

## JEE Main 2023 30 Jan Shift 1 Question Paper

Time Allowed :180 minutes	Maximum Marks :300	Total questions :90
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### General Instructions

**Read the following instructions very carefully and strictly follow them:**

1. The test is of 3 hours duration.
2. The question paper consists of 90 questions, out of which 75 are to attempted.  
The maximum marks are 300.
3. There are three parts in the question paper consisting of Physics, Chemistry and Mathematics having 30 questions in each part of equal weightage.
4. Each part (subject) has two sections.
  - (i) Section-A: This section contains 20 multiple choice questions which have only one correct answer. Each question carries 4 marks for correct answer and –1 mark for wrong answer.
  - (ii) Section-B: This section contains 10 questions. In Section-B, attempt any five questions out of 10. The answer to each of the questions is a numerical value. Each question carries 4 marks for correct answer and –1 mark for wrong answer. For Section-B, the answer should be rounded off to the nearest integer

# Mathematics

## Section A

**1. Let**

$$A = \begin{bmatrix} m & n \\ p & q \end{bmatrix}, d = |A| \neq 0, \text{ and } |A - d(\mathbf{Adj}A)| = 0.$$

**Then:**

(1)  $(1 + d)^2 = (m + q)^2$

(2)  $1 + d^2 = (m + q)^2$

(3)  $(1 + d)^2 = m^2 + q^2$

(4)  $1 + d^2 = m^2 + q^2$

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**2. The line  $\ell_1$  passes through the point  $(2, 6, 2)$  and is perpendicular to the plane**

**$2x + y - 2z = 10$ . Then the shortest distance between the line  $\ell_1$  and the line**

$$\frac{x+1}{2} = \frac{y+4}{-3} = \frac{z}{2}$$

**is:**

(1) 7

(2)  $\frac{19}{3}$

(3)  $\frac{19}{2}$

(4) 9

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**3. If an unbiased die, marked with  $-2, -1, 0, 1, 2, 3$  on its faces, is thrown five times, then the probability that the product of the outcomes is positive, is:**

(1)  $\frac{881}{2592}$

(2)  $\frac{521}{2592}$

(3)  $\frac{440}{2592}$

(4)  $\frac{27}{288}$

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**4. Let the system of linear equations**

$$x + y + kz = 2$$

$$2x + 3y - z = 1$$

$$3x + 4y + 2z = k$$

**have infinitely many solutions. Then the system**

$$(k+1)x + (2k-1)y = 7$$

$$(2k+1)x + (k+5)y = 10$$

**has:**

- (1) infinitely many solutions
  - (2) unique solution satisfying  $x - y = 1$
  - (3) no solution
  - (4) unique solution satisfying  $x + y = 1$
- 

**5. If**

$$\tan 15^\circ + \frac{1}{\tan 75^\circ} + \tan 105^\circ + \tan 195^\circ = 2a,$$

**then the value of  $a + \frac{1}{a}$  is:**

- (1) 4
  - (2)  $4 - 2\sqrt{3}$
  - (3) 2
  - (4)  $5 - 3\sqrt{3}$
- 

**6. Suppose  $f : \mathbb{R} \rightarrow (0, \infty)$  be a differentiable function such that**

**$5f(x+y) = f(x) \cdot f(y), \forall x, y \in \mathbb{R}$ . If  $f(3) = 320$ , then  $\sum_{n=0}^5 f(n)$  is equal to:**

- (1) 6875
  - (2) 6575
  - (3) 6825
  - (4) 6528
- 

**7. If**

$$a_n = \frac{-2}{4n^2 - 16n + 15}, \quad \text{then } a_1 + a_2 + \cdots + a_5 \text{ is equal to:}$$

- (1)  $\frac{51}{144}$
- (2)  $\frac{49}{138}$
- (3)  $\frac{50}{141}$

(4)  $\frac{52}{147}$

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**8. If the coefficient of  $x^{15}$  in the expansion of**

$$\left(ax^3 + \frac{1}{bx^3}\right)^{15}$$

**is equal to the coefficient of  $x^{-15}$  in the expansion of**

$$\left(\frac{a}{x^3} - \frac{1}{bx^3}\right)^{15},$$

**where  $a$  and  $b$  are positive real numbers, then for each such ordered pair  $(a, b)$ :**

- (1)  $a = b$
  - (2)  $ab = 1$
  - (3)  $a = 3b$
  - (4)  $ab = 3$
- 

**9. If  $\mathbf{a}, \mathbf{b}, \mathbf{c}$  are three non-zero vectors and  $\hat{n}$  is a unit vector perpendicular to  $\mathbf{c}$  such that**

$$\mathbf{a} = \alpha \mathbf{b} - \hat{n}, \quad (\alpha \neq 0)$$

**and**

$$\vec{b} \cdot \vec{c} = 12, \quad \text{then} \quad \left| \vec{c} \times (\vec{a} \times \vec{b}) \right|$$

**is equal to:**

- (1) 15
  - (2) 9
  - (3) 12
  - (4) 6
- 

**10. The number of points on the curve**

$$y = 54x^5 - 135x^4 - 70x^3 + 180x^2 + 210x$$

**at which the normal lines are parallel to**

$$x + 90y + 2 = 0$$

**is:**

- (1) 2
  - (2) 3
  - (3) 4
  - (4) 0
- 

**11. Let**

$$y = x + 2, \quad 4y = 3x + 6, \quad \text{and} \quad 3y = 4x + 1$$

**be three tangent lines to the circle**

$$(x - h)^2 + (y - k)^2 = r^2.$$

**Then  $h + k$  is equal to:**

- (1) 5
  - (2)  $5(1 + \sqrt{2})$
  - (3) 6
  - (4)  $5\sqrt{2}$
- 

**12. Let the solution curve  $y = y(x)$  of the differential equation**

$$\frac{dy}{dx} - \frac{3x^5 \tan^{-1}(x^3)}{(1 + x^6)^{3/2}} y = 2x$$

$$\exp \frac{x^3 - \tan^{-1} x^3}{\sqrt{(1 + x^6)^{3/2}}}$$

**pass through the origin. Then  $y(1)$  is equal to:**

- (1)  $\exp \left( \frac{4 - \pi}{4\sqrt{2}} \right)$
  - (2)  $\exp \left( \frac{\pi - 4}{4\sqrt{2}} \right)$
  - (3)  $\exp \left( \frac{1 - \pi}{4\sqrt{2}} \right)$
  - (4)  $\exp \left( \frac{4 + \pi}{4\sqrt{2}} \right)$
- 

**13. Let a unit vector  $\vec{OP}$  make angles  $\alpha, \beta, \gamma$  with the positive directions of the coordinate axes  $OX, OY, OZ$  respectively, where  $\beta \in (0, \frac{\pi}{2})$ , and  $\vec{OP}$  is perpendicular to the plane through points  $(1, 2, 3), (2, 3, 4)$ , and  $(1, 5, 7)$ . Then which one of the following is true?**

- (1)  $\alpha \in \left(\frac{\pi}{2}, \pi\right)$  and  $\gamma \in \left(\frac{\pi}{2}, \pi\right)$   
 (2)  $\alpha \in \left(0, \frac{\pi}{2}\right)$  and  $\gamma \in \left(0, \frac{\pi}{2}\right)$   
 (3)  $\alpha \in \left(\frac{\pi}{2}, \pi\right)$  and  $\gamma \in \left(0, \frac{\pi}{2}\right)$   
 (4)  $\alpha \in \left(0, \frac{\pi}{2}\right)$  and  $\gamma \in \left(\frac{\pi}{2}, \pi\right)$
- 

**14. If  $[t]$  denotes the greatest integer  $\leq t$ , then the value of**

$$\frac{3(e-1)^2}{e} \int_1^2 x^2 e^{[x]+[x^3]} dx$$

**is:**

- (1)  $e^9 - e$   
 (2)  $e^8 - e$   
 (3)  $e^7 - 1$   
 (4)  $e^8 - 1$
- 

**15. If  $P(h, k)$  be a point on the parabola  $x = 4y^2$ , which is nearest to the point  $Q(0, 33)$ , then the distance of  $P$  from the directrix of the parabola  $y^2 = 4(x + y)$  is equal to:**

- (1) 2  
 (2) 4  
 (3) 8  
 (4) 6
- 

**16. A straight line cuts off the intercepts  $OA = a$  and  $OB = b$  on the positive directions of the  $x$ -axis and  $y$ -axis, respectively. If the perpendicular from the origin  $O$  to this line makes an angle of  $\frac{\pi}{6}$  with the positive direction of the  $y$ -axis and the area of  $\triangle OAB$  is  $\frac{98}{3}\sqrt{3}$ , then  $a^2 - b^2$  is equal to:**

- (1)  $\frac{392}{3}$   
 (2) 196  
 (3)  $\frac{196}{3}$

(4) 98

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**17. The coefficient of  $x^{301}$  in**

$$(1+x)^{500} + x(1+x)^{499} + x^2(1+x)^{498} + \dots + x^{500}$$

**is:**

- (1)  $^{501}C_{302}$
  - (2)  $^{500}C_{301}$
  - (3)  $^{500}C_{300}$
  - (4)  $^{501}C_{200}$
- 

**18. Among the statements:**

**(S1)**  $((p \vee q) \Rightarrow r) \Leftrightarrow (p \Rightarrow r)$

**(S2)**  $((p \vee q) \Rightarrow r) \Leftrightarrow ((p \Rightarrow r) \vee (q \Rightarrow r))$

**Which of the following is true?**

- (1) Only (S1) is a tautology
  - (2) Neither (S1) nor (S2) is a tautology
  - (3) Only (S2) is a tautology
  - (4) Both (S1) and (S2) are tautologies
- 

**19. The minimum number of elements that must be added to the relation**

$$R = \{(a, b), (b, c)\}$$

**on the set**

$$\{a, b, c\}$$

**so that it becomes symmetric and transitive is:**

- (1) 4
- (2) 7
- (3) 5

(4) 3

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**20. If the solution of the equation**

$$\log_{\cos x} \cot x + 4 \log_{\sin x} \tan x = 1, x \in \left(0, \frac{\pi}{2}\right),$$

**is**

$$\sin^{-1} \left( \frac{\alpha + \sqrt{\beta}}{2} \right),$$

**where  $\alpha, \beta$  are integers, then  $\alpha + \beta$  is equal to:**

- (1) 3
  - (2) 5
  - (3) 6
  - (4) 4
- 

## Section B

**21. Let  $S = \{1, 2, 3, 4, 5, 6\}$ . Then the number of one-one functions  $f : S \rightarrow P(S)$ , where  $P(S)$  denotes the power set of  $S$ , such that  $f(n) \subset f(m)$  where  $n < m$ , is .....**

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**22. Let  $\alpha$  be the area of the larger region bounded by the curve**

$$y^2 = 8x$$

**and the lines**

$$y = x \quad \text{and} \quad x = 2,$$

**which lies in the first quadrant. Then the value of  $3\alpha$  is equal to:**

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**23.  $\lambda_1 < \lambda_2$  are two values of  $\lambda$  such that the angle between the planes**

$$P_1 : \vec{r} \cdot (3\hat{i} - 5\hat{j} + \hat{k}) = 7$$



and

$$P_2 : \vec{r} \cdot (\lambda \hat{i} + \hat{j} - 3\hat{k}) = 9$$

is  $\sin^{-1} \left( \frac{2\sqrt{6}}{5} \right)$ , then the square of the length of the perpendicular from the point  $(38\lambda, 10\lambda, 2)$  to the plane  $P_1$  is .....

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24. Let  $z = 1 + i$  and  $z_1 = \frac{1+i\bar{z}}{\bar{z}(1-z)+\frac{1}{z}}$ . Then  $\frac{12}{\pi} \arg(z_1)$  is equal to .....

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25.

$$\lim_{x \rightarrow 0} \frac{48}{x^4} \int_0^x \frac{t^3}{t^6 + 1} dt \text{ is equal to } .....$$

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26. The mean and variance of 7 observations are 8 and 16, respectively. If one observation 14 is omitted and  $a$  and  $b$  are respectively the mean and variance of the remaining 6 observations, then  $a + 3b - 5$  is equal to:

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27. If the equation of the plane passing through the point  $(1, 1, 2)$  and perpendicular to the line

$$x - 3y + 2z - 1 = 0, \quad 4x - y + z = 0 \quad \text{is} \quad Ax + By + Cz = 1,$$

then  $140(C - B + A)$  is equal to:

---

28. Let

$$\sum_{n=0}^{\infty} \frac{n^3((2n)!) + (2n-1)(n!)}{(n!)(2n)!} = ae + \frac{b}{e} + c,$$

where  $a, b, c \in \mathbb{Z}$  and  $e = \sum_{n=0}^{\infty} \frac{1}{n!}$ . Then  $a^2 - b + c$  is equal to .....

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29. Number of 4-digit numbers (the repetition of digits is allowed) which are made using the digits 1, 2, 3, and 5 and are divisible by 15 is equal to:

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**30. Let**

$$f^1(x) = \frac{3x+2}{2x+3}, \quad x \in \mathbb{R}, \quad R = \left(-\frac{3}{2}\right).$$

**For  $n \geq 2$ , define  $f^n(x) = f^1 \circ f^{n-1}(x)$  and if**

$$f^5(x) = \frac{ax+b}{bx+a}, \quad \gcd(a,b) = 1, \quad \text{then } a+b \text{ is equal to:}$$

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## Physics

### Section A

**31. The charge flowing in a conductor changes with time as**

$$Q(t) = \alpha t - \beta t^2 + \gamma t^3,$$

**where  $\alpha, \beta, \gamma$  are constants. The minimum value of current is:**

- (1)  $\alpha - \frac{3\beta^2}{\gamma}$
  - (2)  $\alpha - \frac{\gamma^2}{3\beta}$
  - (3)  $\beta - \frac{\alpha^2}{3\gamma}$
  - (4)  $\alpha - \frac{\beta^2}{3\gamma}$
- 

**32. The pressure (P) and temperature (T) relationship of an ideal gas obeys the equation**

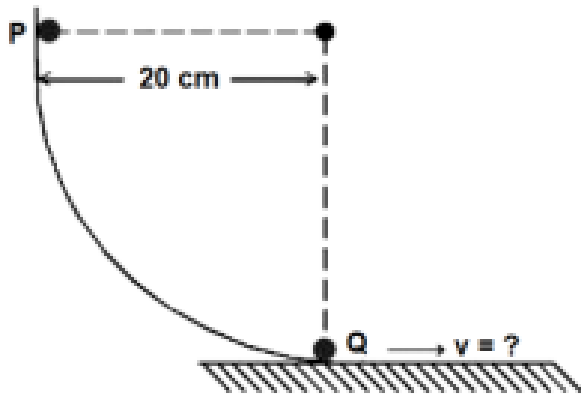
**$PT^2 = \text{constant}$ . The volume expansion coefficient of the gas will be:**

- (1)  $3T^2$
  - (2)  $\frac{3}{T^2}$
  - (3)  $\frac{3}{T^3}$
  - (4)  $\frac{3}{T}$
-

**33. A person has been using spectacles of power -1.0 diopter for distant vision and a separate reading glass of power 2.0 diopters. What is the least distance of distinct vision for this person?**

- (1) 10 cm
  - (2) 40 cm
  - (3) 30 cm
  - (4) 50 cm
- 

**34. As per the given figure, a small ball P slides down the quadrant of a circle and hits the other ball Q of equal mass which is initially at rest. Neglecting the effect of friction and assume the collision to be elastic, the velocity of ball Q after collision will be: ( $g = 10 \text{ m/s}^2$ )**



- (1) 0
  - (2) 0.25 m/s
  - (3) 2 m/s
  - (4) 4 m/s
- 

**35. Choose the correct relationship between Poisson ratio ( $\sigma$ ), bulk modulus ( $K$ ) and modulus of rigidity ( $\eta$ ) of a given solid object:**

- (1)  $\sigma = \frac{3K-2\eta}{6K+2\eta}$
  - (2)  $\sigma = \frac{6K+2\eta}{3K-2\eta}$
  - (3)  $\sigma = \frac{3K+2\eta}{6K+2\eta}$
  - (4)  $\sigma = \frac{6K-2\eta}{3K+2\eta}$
-

**36. The magnetic moments associated with two closely wound circular coils A and B of radius  $r_A = 10\text{ cm}$  and  $r_B = 20\text{ cm}$  respectively are equal if: (Where  $N_A, I_A$  and  $N_B, I_B$  are number of turns and current of A and B respectively)**

- (1)  $2N_AI_A = N_BI_B$
  - (2)  $N_A = 2N_B$
  - (3)  $N_AI_A = 4N_BI_B$
  - (4)  $4N_AI_A = N_BI_B$
- 

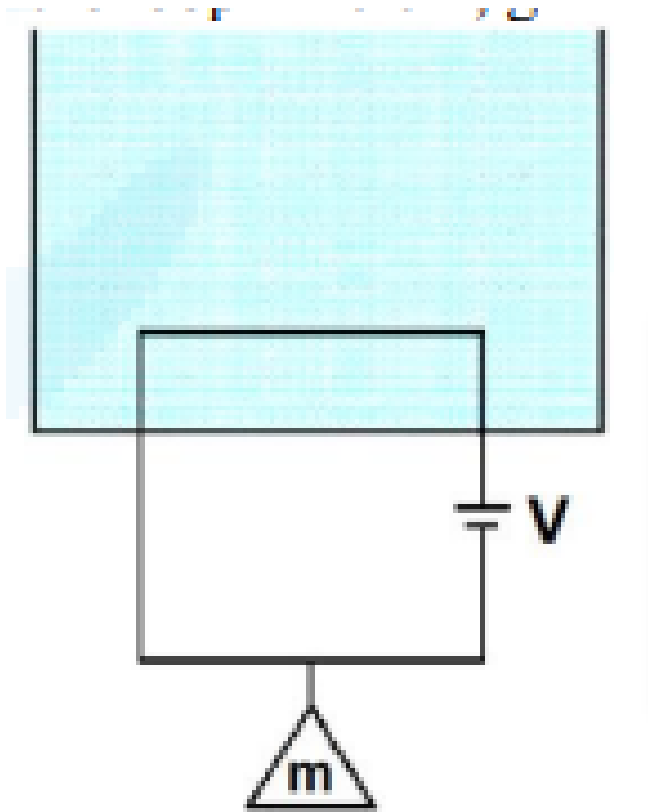
**37. A small object at rest absorbs a light pulse of power  $20\text{ mW}$  and duration  $300\text{ ns}$ . Assuming speed of light as  $3 \times 10^8\text{ m/s}$ , the momentum of the object becomes equal to:**

- (1)  $0.5 \times 10^{-17}\text{ kg m/s}$
  - (2)  $2 \times 10^{-17}\text{ kg m/s}$
  - (3)  $3 \times 10^{-17}\text{ kg m/s}$
  - (4)  $1 \times 10^{-17}\text{ kg m/s}$
- 

**38. Speed of an electron in Bohr's 7<sup>th</sup> orbit for Hydrogen atom is  $3.6 \times 10^6\text{ m/s}$ . The corresponding speed of the electron in the 3<sup>rd</sup> orbit, in m/s, is:**

- (1)  $1.8 \times 10^6\text{ m/s}$
  - (2)  $7.5 \times 10^6\text{ m/s}$
  - (3)  $3.6 \times 10^6\text{ m/s}$
  - (4)  $8.4 \times 10^6\text{ m/s}$
- 

**39. A massless square loop, of wire resistance  $10\ \Omega$ , supporting a mass of  $1\text{ g}$ , hangs vertically with one of its sides in a uniform magnetic field of  $10^3\text{ G}$ , directed outwards in the shaded region. A dc voltage  $V$  is applied to the loop. For what value of  $V$  will the magnetic force exactly balance the weight of the supporting mass of  $1\text{ g}$ ? (If sides of the loop =  $10\text{ cm}$ ,  $g = 10\text{ m/s}^2$ )**



- (1)  $\frac{1}{10} V$
- (2)  $100 V$
- (3)  $1 V$
- (4)  $10 V$

**40. Two isolated metallic solid spheres of radii  $R$  and  $2R$  are charged such that both have the same charge density  $\sigma$ . The spheres are then connected by a thin conducting wire. If the new charge density of the bigger sphere is  $\sigma'$ , the ratio  $\frac{\sigma'}{\sigma}$  is:**

- (1)  $\frac{9}{4}$
- (2)  $\frac{4}{3}$
- (3)  $\frac{5}{3}$
- (4)  $\frac{5}{6}$

**41. Heat is given to an ideal gas in an isothermal process.**

- A. Internal energy of the gas will decrease.
- B. Internal energy of the gas will increase.

- C. Internal energy of the gas will not change.
- D. The gas will do positive work.
- E. The gas will do negative work.

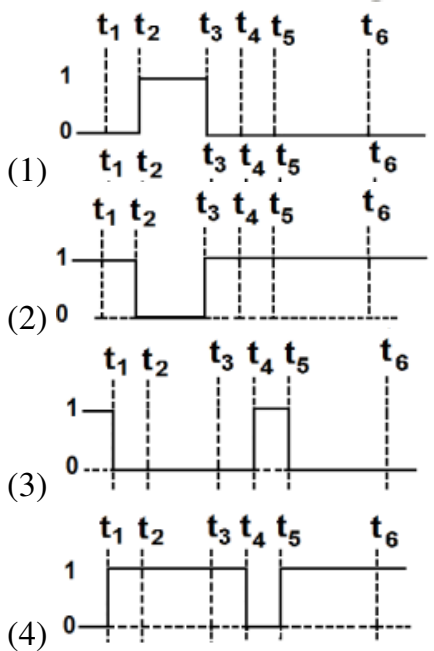
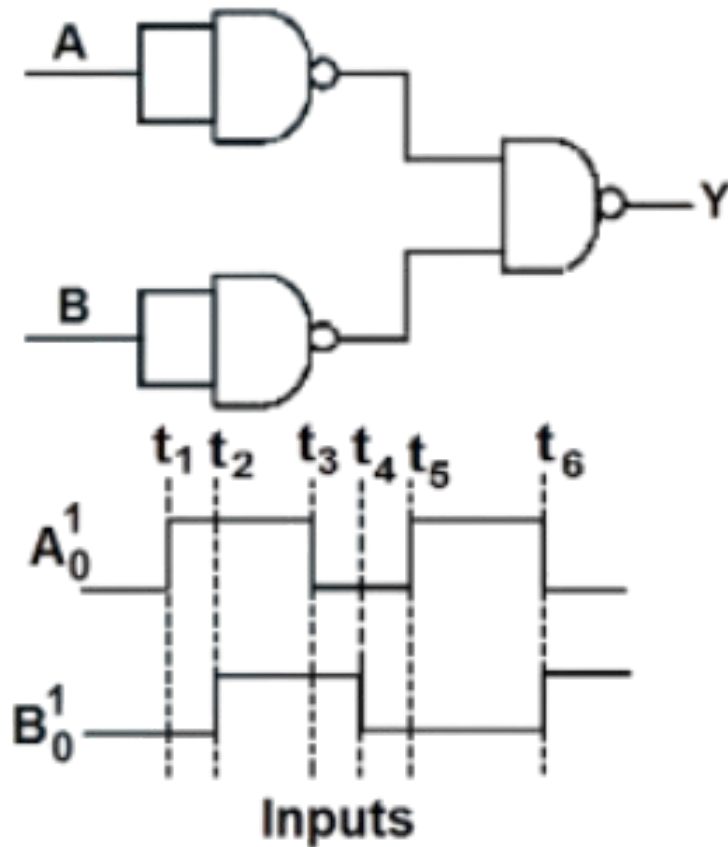
Choose the correct answer from the options given below:

- (1) A and E only
  - (2) B and D only
  - (3) C and E only
  - (4) C and D only
- 

**42. Electric field in a certain region is given by  $\mathbf{E} = \left( \frac{A}{x^2} \hat{i} + \frac{B}{y^3} \hat{j} \right)$ . The SI unit of  $A$  and  $B$  are:**

- (1)  $\text{Nm}^2\text{C}^{-1}$ ,  $\text{Nm}^2\text{C}^{-1}$
  - (2)  $\text{Nm}^2\text{C}^{-1}$ ,  $\text{Nm}^3\text{C}^{-1}$
  - (3)  $\text{Nm}^3\text{C}$ ,  $\text{Nm}^3\text{C}$
  - (4)  $\text{Nm}^2\text{C}^{-1}$ ,  $\text{Nm}^3\text{C}$
- 

**43. The output waveform of the given logical circuit for the following inputs A and B is shown below:**



44. The height of the liquid column raised in a capillary tube of certain radius when dipped in liquid A vertically is 5 cm. If the tube is dipped in a similar manner in another liquid B of surface tension and density double the values of liquid A, the height of the liquid column raised in liquid B would be:

- (1) 0.20
  - (2) 0.5
  - (3) 0.10
  - (4) 0.05
- 

**45. A sinusoidal carrier voltage is amplitude modulated. The resultant amplitude modulated wave has maximum and minimum amplitude of 120 V and 80 V respectively. The amplitude of each sideband is:**

- (1) 15 V
  - (2) 10 V
  - (3) 20 V
  - (4) 5 V
- 

**46. In a series LR circuit with  $X_L = R$ , the power factor is  $P_1$ . If a capacitor of capacitance  $C$  with  $X_C = X_L$  is added to the circuit, the power factor becomes  $P_2$ . The ratio of  $P_1$  to  $P_2$  will be:**

- (1) 3:1
  - (2)  $1:\sqrt{2}$
  - (3) 1:1
  - (4) 1:2
- 

**47. If the gravitational field in the space is given as  $-\frac{K}{r^2}$ , taking the reference point to be at  $r = 2$  cm with gravitational potential  $V = 10$  J/kg, find the gravitational potential at  $r = 3$  cm in SI units. (Given that  $K = 6$  J cm/kg)**

- (1) 9
  - (2) 11
  - (3) 12
  - (4) 10
- 


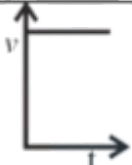

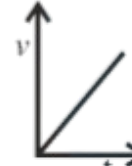

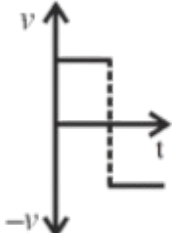

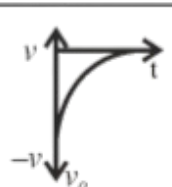
**48. A ball of mass 200 g rests on a vertical post of height 20 m. A bullet of mass 10 g, travelling in horizontal direction, hits the centre of the ball. After collision both travel**



independently. The ball hits the ground at a distance of 30 m and the bullet at a distance of 120 m from the foot of the post. The value of initial velocity of the bullet will be (if  $g = 10 \text{ m/s}^2$ ):

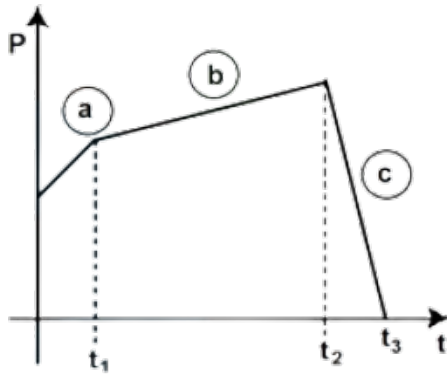
- (1) 120 m/s
- (2) 60 m/s
- (3) 400 m/s
- (4) 360 m/s

**49. Match Column-I with Column-II:**

Column-I (x-t graphs)		Column-II (v-t graphs)	
A.		I.	
B.		II.	
C.		III.	
D.		IV.	

- (1) A-II, B-IV, C-III, D-I
- (2) A-I, B-II, C-III, D-IV
- (3) A-II, B-III, C-IV, D-II
- (4) A-I, B-III, C-IV, D-I

50. The figure represents the momentum time ( $p - t$ ) curve for a particle moving along an axis under the influence of the force. Identify the regions on the graph where the magnitude of the force is maximum and minimum respectively? If  $t_3 - t_2 < t_1$ :



- (1) c and a
- (2) b and c
- (3) c and b
- (4) a and b

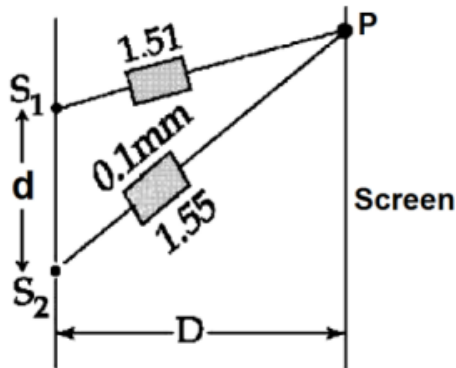
### Section - B

51. The general displacement of a simple harmonic oscillator is  $x = A \sin(\omega t)$ . Let  $T$  be its time period. The slope of its potential energy ( $U$ ) - time ( $t$ ) curve will be maximum when  $t = \frac{T}{\beta}$ . The value of  $\beta$  is:

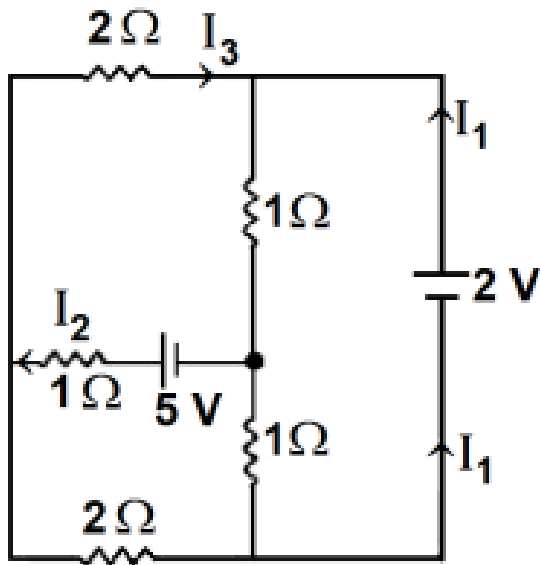
52. A capacitor of capacitance  $900 \mu\text{F}$  is charged by a  $100 \text{ V}$  battery. The capacitor is disconnected from the battery and connected to another uncharged identical capacitor such that one plate of the uncharged capacitor is connected to the positive plate and another plate of the uncharged capacitor is connected to the negative plate of the charged capacitor. The loss of energy in this process is measured as  $x \times 10^{-2} \text{ J}$ . The value of  $x$  is:

53. In Young's double slit experiment, two slits  $S_1$  and  $S_2$  are 'd' distance apart and the separation from slits to screen is  $D$  (as shown in figure). Now if two transparent slabs of equal thickness  $0.1 \text{ mm}$  but refractive index  $1.51$  and  $1.55$  are introduced in the path of

beam ( $\lambda = 4000 \text{ \AA}$ ) from  $S_1$  and  $S_2$  respectively. The central bright fringe spot will shift by \_\_\_\_ number of fringes.



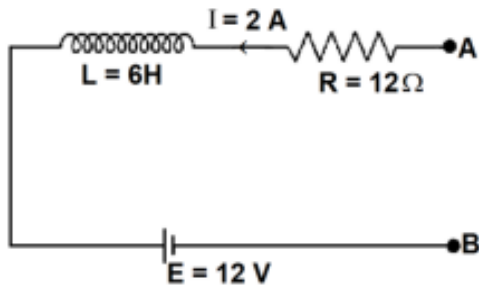
54. In the following circuit, the magnitude of current  $I_1$  is \_\_\_\_ A.



55. A horse rider covers half the distance with  $5 \text{ m/s}$  speed. The remaining part of the distance was travelled with speed  $10 \text{ m/s}$  for half the time and with speed  $15 \text{ m/s}$  for other half of the time. The mean speed of the rider averaged over the whole time of motion is  $\frac{x}{7} \text{ m/s}$ . The value of  $x$  is:

56. A point source of light is placed at the centre of curvature of a hemispherical surface. The source emits a power of  $24 \text{ W}$ . The radius of curvature of the hemisphere is  $10 \text{ cm}$  and the inner surface is completely reflecting. The force on the hemisphere due to the light falling on it is \_\_\_\_  $\times 10^{-8} \text{ N}$ .

57. As per the given figure, if  $\frac{dI}{dt} = -1 \text{ A/s}$ , then the value of  $V_{AB}$  at this instant will be \_\_\_\_ V.



58. In a screw gauge, there are 100 divisions on the circular scale and the main scale moves by 0.5 mm on a complete rotation of the circular scale. The zero of circular scale lies 6 divisions below the line of graduation when two studs are brought in contact with each other. When a wire is placed between the studs, 4 linear scale divisions are clearly visible while the 46th division the circular scale coincide with the reference line. The diameter of the wire is  $\text{-----} \times 10^{-2} \text{ mm}$ .

59. In an experiment for estimating the value of focal length of a converging mirror, image of an object placed at 40 cm from the pole of the mirror is formed at a distance 120 cm from the pole of the mirror. These distances are measured with a modified scale in which there are 20 small divisions in 1 cm. The value of error in measurement of focal length of the mirror is  $1/K \text{ cm}$ . The value of  $K$  is \_\_\_\_\_.

60. A thin uniform rod of length 2m, cross-sectional area 'A' and density 'd' is rotated about an axis passing through the center and perpendicular to its length with angular velocity  $\omega$ . If value of  $\omega$  in terms of its rotational kinetic energy  $E$  is:

$$E = \frac{\alpha E}{Ad}$$

Then the value of  $\alpha$  is \_\_\_\_\_.

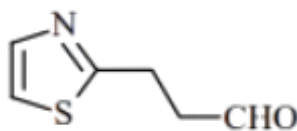
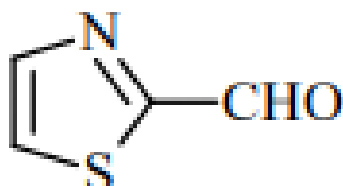
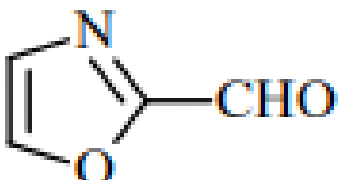
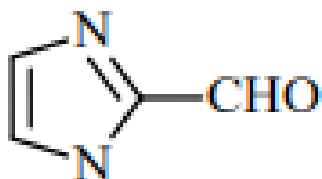
## Chemistry

### Section A

**61. Which of the following compounds would give the following set of qualitative analysis?**

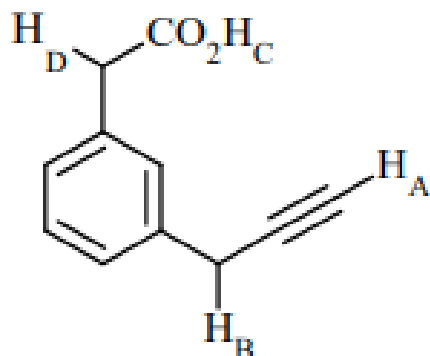
(i) Fehling's Test: Positive

(ii) Na fusion extract upon treatment with sodium nitroprusside gives a blood red colour but not



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**62. What is the correct order of acidity of the protons marked A-D in the given compounds?**



- (1)  $H_C > H_D > H_B > H_A$
- (2)  $H_C > H_D > H_A > H_B$
- (3)  $H_D > H_C > H_B > H_A$
- (4)  $H_C > H_A > H_D > H_B$

**63. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).**

Assertion (A): Ketoses give Seliwanoff's test faster than Aldoses.

Reason (R): Ketoses undergo -elimination followed by formation of furfural.

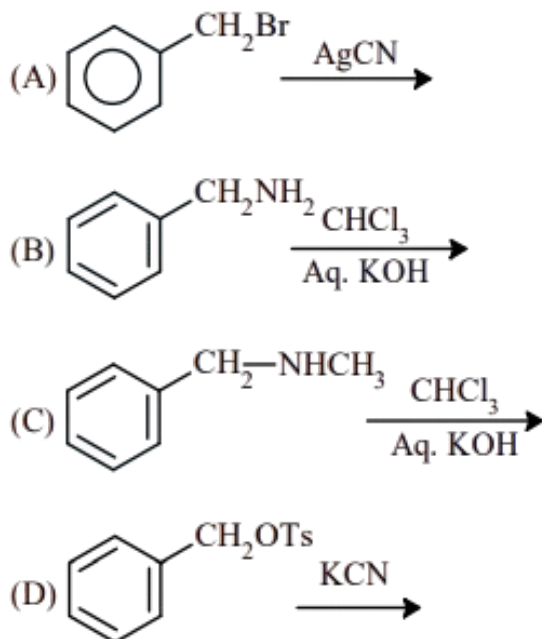
In light of the above statements, choose the correct answer from the options given below:

- (1) (A) is false but (R) is true
- (2) Both (A) and (R) are true and (R) is the correct explanation of (A)
- (3) (A) is true but (R) is false
- (4) Both (A) and (R) are true but (R) is not the correct explanation of (A)

**64. In the extraction of copper, its sulphide ore is heated in a reverberatory furnace after mixing with silica to:**

- (1) separate CuO as  $CuSiO_3$
- (2) remove calcium as  $CaSiO_3$
- (3) decrease the temperature needed for roasting of  $Cu_2S$
- (4) remove FeO as  $FeSiO_3$

67. Benzyl isocyanide can be obtained by:



Choose the correct answer from the options given below:

- (1) A and D
- (2) Only B
- (3) A and B
- (4) B and C

---

68. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).

**Assertion (A):** In expensive scientific instruments, silica gel is kept in watch-glasses or in semipermeable membrane bags.

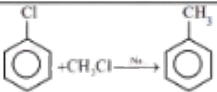
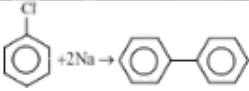
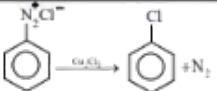
**Reason (R):** Silica gel adsorbs moisture from air via adsorption, thus protects the instrument from water corrosion (rusting) and/or prevents malfunctioning.

In the light of the above statements, choose the correct answer from the options given below:

- (1) A is false but (R) is true
- (2) A is true but (R) is false
- (3) Both (A) and (R) are true and (R) is the correct explanation of (A)
- (4) Both (A) and (R) are true but (R) is not the correct explanation of (A)

---

**69. Match List I with List II:**

List I		List II	
A		I	Fitting reaction
B		II	Wurtz Fitting reaction
C		III	Finkelstein reaction
D	$\text{C}_2\text{H}_5\text{Cl} + \text{NaI} \rightarrow \text{C}_2\text{H}_5\text{I} + \text{NaCl}$	IV	Sandmeyer reaction

- (1) A – IV, B – I, C – III, D – II  
(2) A – I, B – II, C – IV, D – III  
(3) A – I, B – III, C – II, D – I  
(4) A – II, B – I, C – IV, D – III
- 

**70. Caprolactam when heated at high temperature in presence of water gives:**

- (1) Teflon  
(2) Dacron  
(3) Nylon 6, 6  
(4) Nylon 6
- 

**71. The alkaline earth metal sulphate(s) which are readily soluble in water is/are:**

- (A)  $\text{BeSO}_4$   
(B)  $\text{MgSO}_4$   
(C)  $\text{CaSO}_4$   
(D)  $\text{SrSO}_4$   
(E)  $\text{BaSO}_4$

Choose the **correct answer** from the options given below:

- (1) A only



- (2) B only
  - (3) A and B
  - (4) B and C
- 

**72. Which of the following is the correct order of ligand field strength?**

- (1)  $\text{CO} < \text{en} < \text{NH}_3 < \text{C}_2\text{O}_4^{2-} < \text{S}^{2-}$
  - (2)  $\text{S}^{2-} < \text{C}_2\text{O}_4^{2-} < \text{NH}_3 < \text{en} < \text{CO}$
  - (3)  $\text{NH}_3 < \text{en} < \text{CO} < \text{S}^{2-} < \text{C}_2\text{O}_4^{2-}$
  - (4)  $\text{S}^{2-} < \text{NH}_3 < \text{en} < \text{CO} < \text{C}_2\text{O}_4^{2-}$
- 

**73. Formation of photochemical smog involves the following reaction in which A, B, and C are respectively.**

- (i)  $\text{NO}_2 \xrightarrow{h\nu} \text{A} + \text{B}$
- (ii)  $\text{B} + \text{O}_2 \rightarrow \text{C}$
- (iii)  $\text{A} + \text{C} \rightarrow \text{NO}_2 + \text{O}_2$

Choose the correct answer from the options given below:

- (1) O, NO, and  $\text{NO}_3^-$
  - (2)  $\text{N}_2\text{O}$  and NO
  - (3) N,  $\text{O}_2$ , and  $\text{O}_3$
  - (4) NO, O, and  $\text{O}_3$
- 

**74. During the qualitative analysis of  $\text{SO}_3^{2-}$  using dilute  $\text{H}_2\text{SO}_4$ ,  $\text{SO}_2$  gas is evolved which turns  $\text{K}_2\text{Cr}_2\text{O}_7$  solution (acidified with dilute  $\text{H}_2\text{SO}_4$ ):**

- (1) Black
  - (2) Red
  - (3) Green
  - (4) Blue
-

**75. To inhibit the growth of tumours, identify the compounds used from the following:**

- (A) EDTA
- (B) Coordination Compounds of Pt
- (C) D – Penicillamine
- (D) Cis – Platin

Choose the correct answer from the options given below:

- (1) B and D Only
- (2) C and D Only
- (3) A and B Only
- (4) A and C Only

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**76. In the wet tests for identification of various cations by precipitation, which transition element cation doesn't belong to group IV in qualitative inorganic analysis?**

- (1)  $\text{Fe}^{3+}$
- (2)  $\text{Zn}^{2+}$
- (3)  $\text{Co}^{2+}$
- (4)  $\text{Ni}^{2+}$

---

**77. Match List I with List II**

LIST-I (molecules/ions)	LIST-II (No. of lone pairs of $e^-$ on central atom)
(A) $\text{IF}_7$	I. Three
(B) $\text{ICl}_4^-$	II. One
(C) $\text{XeF}_6$	III. Two
(D) $\text{XeF}_2$	IV. Zero

Choose the **correct answer** from the options given below:

- (1) A – II, B – III, C – IV, D – I
- (2) A – IV, B – III, C – II, D – I
- (3) A – II, B – I, C – IV, D – III
- (4) A – IV, B – I, C – II, D – III

---

**78. For  $\text{OF}_2$  molecule consider the following:**

- (A) Number of lone pairs on oxygen is 2.
- (B) F–O–F angle is less than  $104.5^\circ$ .
- (C) Oxidation state of O is  $-2$ .
- (D) Molecule is bent 'V' shaped.
- (E) Molecular geometry is linear.

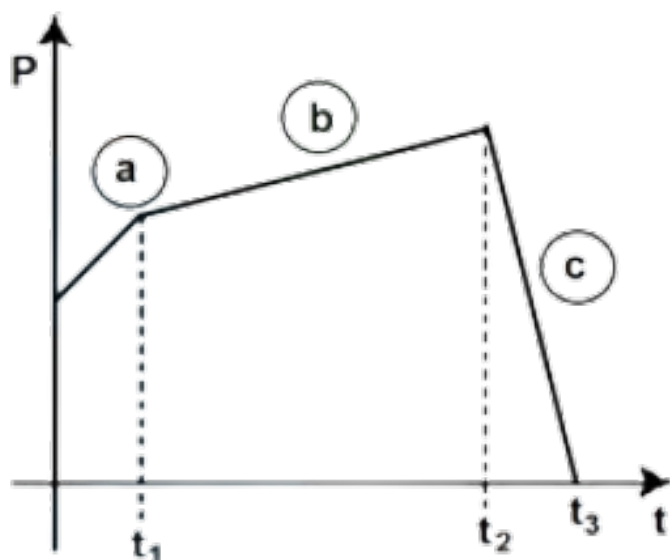
Correct options are:

- (1) C, D, E only
- (2) B, E, A only
- (3) A, C, D only
- (4) A, B, D only

**79. Lithium aluminium hydride can be prepared from the reaction of:**

- (1) LiCl and  $\text{Al}_2\text{H}_6$
- (2) LiH and  $\text{Al}_2\text{Cl}_6$
- (3) LiCl, Al and  $\text{H}_2$
- (4) LiH and  $\text{Al}(\text{OH})_3$

**80. Match List – I with List – II**



Choose the **correct answer** from the options given below:

- (1) A – II, B – IV, C – I, D – III

- (2) A – I, B – III, C – IV, D – II  
(3) A – IV, B – III, C – II, D – I  
(4) A – IV, B – II, C – I, D – III
- 

## Section B

**81. Consider the cell**



**When the potential of the cell is 0.712 V at 298 K, the ratio  $\frac{[\text{Fe}^{2+}]}{[\text{Fe}^{3+}]}$  is \_\_\_\_\_. (Nearest integer)**

**Given:**

$$\text{Fe}^{3+} + e^- \rightarrow \text{Fe}^{2+}, \quad E_{\text{Fe}^{3+}|\text{Fe}^{2+}}^\circ = 0.771 \text{ V}.$$
$$\frac{2.303RT}{F} = 0.06 \text{ V}.$$

---

**82. A 300 mL bottle of soft drink has 0.2 M CO<sub>2</sub> dissolved in it. Assuming CO<sub>2</sub> behaves as an ideal gas, the volume of the dissolved CO<sub>2</sub> at STP is \_\_\_\_\_ mL. (Nearest integer)**

**Given:** At STP, molar volume of an ideal gas is 22.7 L mol<sup>-1</sup>.

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**83. A solution containing 2 g of a non-volatile solute in 20 g of water boils at 373.52 K.**

**The molecular mass of the solute is \_\_\_\_\_ g mol<sup>-1</sup>. (Nearest integer)**

**Given:** Water boils at 373 K,  $K_b$  for water = 0.52 K kg mol<sup>-1</sup>.

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**84. If compound A reacts with B following first-order kinetics with rate constant**

**$2.011 \times 10^{-3} \text{ s}^{-1}$ , the time taken by A (in seconds) to reduce from 7 g to 2 g will be \_\_\_\_\_.**

**(Nearest Integer)**

**Given:**

$$\log 5 = 0.698, \quad \log 7 = 0.845, \quad \log 2 = 0.301.$$

---

**85. The energy of one mole of photons of radiation of frequency  $2 \times 10^{12}$  Hz in  $\text{J mol}^{-1}$  is \_\_\_\_\_. (Nearest integer)**

**Given:**  $h = 6.626 \times 10^{-34} \text{ Js}$ ,  $N_A = 6.022 \times 10^{23} \text{ mol}^{-1}$ .

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**86. The number of electrons involved in the reduction of permanganate to manganese dioxide in acidic medium is \_\_\_\_\_.**

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**87. When 2 liters of ideal gas expands isothermally into a vacuum to a total volume of 6 liters, the change in internal energy is \_\_\_\_\_ J. (Nearest integer)**

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**88. 600 mL of 0.01 M HCl is mixed with 400 mL of 0.01 M  $\text{H}_2\text{SO}_4$ . The pH of the mixture is \_\_\_\_\_  $\times 10^{-2}$ . (Nearest integer)**

**Given:**

$$\log 2 = 0.30, \quad \log 3 = 0.48, \quad \log 5 = 0.69, \quad \log 7 = 0.84, \quad \log 11 = 1.04.$$

---

**89. A trisubstituted compound 'A',  $\text{C}_{10}\text{H}_{12}\text{O}_2$ , gives neutral  $\text{FeCl}_3$  test positive.**

**Treatment of compound 'A' with NaOH and  $\text{CH}_3\text{Br}$  gives  $\text{C}_{11}\text{H}_{14}\text{O}_2$ , with hydroiodic acid gives methyl iodide and with hot conc. NaOH gives a compound 'B',  $\text{C}_{10}\text{H}_{12}\text{O}_2$ . Compound 'A' also decolourises alkaline  $\text{KMnO}_4$ . The number of  $\pi$  bond/s present in the compound 'A' is \_\_\_\_\_.**

---

**90. Some amount of dichloromethane ( $\text{CH}_2\text{Cl}_2$ ) is added to 671.141 mL of chloroform ( $\text{CHCl}_3$ ) to prepare a  $2.6 \times 10^{-3} \text{ M}$  solution of  $\text{CH}_2\text{Cl}_2$  (DCM). The concentration of DCM is \_\_\_\_\_ ppm (by mass).**

**Given:** Atomic mass C = 12, H = 1, Cl = 35.5, density of  $\text{CHCl}_3 = 1.49 \text{ g cm}^{-3}$ .

---