the wave at a particular point of space and time is  $E = 6\text{ V m}^{-1}$  along y-direction. Its corresponding magnetic field component, B would be :

- (A)  $2 \times 10^{-8}\text{ T}$  along y-direction (B)  $6 \times 10^{-8}\text{ T}$  along z-direction  
(C)  $2 \times 10^{-8}\text{ T}$  along z-direction (D)  $6 \times 10^{-8}\text{ T}$  along x-direction

53. Two identical beakers A and B contain equal volumes of two different liquids at  $60^\circ\text{C}$  each and left to cool down. Liquid in A has density of  $8 \times 10^2\text{ kg/m}^3$  and specific heat of  $2000\text{ J kg}^{-1}\text{ K}^{-1}$  while liquid in B has density of  $10^3\text{ kg m}^{-3}$  and specific heat of  $4000\text{ J kg}^{-1}\text{ K}^{-1}$ . Which of the following best describes their temperature versus time graph schematically? (assume the emissivity of both the beakers to be the same)

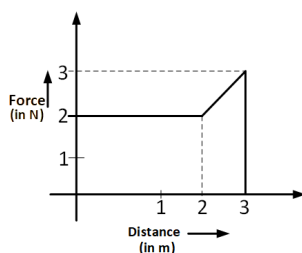


54. For the circuit shown, with  $R_1 = 1.0\Omega$ ,  $R_2 = 2.0\Omega$ ,  $E_1 = 2\text{ V}$  and  $E_2 = E_3 = 4\text{ V}$ , the potential difference between the points 'a' and 'b' is approximately (in V):



- (A) 3.3 (B) 2.7  
(C) 2.3 (D) 3.7

55. A particle moves in one dimension from rest under the influence of a force that varies with the distance travelled by the particle as shown in the figure. The kinetic energy of the particle after it has travelled 3m is :



- (A) 6.5 J (B) 2.5 J  
(C) 5 J (D) 4 J

56. In SI units, the dimensions of

$$\sqrt{\frac{\epsilon_0}{\mu_0}}$$

is :

- (A)  $A^{-1} T M L^3$  (B)  $A^2 T^3 M^{-1} L^{-2}$   
(C)  $A T^{-3} M L^{3/2}$  (D)  $A T^2 M^{-1} L^{-1}$

57. A boy's catapult is made of rubber cord which is 42 cm long, with 6 mm diameter of cross-section and of negligible mass. The boy keeps a stone weighing 0.02kg on it and stretches the cord by 20 cm by applying a constant force. When released, the stone flies off with a velocity of  $20\text{ ms}^{-1}$ . Neglect the change in the area of cross-section of the cord while stretched. The Young's modulus of rubber is closest to:

- (A)  $10^4\text{ Nm}^{-2}$  (B)  $10^6\text{ Nm}^{-2}$   
(C)  $10^8\text{ Nm}^{-2}$  (D)  $10^3\text{ Nm}^{-2}$

58. A solid conducting sphere, having a charge  $Q$ , is surrounded by an uncharged conducting hollow spherical shell. Let the potential difference between the surface of the solid sphere and that of the outer surface of the hollow shell be  $V$ . If the shell is now given a charge of  $-4Q$ , the new potential difference between the same two surfaces is :

- (A)  $V$  (B)  $2V$   
(C)  $-2V$  (D)  $4V$

59. A  $200\Omega$  resistor has a certain color code. If one replaces the red color by green in the code, the new resistance will be :

- (A)  $500\Omega$  (B)  $100\Omega$   
(C)  $200\Omega$  (D)  $300\Omega$

60. The wavelength of the carrier waves in a modern optical fiber communication network is close to :

- (A) 1500 nm (B) 2400 nm  
(C) 600 nm (D) 900 nm

61. Which of the following amines can be prepared by Gabriel phthalimide reaction ?

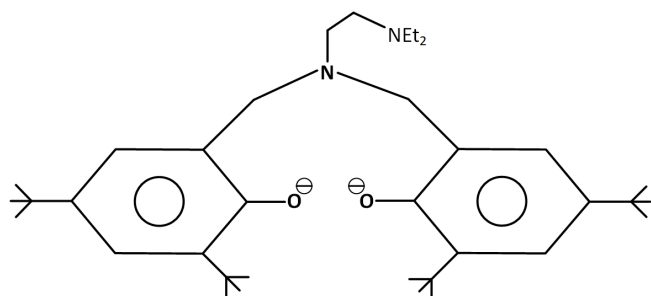
- (A) neo-pentylamine      (B) n-butylamine  
(C) t-butylamine      (D) triethylamine

62. The correct order of the spin-only magnetic moment of metal ions in the following low-spin complexes,

$[\text{V}(\text{CN})_6]^{4-}$ ,  $[\text{Fe}(\text{CN})_6]^{4-}$ ,  $[\text{Ru}(\text{NH}_3)_6]^{3+}$ , and  $[\text{Cr}(\text{NH}_3)_6]^{2+}$ , is :

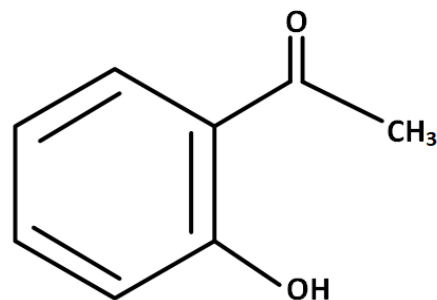
- (A)  $\text{V}^{2+} > \text{Ru}^{3+} > \text{Cr}^{2+} > \text{Fe}^{2+}$       (B)  $\text{V}^{2+} > \text{Cr}^{2+} > \text{Ru}^{3+} > \text{Fe}^{2+}$   
(C)  $\text{Cr}^{2+} > \text{V}^{2+} > \text{Ru}^{3+} > \text{Fe}^{2+}$       (D)  $\text{Cr}^{2+} > \text{Ru}^{3+} > \text{Fe}^{2+} > \text{V}^{2+}$

63. The following ligand is :

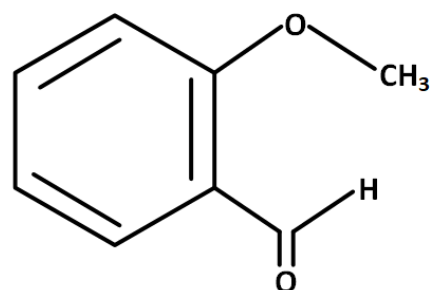


- (A) hexadentate      (B) bidentate  
(C) tetradentate      (D) tridentate

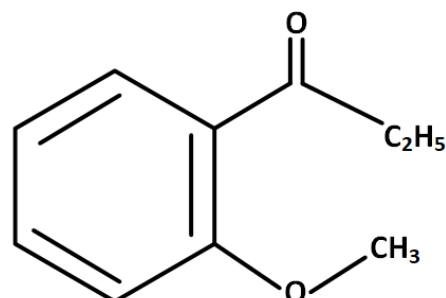
64. An organic compound neither reacts with neutral ferric chloride solution nor with fehling solution. it however, reacts with Grignard reagent and gives positive iodoform test. The compound is :



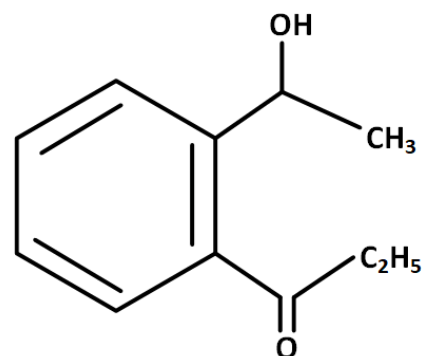
(A)



(B)

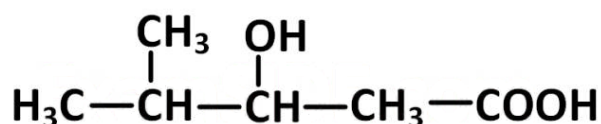


(C)



(D)

65. The IUPAC name of the following compound is :



- |                                         |                                         |
|-----------------------------------------|-----------------------------------------|
| (A) 3-Hydroxy-4-methylpentanoic acid    | (B) 4,4-Dimethyl-3-hydroxybutanoic acid |
| (C) 2-Methyl-3-hydroxypentan-5-oic acid | (D) 4-Methyl-3-hydroxypentanoic acid    |

66. For silver,  $C_p(\text{J K}^{-1} \text{mol}^{-1}) = 23 + 0.01 T$ . If the temperature (T) of 3 moles of silver is raised from 300 K to 1000 K at 1 atm pressure, the value of  $\Delta H$  will be close to :

- |           |           |
|-----------|-----------|
| (A) 62 KJ | (B) 16 KJ |
| (C) 13 KJ | (D) 21 KJ |

67. The size of the iso-electronic species  $\text{Cl}^-$ , Ar and  $\text{Ca}^{2+}$  is affected by :

- |                                                         |                                               |
|---------------------------------------------------------|-----------------------------------------------|
| (A) electron-electron interaction in the outer orbitals | (B) Principal quantum number of valence shell |
| (C) nuclear charge                                      | (D) azimuthal quantum number of valence shell |

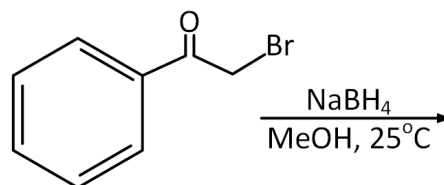
68. If solubility product of  $\text{Zr}_3(\text{PO}_4)_4$  is denoted by  $K_{sp}$  and its molar solubility is denoted by S, then which of the following relation between S and  $K_{sp}$  is correct ?

- |     |                                                |
|-----|------------------------------------------------|
| (A) | $S = \left( \frac{K_{sp}}{929} \right)^{1/9}$  |
| (B) | $S = \left( \frac{K_{sp}}{6912} \right)^{1/7}$ |
| (C) | $S = \left( \frac{K_{sp}}{144} \right)^{1/6}$  |
| (D) | $S = \left( \frac{K_{sp}}{216} \right)^{1/7}$  |

69. Maltose on treatment with dilute HCl gives :

- |                 |                              |
|-----------------|------------------------------|
| (A) D-Galactose | (B) D-Glucose and D-Fructose |
| (C) D-Glucose   | (D) D-Fructose               |

70. The major product of the following reaction is :



- |     |  |
|-----|--|
| (A) |  |
| (B) |  |
| (C) |  |
| (D) |  |

71. The lathanide ion that would show colour is :

- (A)  $\text{Sm}^{3+}$  (B)  $\text{Gd}^{3+}$   
(C)  $\text{Lu}^{3+}$  (D)  $\text{La}^{3+}$

72. Given that

$$E^\ominus_{\text{O}_2/\text{H}_2\text{O}} = 1.23 \text{ V}$$

;

$$E^\ominus_{\text{S}_2\text{O}_8^{2-}/\text{SO}_4^{2-}} = 2.05 \text{ V}$$

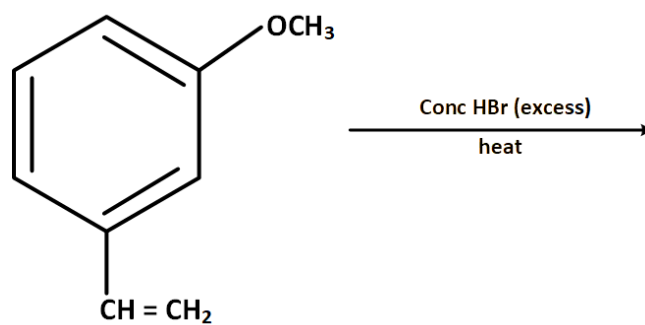
$$E^\ominus_{\text{Br}_2/\text{Br}^-} = 1.09 \text{ V}$$

$$E^\ominus_{\text{Au}^{3+}/\text{Au}} = 1.4 \text{ V}$$

The strongest oxidizing agent is :

- (A)  $\text{O}_2$   
(B)  $\text{Au}^{3+}$   
(C)  $\text{Br}_2$   
(D)  $\text{S}_2\text{O}_8^{2-}$

73. The major product of the following reaction is :



- (A)
- (B)
- (C)
- (D)

74. In order to oxidise a mixture of one mole of each of  $\text{FeC}_2\text{O}_4$ ,  $\text{Fe}_2(\text{C}_2\text{O}_4)_3$ ,  $\text{FeSO}_4$  and  $\text{Fe}_2(\text{SO}_4)_3$  in acidic medium, the number of moles of  $\text{KMnO}_4$  required is :

- (A) 1.5 (B) 3  
(C) 2 (D) 1

75. For the reaction  $2\text{A} + \text{B} \rightarrow \text{C}$ , the values of initial rate at different reactant concentrations are given in the table below. The rate law for the reaction is :

| [A] ( $\text{mol L}^{-1}$ ) | [B] ( $\text{mol L}^{-1}$ ) | Initial Rate ( $\text{mol L}^{-1}\text{s}^{-1}$ ) |
|-----------------------------|-----------------------------|---------------------------------------------------|
| 0.05                        | 0.05                        | 0.045                                             |
| 0.10                        | 0.05                        | 0.090                                             |
| 0.20                        | 0.10                        | 0.72                                              |

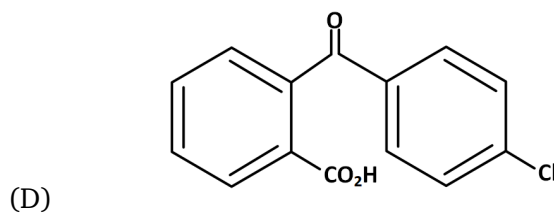
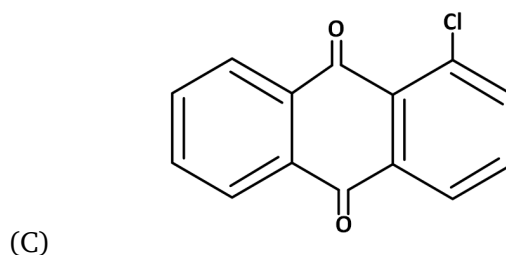
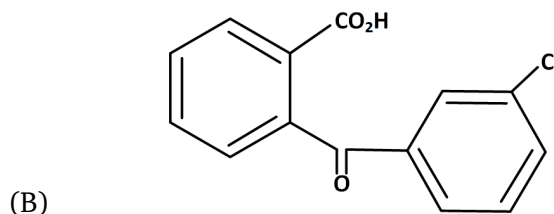
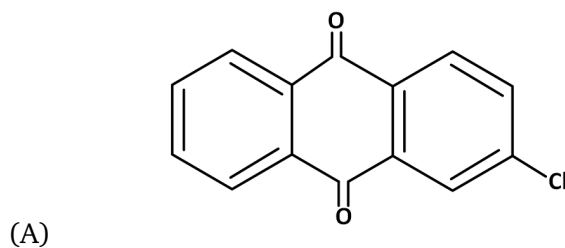
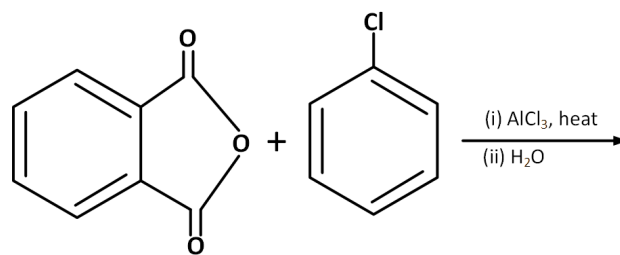
- (A) Rate =  $k[\text{A}][\text{B}]^2$  (B) Rate =  $k[\text{A}]^2[\text{B}]^2$   
(C) Rate =  $k[\text{A}]^2[\text{B}]$  (D) Rate =  $k[\text{A}][\text{B}]$

76. An organic compound 'X' showing the following solubility profile is :

|     |                      |             |
|-----|----------------------|-------------|
| 'X' | water                | → insoluble |
|     | 5% HCl               | → insoluble |
|     | 10% NaOH             | → soluble   |
|     | 10% $\text{NaHCO}_3$ | → insoluble |

- (A) o-Toluidine (B) Benzamide  
(C) Oleic acid (D) m-Cresol

77. The major product of the following reaction is :



78. In the following compounds, the decreasing order of basic strength will be :

- (A)  $(\text{C}_2\text{H}_5)_2\text{NH} > \text{NH}_3$       (B)  $\text{NH}_3 > \text{C}_2\text{H}_5\text{NH}_2 > (\text{C}_2\text{H}_5)_2\text{NH}$   
 (C)  $(\text{C}_2\text{H}_5)_2\text{NH} > \text{C}_2\text{H}_5\text{NH}_2 > \text{NH}_3$       (D)  $\text{C}_2\text{H}_5\text{NH}_2 > \text{NH}_3 > (\text{C}_2\text{H}_5)_2\text{NH}$

79. The vapour pressures of pure liquids A and B are 400 and 600 mmHg, respectively at 298 K on mixing the two liquids, the sum of their initial volume is equal to the volume of the final mixture. The mole fraction of liquid B is 0.5 in the mixture, The vapour pressure of the final solution, the mole fractions of components A and B in vapour phase, respectively are :

- (A) 500 mmHg, 0.5, 0.5      (B) 500 mmHg, 0.4, 0.6  
 (C) 450 mmHg, 0.4, 0.6      (D) 450 mmHg, 0.5, 0.5

80. Which one of the following equations does not correctly represent the first law of thermodynamics for the given processes involving an ideal gas? (Assume non-expansion work is zero)

- (A) Adiabatic process :  $\Delta U = -w$   
 (B) Cyclic process :  $q = -w$   
 (C) Isochoric process :  $\Delta U = q$   
 (D) Isothermal process :  $q = -w$

81. The quantum number of four electrons are given below :

$$n = 4, l = 2, m_l = -2, m_s = -1/2$$

$$n = 3, l = 2, m_l = 1, m_s = +1/2$$

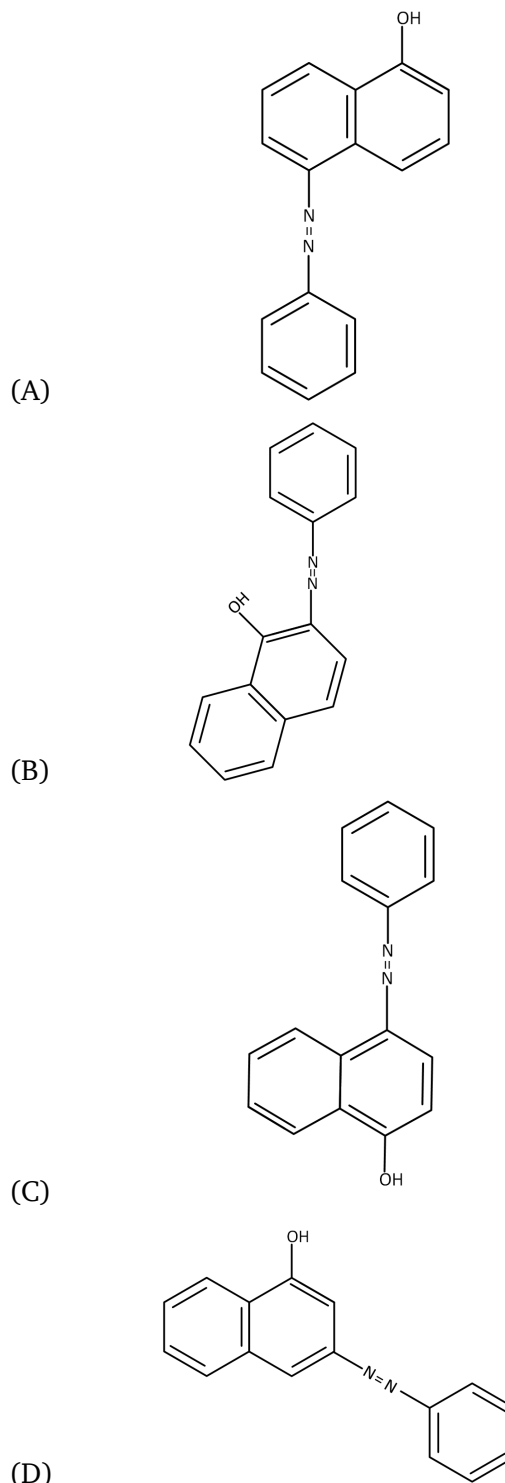
$$n = 4, l = 1, m_l = 0, m_s = +1/2$$

$$n = 3, l = 1, m_l = 1, m_s = -1/2$$

The correct order of their increasing energies will be :

- (A) IV < II < III < I      (B) I < III < II < IV  
 (C) IV < III < II < I      (D) I < II < III < IV

82. Coupling of benzene diazonium chloride with 1-naphthol in alkaline medium will give :



83. Which is wrong with respect to our responsibility as a human being to protect our environment?

- (A) Restricting the use of vehicles      (B) Setting up compost tin in gardens.  
(C) Avoiding the use of floodlighted facilities      (D) Using plastic bags.

84. With respect to an ore, Ellingham diagram helps to predict the feasibility of its.

- (A) Electrolysis      (B) Thermal reduction  
(C) Vapour phase refining      (D) Zone refining

85. Diborane ( $B_2H_6$ ) reacts with  $O_2$  and  $H_2O$  independently, then products formed are :

- (A)  $B_2O_3$  and  $HBO_2$       (B)  $B_2O_3$  and  $H_3BO_3$   
(C)  $HBO_2$  and  $H_3BO_3$       (D)  $HBO_2$  and  $HBO_3$

86. The correct order of hydration enthalpies of alkali metal ions is :

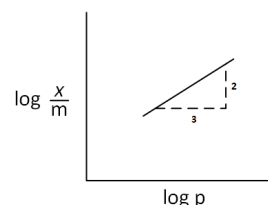
- (A)  $Li^+ > Na^+ > Cs^+ > Rb^+$       (B)  $Na^+ > Li^+ > K^+ > Cs^+ > Rb^+$   
(C)  $Na^+ > Li^+ > K^+ > Rb^+ > Cs^+$       (D)  $Li^+ > Na^+ > K^+ > Rb^+ > Cs^+$

87. 100 mL of a water sample contains 0.81 g of calcium bicarbonate and 0.73 g of magnesium bicarbonate. The hardness of this water sample expressed in terms of equivalents of  $CaCO_3$  is : (Molar mass of calcium bicarbonate is  $162 \text{ g mol}^{-1}$  and magnesium bicarbonate is  $146 \text{ g mol}^{-1}$ )

- (A) 1,000 ppm      (B) 100 ppm  
(C) 10,000 ppm      (D) 5,000 ppm

88. Adsorption of a gas follows freundlich adsorbed isotherm.  $x$  is the mass of the gas adsorbed on mass  $m$  of the adsorbent. The plot  $\log \frac{x}{m}$  versus  $\log p$  is shown in the given graph.

$\frac{x}{m}$   
is proportional to :



- (A)  $p^{2/3}$       (B)  $p^3$   
(C)  $p^2$       (D)  $p^{3/2}$

89. Element 'B' forms ccp structure and 'A' occupies half of the octahedral voids, while oxygen atoms occupy all the tetrahedral voids, The structure of bimetallic oxide is :

- (A)  $AB_2O_4$       (B)  $A_2BO_4$   
(C)  $A_4B_2O$       (D)  $A_2B_2O$

90. **Assertion :** Ozone is destroyed by CFCs in the upper stratosphere.

**Reason :** Ozone holes increase the amount of UV radiation the earth.

- (A) Assertion and reason are both correct, and the reason is the correct explanation for the assertion.      (B) Assertion and reason are incorrect.  
(C) Assertion and reason are correct but, the reason is not the explanation for the assertion.      (D) Assertion is false, but the reason is correct.

- End of Question Paper -