

**Note:** For the benefit of the students, specially the aspiring ones, the question of JEE(Main), 2017 are also given in this booklet. Keeping the interest of students studying in class XI, the questions based on topics from class XI have been marked with ‘\*’, which can be attempted as a test.

# FIITJEE

## Solutions to JEE(Main)-2017

Test Booklet Code

**D**

Instructions as printed on question paper.

**PAPER – 1 MATHEMATICS, PHYSICS & CHEMISTRY**

**Important Instructions:**

1. Immediately fill in the particulars on this page of the Test Booklet with **only Black Ball Point Pen** provided in the examination hall.
2. The Answer Sheet is kept inside this Test Booklet. When you are directed to open the Test Booklet, take out the Answer Sheet and fill in the particulars carefully.
3. The test is of **3 hours** duration.
4. The Test Booklet consists of **90** questions. The maximum marks are **360**.
5. There are **three** parts in the question paper A, B, C consisting of **Mathematics, Physics** and **Chemistry** having 30 questions in each part of equal weightage. Each question is allotted **4 (four)** marks for each correct response.
6. *Candidates will be awarded marks as started above in instruction No. 5 for correct response of each question.  $\frac{1}{4}$  (one fourth) marks of the total marks allotted to the question (i.e. 1 mark) will be deducted for indicating incorrect response of each question. No deduction from that total score will be made if no response is indicated for an item in the answer sheet.*
7. There is only one correct response for each question. Filling up more than one response in any question will be treated as wrong response and marks for wrong response will be deducted accordingly as per instruction 6 above.
8. For writing particulars / marking responses on **Side-1** and **Side-2** of the Answer Sheet use **only Black Ball Point Pen** provided in the examination hall.
9. No candidate is allowed to carry any textual material, printed or written, bits of papers, pager, mobile phone, any electronic device, etc. except the Admit Card inside the examination room/hall.
10. Rough work is to be done on the space provided for this purpose in the Test Booklet only. This space is given at the bottom of each page and in **four** pages (Page **20-30**) at the end of the booklet.
11. On completion of the test, the candidate must hand over the Answer Sheet to the Invigilator on duty in the Room / Hall. **However, the candidates are allowed to take away this Test Booklet with them.**
12. The CODE for this Booklet is **D**. Make sure that the CODE printed on **Side-2** of the Answer Sheet and also tally the serial number of the Test Booklet and Answer Sheet are the same as that on this booklet. In case of discrepancy, the candidate should immediately report the matter to the Invigilator for replacement of both the Test Booklet and the Answer Sheet.
13. **Do not fold or make any stray mark on the Answer Sheet.**

Name of the Candidate (in Capital letters): \_\_\_\_\_

Roll Number : in figures

: in words \_\_\_\_\_

Examination Centre Number :

Name of Examination Centre (in Capital letters): \_\_\_\_\_

Candidate's Signature : \_\_\_\_\_

1. Invigilator's Signature : \_\_\_\_\_

2. Invigilator's Signature : \_\_\_\_\_

PART A – MATHEMATICS

1. If  $S$  is the set of distinct values of 'b' for which the following system of linear equations  
 $x + y + z = 1$   
 $x + ay + z = 1$   
 $ax + by + z = 0$   
has no solution, then  $S$  is:  
(1) an empty set (2) an infinite set  
(3) a finite set containing two or more elements (4) a singleton
- \*2. The following statement  $(p \rightarrow q) \rightarrow [(\sim p \rightarrow q) \rightarrow q]$  is:  
(1) a tautology (2) equivalent to  $\sim p \rightarrow q$   
(3) equivalent to  $p \rightarrow \sim q$  (4) a fallacy
- \*3. If  $5(\tan^2 x - \cos^2 x) = 2 \cos 2x + 9$ , then the value of  $\cos 4x$  is:  
(1)  $-\frac{3}{5}$  (2)  $\frac{1}{3}$   
(3)  $\frac{2}{9}$  (4)  $-\frac{7}{9}$
4. For three events  $A, B$  and  $C$ ,  $P(\text{Exactly one of } A \text{ or } B \text{ occurs}) = P(\text{Exactly one of } B \text{ or } C \text{ occurs}) = P(\text{Exactly one of } C \text{ or } A \text{ occurs}) = \frac{1}{4}$  and  $P(\text{All the three events occur simultaneously}) = \frac{1}{16}$ . Then the probability that at least one of the events occurs, is:  
(1)  $\frac{7}{32}$  (2)  $\frac{7}{16}$   
(3)  $\frac{7}{64}$  (4)  $\frac{3}{16}$
- \*5. Let  $\omega$  be a complex number such that  $2\omega + 1 = z$  where  $z = \sqrt{-3}$ . If  

$$\begin{vmatrix} 1 & 1 & 1 \\ 1 & -\omega^2 - 1 & \omega^2 \\ 1 & \omega^2 & \omega^7 \end{vmatrix} = 3k$$
, then  $k$  is equal to:  
(1)  $-z$  (2)  $z$   
(3)  $-1$  (4)  $1$
- \*6. Let  $k$  be an integer such that the triangle with vertices  $(k, -3k), (5, k)$  and  $(-k, 2)$  has area 28 sq. units. Then the orthocentre of this triangle is at the point:  
(1)  $\left(2, -\frac{1}{2}\right)$  (2)  $\left(1, \frac{3}{4}\right)$   
(3)  $\left(1, -\frac{3}{4}\right)$  (4)  $\left(2, \frac{1}{2}\right)$
- \*7. Twenty meters of wire is available for fencing off a flower-bed in the form of a circular sector. Then the maximum area (in sq. m) of the flower-bed, is:  
(1) 12.5 (2) 10  
(3) 25 (4) 30

8. The area (in sq. units) of the region  $\{(x, y) : x \geq 0, x + y \leq 3, x^2 \leq 4y \text{ and } y \leq 1 + \sqrt{x}\}$  is:
- (1)  $\frac{59}{12}$  (2)  $\frac{3}{2}$   
 (3)  $\frac{7}{3}$  (4)  $\frac{5}{2}$
9. If the image of the point  $P(1, -2, 3)$  in the plane,  $2x + 3y - 4z + 22 = 0$  measured parallel to the line,  $\frac{x}{1} = \frac{y}{4} = \frac{z}{5}$  is  $Q$ , then  $PQ$  is equal to:
- (1)  $3\sqrt{5}$  (2)  $2\sqrt{42}$   
 (3)  $\sqrt{42}$  (4)  $6\sqrt{5}$
10. If for  $x \in \left(0, \frac{1}{4}\right)$ , the derivative of  $\tan^{-1}\left(\frac{6x\sqrt{x}}{1-9x^3}\right)$  is  $\sqrt{x} \cdot g(x)$ , then  $g(x)$  equals:
- (1)  $\frac{9}{1+9x^3}$  (2)  $\frac{3x\sqrt{x}}{1-9x^3}$   
 (3)  $\frac{3x}{1-9x^3}$  (4)  $\frac{3}{1+9x^3}$
11. If  $(2 + \sin x) \frac{dy}{dx} + (y + 1)\cos x = 0$  and  $y(0) = 1$ , then  $y\left(\frac{\pi}{2}\right)$  is equal to:
- (1)  $\frac{1}{3}$  (2)  $-\frac{2}{3}$   
 (3)  $-\frac{1}{3}$  (4)  $\frac{4}{3}$
- \*12. Let a vertical tower  $AB$  have its end  $A$  on the level ground. Let  $C$  be the mid-point of  $AB$  and  $P$  be a point on the ground such that  $AP = 2AB$ . If  $\angle BPC = \beta$ , then  $\tan \beta$  is equal to:
- (1)  $\frac{6}{7}$  (2)  $\frac{1}{4}$   
 (3)  $\frac{2}{9}$  (4)  $\frac{4}{9}$
13. If  $A = \begin{bmatrix} 2 & -3 \\ -4 & 1 \end{bmatrix}$ , then  $\text{adj}(3A^2 + 12A)$  is equal to:
- (1)  $\begin{bmatrix} 72 & -84 \\ -63 & 51 \end{bmatrix}$  (2)  $\begin{bmatrix} 51 & 63 \\ 84 & 72 \end{bmatrix}$   
 (3)  $\begin{bmatrix} 51 & 84 \\ 63 & 72 \end{bmatrix}$  (4)  $\begin{bmatrix} 72 & -63 \\ -84 & 51 \end{bmatrix}$
- \*14. For any three positive real numbers  $a, b$  and  $c$ ,  $9(25a^2 + b^2) + 25(c^2 - 3ac) = 15b(3a + c)$ . Then:
- (1)  $b, c$  and  $a$  are in G.P. (2)  $b, c$  and  $a$  are in A.P.  
 (3)  $a, b$  and  $c$  are in A.P. (4)  $a, b$  and  $c$  are in G.P.

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15. The distance of the point  $(1, 3, -7)$  from the plane passing through the point  $(1, -1, -1)$ , having normal perpendicular to both the lines  $\frac{x-1}{1} = \frac{y+2}{-2} = \frac{z-4}{3}$  and  $\frac{x-2}{2} = \frac{y+1}{-1} = \frac{z+7}{-1}$ , is:
- (1)  $\frac{20}{\sqrt{74}}$  (2)  $\frac{10}{\sqrt{83}}$   
 (3)  $\frac{5}{\sqrt{83}}$  (4)  $\frac{10}{\sqrt{74}}$
16. Let  $I_n = \int \tan^n x \, dx$ , ( $n > 1$ ). If  $I_4 + I_6 = a \tan^5 x + bx^5 + C$ , where  $C$  is a constant of integration, then the ordered pair  $(a, b)$  is equal to:
- (1)  $\left(-\frac{1}{5}, 1\right)$  (2)  $\left(\frac{1}{5}, 0\right)$   
 (3)  $\left(\frac{1}{5}, -1\right)$  (4)  $\left(-\frac{1}{5}, 0\right)$
- \*17. The eccentricity of an ellipse whose centre is at the origin is  $\frac{1}{2}$ . If one of its directrices is  $x = -4$ , then the equation of the normal to it at  $\left(1, \frac{3}{2}\right)$  is:
- (1)  $2y - x = 2$  (2)  $4x - 2y = 1$   
 (3)  $4x + 2y = 7$  (4)  $x + 2y = 4$
- \*18. A hyperbola passes through the point  $P(\sqrt{2}, \sqrt{3})$  and has foci at  $(\pm 2, 0)$ . Then the tangent to this hyperbola at  $P$  also passes through the point:
- (1)  $(3\sqrt{2}, 2\sqrt{3})$  (2)  $(2\sqrt{2}, 3\sqrt{3})$   
 (3)  $(\sqrt{3}, \sqrt{2})$  (4)  $(-\sqrt{2}, -\sqrt{3})$
19. The function  $f : \mathbb{R} \rightarrow \left[-\frac{1}{2}, \frac{1}{2}\right]$  defined as  $f(x) = \frac{x}{1+x^2}$ , is:
- (1) invertible. (2) injective but not surjective.  
 (3) surjective but not injective. (4) neither injective nor surjective.
20.  $\lim_{x \rightarrow \frac{\pi}{2}} \frac{\cot x - \cos x}{(\pi - 2x)^3}$  equals:
- (1)  $\frac{1}{24}$  (2)  $\frac{1}{16}$   
 (3)  $\frac{1}{8}$  (4)  $\frac{1}{4}$
21. Let  $\vec{a} = 2\hat{i} + \hat{j} - 2\hat{k}$  and  $\vec{b} = \hat{i} + \hat{j}$ . Let  $\vec{c}$  be a vector such that  $|\vec{c} - \vec{a}| = 3$ ,  $|(\vec{a} \times \vec{b}) \times \vec{c}| = 3$  and the angle between  $\vec{c}$  and  $\vec{a} \times \vec{b}$  be  $30^\circ$ . Then  $\vec{a} \cdot \vec{c}$  is equal to:
- (1)  $\frac{25}{8}$  (2) 2  
 (3) 5 (4)  $\frac{1}{8}$

22. The normal to the curve  $y(x - 2)(x - 3) = x + 6$  at the point where the curve intersects the  $y$ -axis passes through the point:
- (1)  $\left(-\frac{1}{2}, -\frac{1}{2}\right)$  (2)  $\left(\frac{1}{2}, \frac{1}{2}\right)$   
 (3)  $\left(\frac{1}{2}, -\frac{1}{3}\right)$  (4)  $\left(\frac{1}{2}, \frac{1}{3}\right)$
23. If two different numbers are taken from the set  $\{0, 1, 2, 3, \dots, 10\}$ ; then the probability that their sum as well as absolute difference are both multiple of 4, is:
- (1)  $\frac{6}{55}$  (2)  $\frac{12}{55}$   
 (3)  $\frac{14}{45}$  (4)  $\frac{7}{55}$
- \*24. A man X has 7 friends, 4 of them are ladies and 3 are men. His wife Y also has 7 friends, 3 of them are ladies and 4 are men. Assume X and Y have no common friends. Then the total number of ways in which X and Y together can throw a party inviting 3 ladies and 3 men, so that 3 friends of each of X and Y are in this party, is:
- (1) 485 (2) 468  
 (3) 469 (4) 484
- \*25. The value of  $\binom{21}{1} - \binom{10}{1} + \binom{21}{2} - \binom{10}{2} + \binom{21}{3} - \binom{10}{3} + \binom{21}{4} - \binom{10}{4} + \dots + \binom{21}{10} - \binom{10}{10}$  is:
- (1)  $2^{21} - 2^{11}$  (2)  $2^{21} - 2^{10}$   
 (3)  $2^{20} - 2^9$  (4)  $2^{20} - 2^{10}$
26. A box contains 15 green and 10 yellow balls. If 10 balls are randomly drawn, one-by-one, with replacement, then the variance of the number of green balls drawn is:
- (1)  $\frac{12}{5}$  (2) 6  
 (3) 4 (4)  $\frac{6}{25}$
27. Let  $a, b, c \in \mathbb{R}$ . If  $f(x) = ax^2 + bx + c$  is such that  $a + b + c = 3$  and  $f(x + y) = f(x) + f(y) + xy, \forall x, y \in \mathbb{R}$ , then  $\sum_{n=1}^{10} f(n)$  is equal to:
- (1) 330 (2) 165  
 (3) 190 (4) 255
- \*28. The radius of a circle, having minimum area, which touches the curve  $y = 4 - x^2$  and the lines,  $y = |x|$  is:
- (1)  $2(\sqrt{2} + 1)$  (2)  $2(\sqrt{2} - 1)$   
 (3)  $4(\sqrt{2} - 1)$  (4)  $4(\sqrt{2} + 1)$
29. If, for a positive integer  $n$ , the quadratic equation,  $x(x + 1) + (x + 1)(x + 2) + \dots + (x + n - 1)(x + n) = 10n$  has two consecutive integral solutions, then  $n$  is equal to:
- (1) 12 (2) 9  
 (3) 10 (4) 11
30. The integral  $\int_{\frac{\pi}{4}}^{\frac{3\pi}{4}} \frac{dx}{1 + \cos x}$  is equal to:
- (1) -2 (2) 2  
 (3) 4 (4) -1

**PART B - PHYSICS**

**ALL THE GRAPHS/DIAGRAMS GIVEN ARE SCHEMATIC AND NOT DRAWN TO SCALE.**

31. A radioactive nucleus A with a half life T, decays into a nucleus B. At  $t = 0$ , there is no nucleus B. At sometime t, the ratio of the number of B to that of A is 0.3. Then, t is given by :

- (1)  $t = \frac{T}{\log(1.3)}$  (2)  $t = \frac{T \log 2}{2 \log 1.3}$   
 (3)  $t = T \frac{\log 1.3}{\log 2}$  (4)  $t = T \log(1.3)$

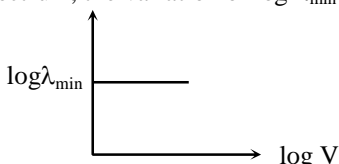
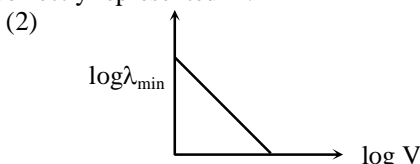
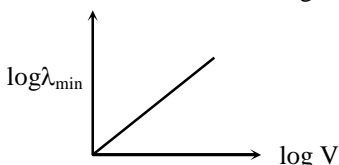
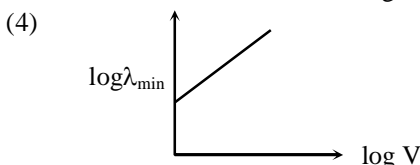
32. The following observations were taken for determining surface tension T of water by capillary method:  
 diameter of capillary,  $D = 1.25 \times 10^{-2}$  m  
 rise of water,  $h = 1.45 \times 10^{-2}$  m

Using  $g = 9.80 \text{ m/s}^2$  and the simplified relation  $T = \frac{r h g}{2} \times 10^3 \text{ N/m}$ , the possible error in surface tension is

closest to :

- (1) 10 % (2) 0.15 %  
 (3) 1.5 % (4) 2.4 %

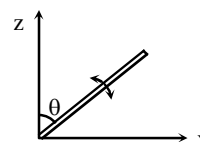
33. An electron beam is accelerated by a potential difference V to hit a metallic target to produce X-rays. It produces continuous as well as characteristic X-rays. If  $\lambda_{\min}$  is the smallest possible wavelength of X-ray in the spectrum, the variation of  $\log \lambda_{\min}$  with  $\log V$  is correctly represented in:

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

\*34. The moment of inertia of a uniform cylinder of length  $\ell$  and radius R about its perpendicular bisector is I. What is the ratio  $\ell/R$  such that the moment of inertia is minimum ?

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

\*35. A slender uniform rod of mass M and length  $\ell$  is pivoted at one end so that it can rotate in a vertical plane (see figure). There is negligible friction at the pivot. The free end is held vertically above the pivot and then released. The angular acceleration of the rod when it makes an angle  $\theta$  with the vertical is:

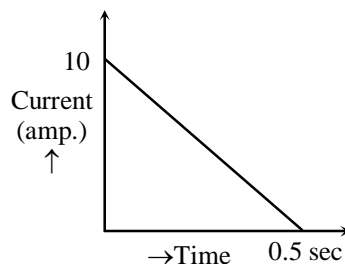


- (1)  $\frac{2g}{3\ell} \cos \theta$  (2)  $\frac{3g}{2\ell} \sin \theta$   
 (3)  $\frac{2g}{3\ell} \sin \theta$  (4)  $\frac{3g}{2\ell} \cos \theta$

- \*36.  $C_p$  and  $C_v$  are specific heats at constant pressure and constant volume respectively. It is observed that  
 $C_p - C_v = a$  for hydrogen gas  
 $C_p - C_v = b$  for nitrogen gas  
 The correct relation between a and b is
- (1)  $a = 28b$  (2)  $a = \frac{1}{14}b$   
 (3)  $a = b$  (4)  $a = 14b$
- \*37. A copper ball of mass 100 gm is at a temperature T. It is dropped in a copper calorimeter of mass 100 gm, filled with 170 gm of water at room temperature. Subsequently, the temperature of the system is found to be  $75^\circ\text{C}$ . T is given by: (Given : room temperature =  $30^\circ\text{C}$ , specific heat of copper =  $0.1 \text{ cal/gm}^\circ\text{C}$ )
- (1)  $825^\circ\text{C}$  (2)  $800^\circ\text{C}$   
 (3)  $885^\circ\text{C}$  (4)  $1250^\circ\text{C}$
38. In amplitude modulation, sinusoidal carrier frequency used is denoted by  $\omega_c$  and the signal frequency is denoted by  $\omega_m$ . The bandwidth ( $\Delta\omega_m$ ) of the signal is such that  $\Delta\omega_m \ll \omega_c$ . Which of the following frequencies is **not** contained in the modulated wave?
- (1)  $\omega_c - \omega_m$  (2)  $\omega_m$   
 (3)  $\omega_c$  (4)  $\omega_m + \omega_c$
- \*39. The temperature of an open room of volume  $30 \text{ m}^3$  increases from  $17^\circ\text{C}$  to  $27^\circ\text{C}$  due to the sunshine. The atmospheric pressure in the room remains  $1 \times 10^5 \text{ Pa}$ . If  $n_i$  and  $n_f$  are the number of molecules in the room before and after heating, then  $n_f - n_i$  will be :
- (1)  $-2.5 \times 10^{25}$  (2)  $-1.61 \times 10^{23}$   
 (3)  $1.38 \times 10^{23}$  (4)  $2.5 \times 10^{25}$
40. In a Young's double slit experiment, slits are separated by 0.5 mm, and the screen is placed 150 cm away. A beam of light consisting of two wavelengths, 650 nm and 520 nm, is used to obtain interference fringes on the screen. The least distance from the common central maximum to the point where the bright fringes due to both the wavelengths coincide is
- (1) 15.6 mm (2) 1.56 mm  
 (3) 7.8 mm (4) 9.75 mm
41. A particle A of mass m and initial velocity v collides with a particle B of mass  $\frac{m}{2}$  which is at rest. The collision is head on, and elastic. The ratio of the de-Broglie wavelengths  $\lambda_A$  to  $\lambda_B$  after the collision is:
- (1)  $\frac{\lambda_A}{\lambda_B} = \frac{1}{2}$  (2)  $\frac{\lambda_A}{\lambda_B} = \frac{1}{3}$   
 (3)  $\frac{\lambda_A}{\lambda_B} = 2$  (4)  $\frac{\lambda_A}{\lambda_B} = \frac{2}{3}$
42. A magnetic needle of magnetic moment  $6.7 \times 10^{-2} \text{ Am}^2$  and moment of inertia  $7.5 \times 10^{-6} \text{ kg m}^2$  is performing simple harmonic oscillations in a magnetic field of 0.01 T. Time taken for 10 complete oscillations is:
- (1) 8.76 s (2) 6.65 s  
 (3) 8.89 s (4) 6.98 s
43. An electric dipole has a fixed dipole moment  $\vec{p}$ , which makes angle  $\theta$  with respect to x-axis. When subjected to an electric field  $\vec{E}_1 = E\hat{i}$ , it experiences a torque  $\vec{T}_1 = \tau\hat{k}$ . When subjected to another electric field  $\vec{E}_2 = \sqrt{3}E\hat{j}$  it experiences a torque  $\vec{T}_2 = -\vec{T}_1$ . The angle  $\theta$  is:
- (1)  $90^\circ$  (2)  $30^\circ$   
 (3)  $45^\circ$  (4)  $60^\circ$

44. In a coil of resistance  $100 \Omega$ , a current is induced by changing the magnetic flux through it as shown in the figure. The magnitude of change in flux through the coil is:

- (1) 275 Wb
- (2) 200 Wb
- (3) 225 Wb
- (4) 250 Wb

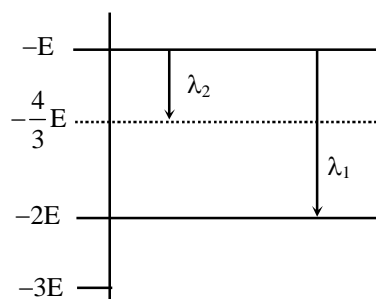


\*45. A time dependent force  $F = 6t$  acts on a particle of mass 1 kg. If the particle starts from rest, the work done by the force during the first 1 sec. will be:

- (1) 18 J
- (2) 4.5 J
- (3) 22 J
- (4) 9 J

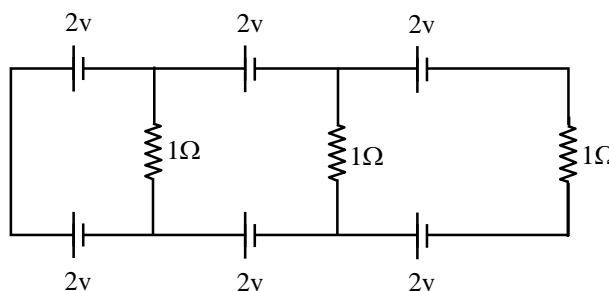
46. Some energy levels of a molecule are shown in the figure. The ratio of the wavelengths  $r = \lambda_1/\lambda_2$ , is given by:

- (1)  $r = \frac{1}{3}$
- (2)  $r = \frac{4}{3}$
- (3)  $r = \frac{2}{3}$
- (4)  $r = \frac{3}{4}$



47. In the given circuit, the current in each resistance is:

- (1) 0 A
- (2) 1 A
- (3) 0.25 A
- (4) 0.5 A



\*48. A body is thrown vertically upwards. Which one of the following graphs correctly represent the velocity vs time?

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

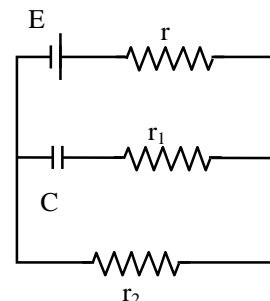


49. A capacitance of  $2 \mu\text{F}$  is required in an electrical circuit across a potential difference of  $1.0 \text{ kV}$ . A large number of  $1 \mu\text{F}$  capacitors are available which can withstand a potential difference of not more than  $300 \text{ V}$ . The minimum number of capacitors required to achieve this is:

- (1) 32 (2) 2  
(3) 16 (4) 24

50. In the given circuit diagram when the current reaches steady state in the circuit, the charge on the capacitor of capacitance  $C$  will be:

- (1)  $CE \frac{r_1}{(r_1 + r)}$  (2)  $CE$   
(3)  $CE \frac{r_1}{(r_2 + r)}$  (4)  $CE \frac{r_2}{(r + r_2)}$



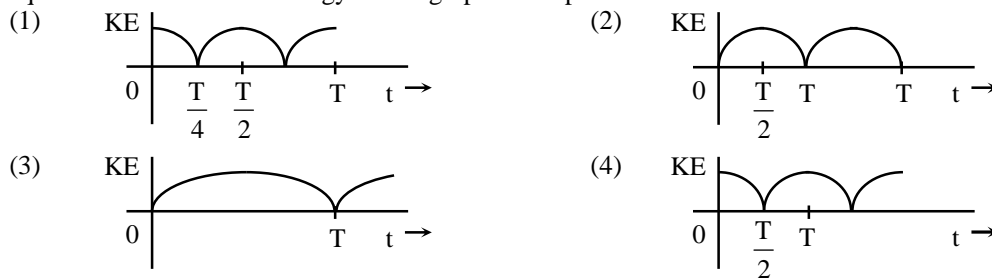
51. In a common emitter amplifier circuit using an n-p-n transistor, the phase difference between the input and the output voltages will be:

- (1)  $180^\circ$  (2)  $45^\circ$   
(3)  $90^\circ$  (4)  $135^\circ$

52. Which of the following statements is **false**?

- (1) Kirchhoff's second law represents energy conservation.  
(2) Wheatstone bridge is the most sensitive when all the four resistances are of the same order of magnitude.  
(3) In a balanced wheatstone bridge if the cell and the galvanometer are exchanged, the null point is disturbed.  
(4) A rheostat can be used as a potential divider.

- \*53. A particle is executing simple harmonic motion with a time period  $T$ . At time  $t = 0$ , it is at its position of equilibrium. The kinetic energy – time graph of the particle will look like:



54. An observer is moving with half the speed of light towards a stationary microwave source emitting waves at frequency  $10 \text{ GHz}$ . What is the frequency of the microwave measured by the observer? (speed of light =  $3 \times 10^8 \text{ ms}^{-1}$ )

- (1)  $15.3 \text{ GHz}$  (2)  $10.1 \text{ GHz}$   
(3)  $12.1 \text{ GHz}$  (4)  $17.3 \text{ GHz}$

- \*55. A man grows into a giant such that his linear dimensions increase by a factor of 9. Assuming that his density remains same, the stress in the leg will change by a factor of:

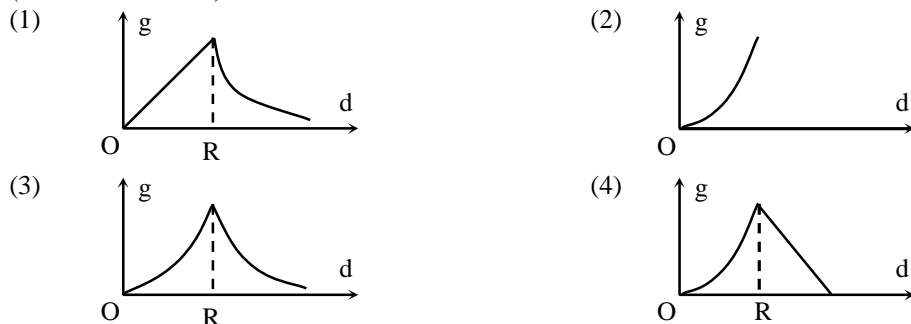
- (1)  $\frac{1}{81}$  (2) 9  
(3)  $\frac{1}{9}$  (4) 81

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56. When a current of 5 mA is passed through a galvanometer having a coil of resistance  $15\Omega$ , it shows full scale deflection. The value of the resistance to be put in series with the galvanometer to convert it into a voltmeter of range 0 – 10V is:

- (1)  $4.005 \times 10^3 \Omega$  (2)  $1.985 \times 10^3 \Omega$   
 (3)  $2.045 \times 10^3 \Omega$  (4)  $2.535 \times 10^3 \Omega$

\*57. The variation of acceleration due to gravity  $g$  with distance  $d$  from centre of the earth is best represented by ( $R = \text{Earth's radius}$ ):



\*58. An external pressure  $P$  is applied on a cube at  $0^\circ\text{C}$  so that it is equally compressed from all sides.  $K$  is the bulk modulus of the material of the cube and  $\alpha$  is its coefficient of linear expansion. Suppose we want to bring the cube to its original size by heating. The temperature should be raised by:

- (1)  $3PK\alpha$  (2)  $\frac{P}{3\alpha K}$   
 (3)  $\frac{P}{\alpha K}$  (4)  $\frac{3\alpha}{PK}$

59. A diverging lens with magnitude of focal length 25 cm is placed at a distance of 15cm from a converging lens of magnitude of focal length 20cm. A beam of parallel light falls on the diverging lens. The final image formed is:

- (1) real and at a distance of 6 cm from the convergent lens.  
 (2) real and at a distance of 40 cm from convergent lens.  
 (3) virtual and at a distance of 40 cm from convergent lens.  
 (4) real and at a distance of 40 cm from the divergent lens.

\*60. A body of mass  $m = 10^{-2} \text{ kg}$  is moving in a medium and experiences a frictional force  $F = -kv^2$ . Its initial speed is  $v_0 = 10 \text{ ms}^{-1}$ . If, after 10 s, its energy is  $\frac{1}{8}mv_0^2$ , the value of  $k$  will be:

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

## PART C - CHEMISTRY

- \*61. 1 gram of a carbonate ( $M_2CO_3$ ) on treatment with excess HCl produces 0.01186 mole of  $CO_2$ . The molar mass of  $M_2CO_3$  in  $g\ mol^{-1}$  is:
- (1) 84.3 (2) 118.6  
(3) 11.86 (4) 1186
- \*62. Given  $C_{(graphite)} + O_2(g) \longrightarrow CO_2(g)$ ;  
 $\Delta_r H^0 = -393.5\ kJ\ mol^{-1}$   
 $H_2(g) + \frac{1}{2}O_2(g) \longrightarrow H_2O(l)$ ;  
 $\Delta_r H^0 = -285.8\ kJ\ mol^{-1}$   
 $CO_2(g) + 2H_2O(l) \longrightarrow CH_4(g) + 2O_2(g)$ ;  
 $\Delta_r H^0 = +890.3\ kJ\ mol^{-1}$
- Based on the above thermochemical equations, the value of  $\Delta_r H^0$  at 298 K for the reaction  $C_{(graphite)} + 2H_2(g) \longrightarrow CH_4(g)$  will be:
- (1)  $+144.0\ kJ\ mol^{-1}$  (2)  $-74.8\ kJ\ mol^{-1}$   
(3)  $-144.0\ kJ\ mol^{-1}$  (4)  $+74.8\ kJ\ mol^{-1}$
63. The freezing point of benzene decreases by  $0.45^\circ C$  when 0.2 g of acetic acid is added to 20g of benzene. If acetic acid associates to form a dimer in benzene, percentage association of acetic acid in benzene will be: ( $K_f$  for benzene =  $5.12\ K\ kg\ mol^{-1}$ )
- (1) 80.4 % (2) 74.6 %  
(3) 94.6 % (4) 64.6 %
- \*64. The most abundant elements by mass in the body of a healthy human adult are: Oxygen (61.4%); Carbon (22.9%), Hydrogen (10.0%); and Nitrogen (2.6%). The weight which a 75 kg person would gain if all  $^1H$  atoms are replaced by  $^2H$  atoms is:
- (1) 37.5 kg (2) 7.5 kg  
(3) 10 kg (4) 15 kg
- \*65.  $\Delta U$  is equal to
- (1) Isobaric work (2) Adiabatic work  
(3) Isothermal work (4) Isochoric work
66. The formation of which of the following polymers involves hydrolysis reaction?
- (1) Bakelite (2) Nylon 6, 6  
(3) Terylene (4) Nylon 6
67. Given  
 $E^0_{Cl_2/Cl^-} = 1.36V, E^0_{Cr^{3+}/Cr} = -0.74\ V$   
 $E^0_{Cr_2O_7^{2-}/Cr^{3+}} = 1.33\ V, E^0_{MnO_4^-/Mn^{2+}} = 1.51V$ .
- Among the following, the strongest reducing agent is
- (1)  $Mn^{2+}$  (2)  $Cr^{3+}$   
(3)  $Cl^-$  (4)  $Cr$

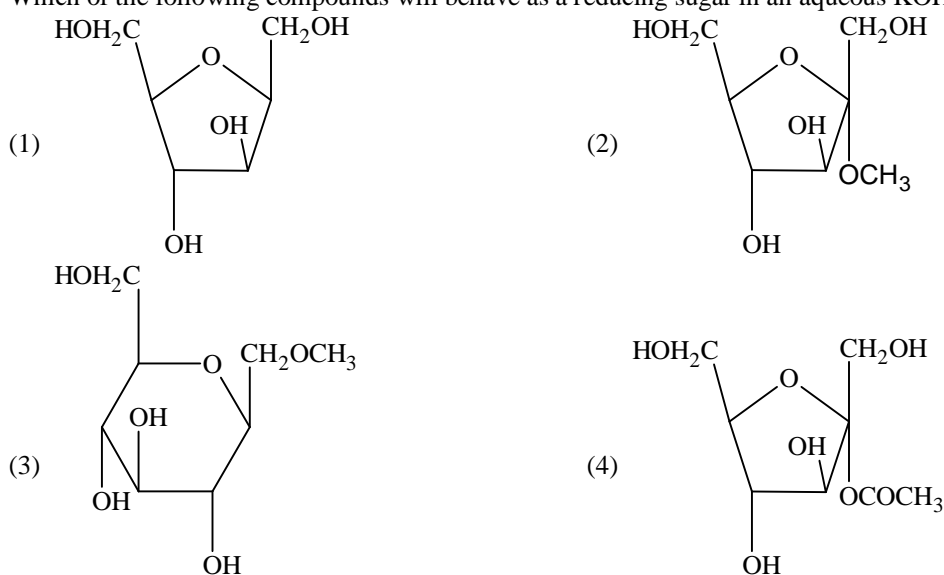
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68. The Tyndall effect is observed only when following conditions are satisfied:  
 (a) The diameter of the dispersed particles is much smaller than the wavelength of the light used.  
 (b) The diameter of the dispersed particle is not much smaller than the wavelength of the light used.  
 (c) The refractive indices of the dispersed phase and dispersion medium are almost similar in magnitude.  
 (d) The refractive indices of the dispersed phase and dispersion medium differ greatly in magnitude.  
 (1) (b) and (d) (2) (a) and (c)  
 (3) (b) and (c) (4) (a) and (d)

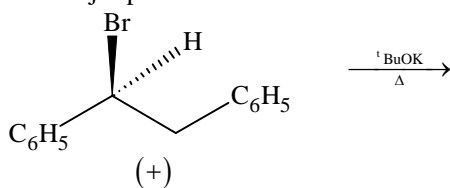
\*69. In the following reactions, ZnO is respectively acting as a/an:

- (a)  $\text{ZnO} + \text{Na}_2\text{O} \longrightarrow \text{Na}_2\text{ZnO}_2$   
 (b)  $\text{ZnO} + \text{CO}_2 \longrightarrow \text{ZnCO}_3$   
 (1) base and base (2) acid and acid  
 (3) acid and base (4) base and acid

70. Which of the following compounds will behave as a reducing sugar in an aqueous KOH solution?



71. The major product obtained in the following reaction is:



- (1)  $\text{C}_6\text{H}_5\text{CH}=\text{CHC}_6\text{H}_5$  (2)  $(+)\text{C}_6\text{H}_5\text{CH}(\text{O}^t\text{Bu})\text{CH}_2\text{C}_6\text{H}_5$   
 (3)  $(-)\text{C}_6\text{H}_5\text{CH}(\text{O}^t\text{Bu})\text{CH}_2\text{C}_6\text{H}_5$  (4)  $(\pm)\text{C}_6\text{H}_5\text{CH}(\text{O}^t\text{Bu})\text{CH}_2\text{C}_6\text{H}_5$

\*72. Which of the following species is **not** paramagnetic?

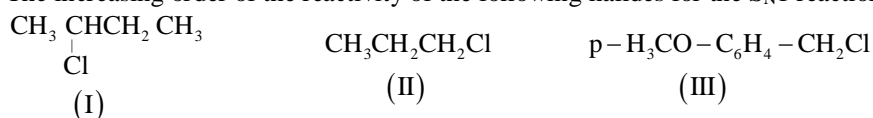
- (1) CO (2)  $\text{O}_2$   
 (3)  $\text{B}_2$  (4) NO

73. On treatment of 100 mL of 0.1 M solution of  $\text{CoCl}_3 \cdot 6\text{H}_2\text{O}$  with excess  $\text{AgNO}_3$ ;  $1.2 \times 10^{22}$  ions are precipitated. The complex is:

- (1)  $[\text{Co}(\text{H}_2\text{O})_3\text{Cl}_3] \cdot 3\text{H}_2\text{O}$  (2)  $[\text{Co}(\text{H}_2\text{O})_6]\text{Cl}_3$   
 (3)  $[\text{Co}(\text{H}_2\text{O})_5\text{Cl}]\text{Cl}_2 \cdot \text{H}_2\text{O}$  (4)  $[\text{Co}(\text{H}_2\text{O})_4\text{Cl}_2]\text{Cl}_2 \cdot 2\text{H}_2\text{O}$

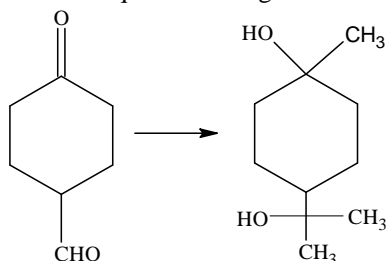
- \*74.  $pK_a$  of a weak acid (HA) and  $pK_b$  of a weak base (BOH) are 3.2 and 3.4, respectively. The pH of their salt (AB) solution is:  
 (1) 6.9 (2) 7.0  
 (3) 1.0 (4) 7.2

75. The increasing order of the reactivity of the following halides for the  $S_N1$  reaction is:

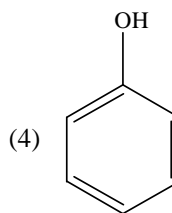
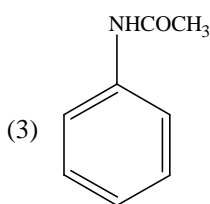
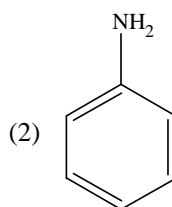
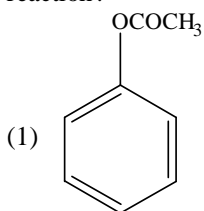


- (1) (II) < (I) < (III) (2) (I) < (III) < (II)  
 (3) (II) < (III) < (I) (4) (III) < (II) < (I)
- \*76. Both lithium and magnesium display several similar properties due to the diagonal relationship; however, the one which is incorrect, is:  
 (1) both form soluble bicarbonates  
 (2) both form nitrides  
 (3) nitrates of both Li and Mg yield  $\text{NO}_2$  and  $\text{O}_2$  on heating  
 (4) both form basic carbonates

77. The correct sequence of reagents for the following conversion will be:



- (1)  $\text{CH}_3\text{MgBr}$ ,  $\text{H}^+ / \text{CH}_3\text{OH}$ ,  $[\text{Ag}(\text{NH}_3)_2]^+ \text{OH}^-$   
 (2)  $\text{CH}_3\text{MgBr}$ ,  $[\text{Ag}(\text{NH}_3)_2]^+ \text{OH}^-$ ,  $\text{H}^+ / \text{CH}_3\text{OH}$   
 (3)  $[\text{Ag}(\text{NH}_3)_2]^+ \text{OH}^-$ ,  $\text{CH}_3\text{MgBr}$ ,  $\text{H}^+ / \text{CH}_3\text{OH}$   
 (4)  $[\text{Ag}(\text{NH}_3)_2]^+ \text{OH}^-$ ,  $\text{H}^+ / \text{CH}_3\text{OH}$ ,  $\text{CH}_3\text{MgBr}$
78. The products obtained when chlorine gas reacts with cold and dilute aqueous NaOH are:  
 (1)  $\text{ClO}_2^-$  and  $\text{ClO}_3^-$  (2)  $\text{Cl}^-$  and  $\text{ClO}^-$   
 (3)  $\text{Cl}^-$  and  $\text{ClO}_2^-$  (4)  $\text{ClO}^-$  and  $\text{ClO}_3^-$
79. Which of the following compounds will form significant amount of *meta* product during mono-nitration reaction?



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\*80. 3-Methyl-pent-2-ene on reaction with HBr in presence of peroxide forms an addition product. The number of possible stereoisomers for the product is :

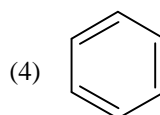
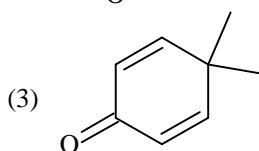
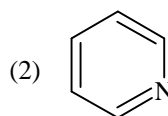
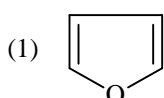
- (1) Zero (2) Two  
(3) Four (4) Six

81. Two reactions  $R_1$  and  $R_2$  have identical pre-exponential factors. Activation energy of  $R_1$  exceeds that of  $R_2$  by  $10 \text{ kJ mol}^{-1}$ . If  $k_1$  and  $k_2$  are rate constants for reactions  $R_1$  and  $R_2$  respectively at  $300 \text{ K}$ , then  $\ln(k_2 / k_1)$  is equal to :

( $R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1}$ )

- (1) 12 (2) 6  
(3) 4 (4) 8

\*82. Which of the following molecules is least resonance stabilized?



\*83. The group having isoelectronic species is:

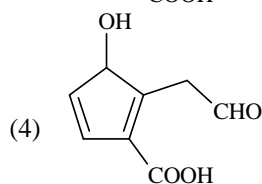
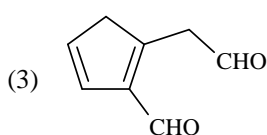
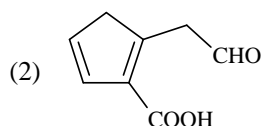
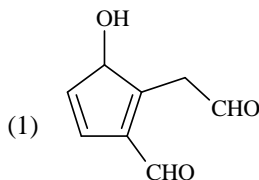
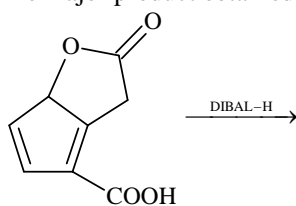
- (1)  $\text{O}^-$ ,  $\text{F}^-$ ,  $\text{Na}$ ,  $\text{Mg}^+$  (2)  $\text{O}^{2-}$ ,  $\text{F}^-$ ,  $\text{Na}$ ,  $\text{Mg}^{2+}$   
(3)  $\text{O}^-$ ,  $\text{F}^-$ ,  $\text{Na}^+$ ,  $\text{Mg}^{2+}$  (4)  $\text{O}^{2-}$ ,  $\text{F}^-$ ,  $\text{Na}^+$ ,  $\text{Mg}^{2+}$

\*84. The radius of the second Bohr orbit for hydrogen atom is:

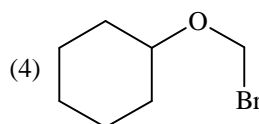
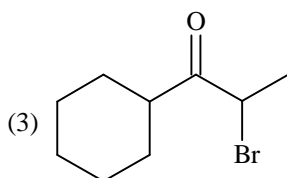
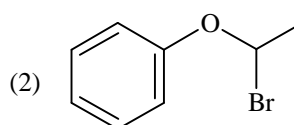
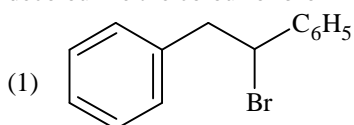
(Planck's Const.  $h = 6.6262 \times 10^{-34} \text{ Js}$ ; mass of electron  $= 9.1091 \times 10^{-31} \text{ kg}$ ; charge of electron  $e = 1.60210 \times 10^{-19} \text{ C}$ ; permittivity of vacuum  $\epsilon_0 = 8.854185 \times 10^{-12} \text{ kg}^{-1} \text{ m}^{-3} \text{ A}^2$ )

- (1)  $4.76 \text{ \AA}$  (2)  $0.529 \text{ \AA}$   
(3)  $2.12 \text{ \AA}$  (4)  $1.65 \text{ \AA}$

85. The major product obtained in the following reaction is:



- \*86. Which of the following reactions is an example of a redox reaction?
- (1)  $\text{XeF}_2 + \text{PF}_5 \longrightarrow [\text{XeF}]^+ \text{PF}_6^-$  (2)  $\text{XeF}_6 + \text{H}_2\text{O} \longrightarrow \text{XeOF}_4 + 2\text{HF}$   
 (3)  $\text{XeF}_6 + 2\text{H}_2\text{O} \longrightarrow \text{XeO}_2\text{F}_2 + 4\text{HF}$  (4)  $\text{XeF}_4 + \text{O}_2\text{F}_2 \longrightarrow \text{XeF}_6 + \text{O}_2$
87. A metal crystallises in a face centred cubic structure. If the edge length of its unit cell is 'a', the closest approach between two atoms in metallic crystal will be:
- (1)  $2\sqrt{2}a$  (2)  $\sqrt{2}a$   
 (3)  $\frac{a}{\sqrt{2}}$  (4)  $2a$
88. Sodium salt of an organic acid 'X' produces effervescence with conc.  $\text{H}_2\text{SO}_4$ . 'X' reacts with the acidified aqueous  $\text{CaCl}_2$  solution to give a white precipitate which decolourises acidic solution of  $\text{KMnO}_4$ . 'X' is:
- (1)  $\text{HCOONa}$  (2)  $\text{CH}_3\text{COONa}$   
 (3)  $\text{Na}_2\text{C}_2\text{O}_4$  (4)  $\text{C}_6\text{H}_5\text{COONa}$
- \*89. A water sample has ppm level concentration of following anions  
 $\text{F}^- = 10$ ;  $\text{SO}_4^{2-} = 100$ ;  $\text{NO}_3^- = 50$   
 The anion/anions that make/makes the water sample unsuitable for drinking is/are:
- (1) both  $\text{SO}_4^{2-}$  and  $\text{NO}_3^-$  (2) only  $\text{F}^-$   
 (3) only  $\text{SO}_4^{2-}$  (4) only  $\text{NO}_3^-$
90. Which of the following, upon treatment with *tert*-BuONa followed by addition of bromine water, fails to decolourize the colour of bromine?



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## ANSWERS

### PART A – MATHEMATICS

1.	4	2.	1	3.	4	4.	2
5.	1	6.	4	7.	3	8.	4
9.	2	10.	1	11.	1	12.	3
13.	2	14.	2	15.	2	16.	2
17.	2	18.	2	19.	3	20.	2
21.	2	22.	2	23.	1	24.	1
25.	4	26.	1	27.	1	28.	3
29.	4	30.	2				

### PART B – PHYSICS

31.	3	32.	3	33.	2	34.	2
35.	2	36.	4	37.	3	38.	2
39.	1	40.	3	41.	3	42.	2
43.	4	44.	4	45.	2	46.	1
47.	1	48.	4	49.	1	50.	4
51.	1	52.	3	53.	1	54.	4
55.	2	56.	2	57.	1	58.	2
59.	2	60.	4				

### PART C – CHEMISTRY

61.	1	62.	2	63.	3	64.	2
65.	2	66.	4	67.	4	68.	1
69.	3	70.	4	71.	1	72.	1
73.	4	74.	1	75.	1	76.	1
77.	4	78.	2	79.	2	80.	3
81.	3	82.	3	83.	4	84.	3
85.	4	86.	4	87.	3	88.	3
89.	2	90.	4				



## HINT AND SOLUTIONS

### PART A – MATHEMATICS

1. Here,  $D = \begin{vmatrix} 1 & 1 & 1 \\ 1 & a & 1 \\ a & b & 1 \end{vmatrix} = 0 \Rightarrow a = 1$

For  $a = 1$ , the equations become

$$x + y + z = 1$$

$$x + y + z = 1$$

$$x + by + z = 0$$

These equations give no solution for  $b = 1$

$\Rightarrow S$  is singleton set

2.  $(p \rightarrow q) \rightarrow ((\sim p \rightarrow q) \rightarrow q)$   
 $= (p \rightarrow q) \rightarrow ((p \vee q) \rightarrow q)$   
 $= (p \rightarrow q) \rightarrow ((\sim p \wedge \sim q) \vee q)$   
 $= (p \rightarrow q) \rightarrow ((\sim p \vee q) \wedge (\sim q \vee q))$   
 $= (p \rightarrow q) \rightarrow (\sim p \vee q)$   
 $= (p \rightarrow q) \rightarrow (p \rightarrow q)$   
 $= T$

3.  $5(\sec^2 x - 1 - \cos^2 x) = 2(2\cos^2 x - 1) + 9$

$$5\left(\frac{1}{t} - 1 - t\right) = 2(2t - 1) + 9$$

$$5(1 - t - t^2) = 4t^2 + 7t$$

$$\Rightarrow 9t^2 + 12t - 5 = 0$$

$$t = \frac{1}{3}, -\frac{5}{3}$$

$$\Rightarrow \cos^2 x = \frac{1}{3}$$

$$\Rightarrow \cos 2x = \frac{2}{3} - 1 = -\frac{1}{3}$$

$$\Rightarrow \cos 4x = -\frac{7}{9}$$

4.  $P(A) + P(B) - 2P(A \cap B) = \frac{1}{4}$

$$P(B) + P(C) - 2P(B \cap C) = \frac{1}{4}$$

$$P(A) + P(C) - 2P(A \cap C) = \frac{1}{4}$$

$$\Rightarrow \sum P(A) - \sum P(A \cap B) = \frac{3}{8}$$

$$\Rightarrow P(A \cup B \cup C) = \sum P(A) - \sum P(A \cap B) + P(A \cap B \cap C)$$

$$= \frac{3}{8} + \frac{1}{16} = \frac{7}{16}$$

5. Determinant simplifies to  $3k = \begin{vmatrix} 1 & 1 & 1 \\ 1 & \omega & \omega^2 \\ 1 & \omega^2 & \omega \end{vmatrix}$

$$= 3 \begin{vmatrix} 1 & 1 & 1 \\ 0 & \omega & \omega^2 \\ 0 & \omega^2 & \omega \end{vmatrix}$$

$$= -3z$$

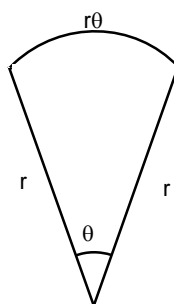
$$\Rightarrow k = -z$$

6.  $\Delta = \frac{1}{2} \begin{vmatrix} k & -3k & 1 \\ 5 & k & 1 \\ -k & 2 & 1 \end{vmatrix} = 28$

$$\Rightarrow k = 2 \text{ (since } k \in \mathbb{I} \text{)}$$

$$\Rightarrow \text{Orthocentre is } \left( 2, \frac{1}{2} \right)$$

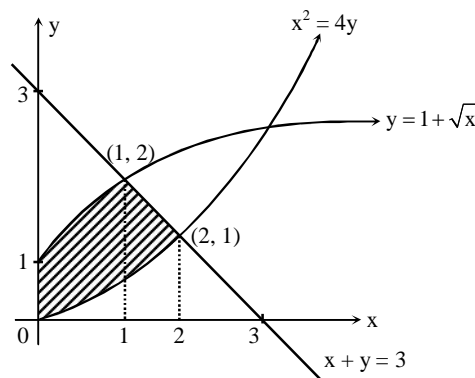
7. Length of wire =  $r(\theta + 2) = 20 \text{ m}$   
 Area  $A = \frac{\theta}{2} r^2$   
 $\Rightarrow A(r) = 10r - r^2$   
 $\Rightarrow$  Area is maximum if  $r = 5$ .  
 Maximum area  $A = 25 \text{ sq. m}$



8. Required area

$$= \int_0^1 (1 + \sqrt{x}) dx + \frac{1}{2}(3 \times 1) - \int_0^2 \frac{x^2}{4} dx$$

$$= \frac{5}{2} \text{ sq. units}$$



9.  $\frac{x-1}{1} = \frac{y+2}{4} = \frac{z-3}{5} = \lambda$

Let midpoint of PQ be M which lies on the plane

$$\Rightarrow M(x, y, z) = (1 + \lambda, 4\lambda - 2, 5\lambda + 3)$$

$$2(1 + \lambda) + 3(4\lambda - 2) - 4(5\lambda + 3) + 22 = 0$$

$$\Rightarrow -6\lambda + 6 = 0 \Rightarrow \lambda = 1$$

$$\Rightarrow M(2, 2, 8), P(1, -2, 3)$$

$$PM = \sqrt{1+16+25} = \sqrt{42}$$

$$PQ = 2\sqrt{42}$$

10. Here,  $y = 2 \tan^{-1} 3x^{\frac{3}{2}}$

$$\frac{dy}{dx} = \frac{9x^{\frac{1}{2}}}{1+9x^3} = \sqrt{x}g(x)$$

$$\Rightarrow g(x) = \frac{9}{1+9x^3}$$

11.  $(2 + \sin x)dy + \cos x(y + 1)dx = 0$

$$(y + 1)(2 + \sin x) = C$$

$$\Rightarrow (1 + 1)(2 + 0) = C = 4$$

$$(y + 1) \cdot (2 + \sin x) = 4$$

Put  $x = \frac{\pi}{2}$

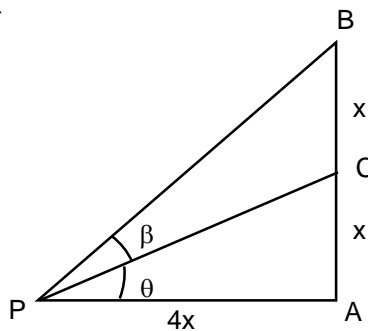
$$y = \frac{1}{3}$$

12.  $\tan(\theta + \beta) = \frac{1}{2}$

and  $\tan \theta = \frac{1}{4}$

$$\Rightarrow \frac{\frac{1}{4} + \tan \beta}{1 - \frac{1}{4} \tan \beta} = \frac{1}{2}$$

$$\Rightarrow 9 \tan \beta = 2 \Rightarrow \tan \beta = \frac{2}{9}$$



13.  $A^2 = \begin{bmatrix} 2 & -3 \\ -4 & 1 \end{bmatrix} \begin{bmatrix} 2 & -3 \\ -4 & 1 \end{bmatrix}$

$$= \begin{bmatrix} 16 & -9 \\ -12 & 13 \end{bmatrix}$$

$$(3A^2 + 12A) = \begin{bmatrix} 72 & -63 \\ -84 & 51 \end{bmatrix}$$

$$\text{Adj}(3A^2 + 12A) = \begin{bmatrix} 51 & 63 \\ 84 & 72 \end{bmatrix}$$

14.  $(15a - 3b)^2 + (15a - 5c)^2 + (3b - 5c)^2 = 0$

Let,  $15a = 3b = 5c = 45\lambda$

$$\Rightarrow a = 3\lambda; b = 15\lambda; c = 9\lambda$$

$$\Rightarrow 2c = a + b$$

b, c, a are in A.P.

15. Equation of plane is  $\begin{vmatrix} x-1 & y+1 & z+1 \\ 1 & -2 & 3 \\ 2 & -1 & -1 \end{vmatrix} = 0$

$$5x + 7y + 3z + 5 = 0$$

$$\text{Distance from } (1, 3, -7) = \frac{|5 + 21 - 21 + 5|}{\sqrt{83}} = \frac{10}{\sqrt{83}}$$

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16.  $I_n = \int \tan^n x dx, n > 1$   
 $= \int \tan^{n-2} x (\sec^2 x - 1) dx$   
 $= \frac{\tan^{n-1} x}{n-1} - I_{n-2} + C$

$\Rightarrow I_n + I_{n-2} = \frac{\tan^{n-1} x}{n-1} + C$

$\Rightarrow I_6 + I_4 = \frac{\tan^5 x}{5} + C$

Given,  $I_4 + I_6 = a \tan^5 x + bx^3 + C$

$\Rightarrow a = \frac{1}{5}, b = 0$

17. Eccentricity,  $e = \frac{1}{2}$

Let 2a be the length of major axis and 2b be the length of minor axis

$\Rightarrow \frac{a}{e} = 4$

$\Rightarrow a = 2$

Also,  $b = \sqrt{3}$ , as  $e = \frac{1}{2}$

$\Rightarrow$  Equation of ellipse is  $\frac{x^2}{4} + \frac{y^2}{3} = 1$

$\Rightarrow$  Equation of normal at  $\left(1, \frac{3}{2}\right)$  is  $4x - 2y = 1$

18.  $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$

$\frac{x^2}{a^2} - \frac{y^2}{4-a^2} = 1$

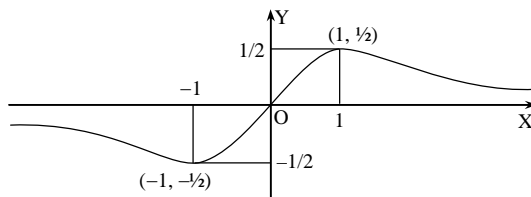
$\Rightarrow a^2 = 8, 1, (a^2 \neq 8)$

$\Rightarrow \frac{x^2}{1} - \frac{y^2}{3} = 1$

Hence equation of tangent at  $P(\sqrt{2}, \sqrt{3})$  is  $\frac{x\sqrt{2}}{1} - \frac{y\sqrt{3}}{3} = 1$

$\Rightarrow \sqrt{6}x - y = \sqrt{3}$

19. For,  $f(x) = \frac{x}{1+x^2}$  the curve has graph as shown



Which is onto but not one-one for,  $f : \mathbb{R} \rightarrow \left[-\frac{1}{2}, \frac{1}{2}\right]$

20. 
$$\lim_{x \rightarrow \frac{\pi}{2}} \frac{\cos x - \cot x}{8 \left( x - \frac{\pi}{2} \right)^3}$$

Put  $x - \frac{\pi}{2} = t$ ;  $x = t + \frac{\pi}{2}$

$$\lim_{t \rightarrow 0} \frac{1}{8} \cdot \frac{-\sin t + \tan t}{t^3}$$

$$\lim_{t \rightarrow 0} \frac{1}{8} \cdot \frac{\sin t(1 - \cos t)}{t \cdot \cos t \cdot t^2}$$

$$= \frac{1}{8} \cdot 1 \cdot \frac{1}{2} = \frac{1}{16}$$

21.  $|\vec{c}|^2 + |\vec{a}|^2 - 2\vec{a} \cdot \vec{c} = 9$

$$\Rightarrow |\vec{c}|^2 - 2\vec{a} \cdot \vec{c} = 0$$

and  $|\vec{a} \times \vec{b}| \cdot |\vec{c}| \cdot \sin 30^\circ = 3$

$$\Rightarrow 3 \times |\vec{c}| \times \frac{1}{2} = 3$$

$$\Rightarrow |\vec{c}| = 2$$

$$\therefore \vec{a} \cdot \vec{c} = 2$$

22.  $\frac{dy}{dx}$  at  $x = 0$  is 1

$$\Rightarrow \text{Slope of normal at } (0, 1) \text{ is } -1$$

$$\Rightarrow \text{Equation of normal is } x + y = 1$$

23. Consider two sequences : 0, 4, 8 and 2, 6, 10  
Take both numbers from either of these sequences.

$$\text{Hence, probability} = \frac{{}^3C_2 + {}^3C_2}{{}^{11}C_2} = \frac{6}{55}$$

24. X : 4L, 3M; Y : 3L, 4M

Possible combinations

	(1)	(2)	(3)	(4)
X	3L	2L, 1M	1L, 2M	3M
Y	3M	1L, 2M	2L, 1M	3L

$$\therefore \text{Number of ways} = {}^4C_3 \cdot {}^4C_3 + {}^4C_2 \cdot {}^3C_1 \cdot {}^3C_1 \cdot {}^4C_2 + {}^4C_1 \cdot {}^3C_2 \cdot {}^3C_2 \cdot {}^4C_1 + {}^3C_3 \cdot {}^3C_3$$

$$= 485$$

25. Let  $S = ({}^{21}C_1 - {}^{10}C_1) + ({}^{21}C_2 - {}^{10}C_2) + \dots + ({}^{21}C_{10} - {}^{10}C_{10})$

$$\Rightarrow S = ({}^{21}C_0 + {}^{21}C_1 + \dots + {}^{21}C_{10}) - ({}^{10}C_0 + {}^{10}C_1 + \dots + {}^{10}C_{10})$$

$$\Rightarrow S = 2^{20} - 2^{10}$$

26.  $p = \frac{15}{25}$ ,  $q = \frac{10}{25}$ ,  $n = 10$

$$\sigma^2 = npq = 10 \cdot \frac{3}{5} \cdot \frac{2}{5} = \frac{12}{5}$$

27. Partially differentiating, we get  
 $f'(x) - x = \text{constant} = \lambda$   
 $\Rightarrow f(x) = \frac{x^2}{2} + \lambda x + k$   
 $f(0) = 0 \Rightarrow k = 0$   
 $\frac{1}{2} + \lambda = 3 \Rightarrow \lambda = \frac{5}{2}$   
 $\sum_{n=1}^{10} f(n) = a \sum_{n=1}^{10} n^2 + b \sum_{n=1}^{10} n$   
 $= \frac{1}{2} \frac{n(n+1)(2n+1)}{6} + \frac{5}{2} \times \frac{n(n+1)}{2}$   
 $= \frac{1}{2} \cdot \frac{10 \times 11 \times 21}{6} + \frac{5}{2} \times \frac{10 \times 11}{2} = 330.$

28. Let  $P\left(\frac{t}{2}, 4 - \frac{t^2}{4}\right)$  be point where circle touches the parabola  $y = 4 - x^2$

$\Rightarrow$  Normal at P:  $ty - x + \frac{t^3}{4} - \frac{7t}{2} = 0$  to the parabola passes through centre (c) of the circle  $(0, \beta)$ .  
 $\Rightarrow t^3 - 14t + 4\beta t = 0 \dots (1)$

Also, radius  $r = \frac{|\beta|}{\sqrt{2}}$   
 $\Rightarrow t^4 + 4t^2 + 8\beta t^2 - 32t^2 - 128\beta + 256 + 16\beta^2 = 16r^2$   
 $\Rightarrow t^4 + (8\beta - 28)t^2 - 128\beta + 256 + 8\beta^2 = 0 \dots (2)$

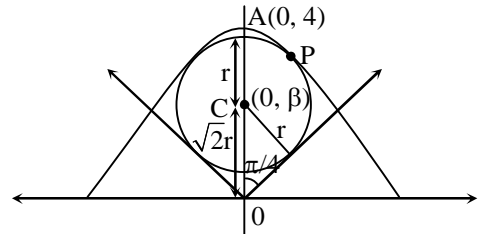
From equation (1) and (2), we get  
 Either  $\beta = 8 \pm 4\sqrt{2}$  for  $t = 0$

or  $\beta = \frac{-\sqrt{2} \pm \sqrt{17}}{\sqrt{2}}$  for  $t^2 = 14 - 4\beta$

As,  $r = \frac{|\beta|}{\sqrt{2}} \Rightarrow r = 4\sqrt{2} \pm 4, \frac{\sqrt{17} - \sqrt{2}}{2}$

$\Rightarrow$  Minimum possible radius,  $r = \frac{\sqrt{17} - \sqrt{2}}{2}$

**[But of the given options  $r = 4(\sqrt{2} - 1)$  is minimum]**



29.  $x^2 + nx + \frac{n^2 - 31}{3} = 0$

Let I and I + 1 be the roots of the equation  
 $2I + 1 = -n \dots (1)$

$I(I + 1) = \frac{n^2 - 31}{3} \dots (2)$

Eliminating I from (1) and (2), we get

$\frac{n^2 - 1}{4} = \frac{n^2 - 31}{3}$

$\Rightarrow n^2 = 121$

$\Rightarrow n = 11.$

$$30. \quad I = \int_{\frac{\pi}{4}}^{\frac{3\pi}{4}} (\operatorname{cosec}^2 x - \operatorname{cosec} x \cdot \cot x) dx$$

$$= 2$$

**PART B – PHYSICS**

$$31. \quad \frac{N_0 - N}{N} = 0.3$$

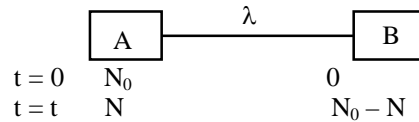
$$\Rightarrow N = \frac{N_0}{1.3}$$

$$N = N_0 e^{-\lambda t}$$

$$\Rightarrow \frac{1}{1.3} = e^{-\lambda t}$$

$$\Rightarrow t = \frac{\ell n(1.3)}{\lambda} = T \frac{\ell n(1.3)}{\ell n(2)}$$

$$\therefore \lambda = \frac{\ell n 2}{T}$$



$$32. \quad T = \frac{r h g}{2} \times 10^3 \text{ N/m}$$

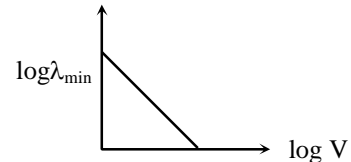
$$\frac{\Delta T}{T} = \left| \frac{\Delta r}{r} \right| + \left| \frac{\Delta h}{h} \right| = \frac{0.01}{1.25} + \frac{0.01}{1.45}$$

$$\% \text{ error} = \frac{\Delta T}{T} \times 100 = \frac{1}{1.25} + \frac{1}{1.45} = 0.8 + 0.69 \approx 1.5\%$$

$$33. \quad \frac{hc}{\lambda_{\min}} = eV$$

$$\log \frac{hc}{e} - \log \lambda_{\min} = \log V$$

$$\Rightarrow \log \lambda_{\min} = k - \log V$$



$$34. \quad I = \frac{m}{12} [3R^2 + \ell^2] \quad \left( R^2 = \frac{m}{\pi \ell \rho} \right)$$

$$= \frac{m}{12} \left[ \frac{3m}{\pi \rho} \ell^{-1} + \ell^2 \right]$$

$$\frac{dI}{d\ell} = \frac{m}{12} \left[ -\frac{3m}{\pi \rho \ell^2} + 2\ell \right]$$

For minima

$$0 = \frac{-3m}{\pi \rho \ell^2} + 2\ell$$

$$\Rightarrow \frac{3\pi R^2 \ell \rho}{\pi \rho \ell^2} = 2\ell$$

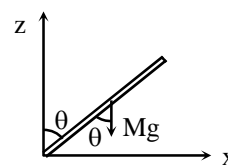
$$\Rightarrow \frac{\ell}{R} = \sqrt{\frac{3}{2}}$$

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35.  $\tau = I\alpha$

$$\Rightarrow Mg \frac{\ell}{2} \sin \theta = \frac{M\ell^2}{3} \alpha$$

$$\Rightarrow \alpha = \frac{3g}{2\ell} \sin \theta$$



36. For ideal gas

$$C_p - C_v = R/M$$

If  $C_p$  and  $C_v$  are specific heats ( $J/kg - ^\circ C$ )

$M$  = molar mass of gas

$$\Rightarrow a = R/2 \text{ and } b = R/28$$

$$\Rightarrow a = 14b$$

37. Final temperature of calorimeter and its contents is given,  $T_0 = 75^\circ C$

$$\Rightarrow 100 \times 0.1 \times (75 - T) + 100 \times 0.1 (75 - 30) + 170 \times 1 \times (75 - 30) = 0$$

$$\Rightarrow 75 - T + 45 + 765 = 0$$

$$\Rightarrow T = 885^\circ C$$

38. Modulated signal can be written as

$$C_m(t) = (A_c + A_m \sin \omega_m t) \sin \omega_c t$$

$$\Rightarrow C_m(t) = A_c \sin \omega_c t + \frac{\mu A_c}{2} \cos(\omega_c - \omega_m)t - \frac{\mu A_c}{2} \cos(\omega_c + \omega_m)t$$

where  $\mu = \frac{A_m}{A_c}$

39. Using,  $n = \left( \frac{PV}{RT} \right)$

$$n_f - n_i = \frac{PV}{R} \left( \frac{1}{T_f} - \frac{1}{T_i} \right) \text{ moles}$$

$$= \frac{1 \times 10^5 \times 30}{8.32} \left( \frac{1}{300} - \frac{1}{290} \right) \times 6.023 \times 10^{23} \text{ molecules}$$

$$= -2.5 \times 10^{25} \text{ molecules}$$

40.  $y = \frac{m \times 650 \times 10^{-9} \times D}{d} = \frac{n \times 520 \times 10^{-9} \times D}{d}$

$$\Rightarrow \frac{m}{n} = \frac{4}{5} \Rightarrow \text{minimum values of } m \text{ and } n \text{ will be } 4 \text{ and } 5 \text{ respectively.}$$

$$y = \frac{4 \times 650 \times 10^{-9} \times 1.5}{5 \times 10^{-4}} \text{ meter}$$

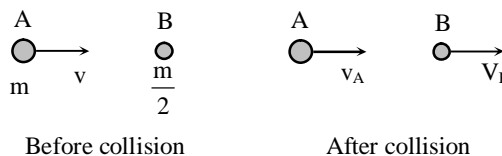
$$= 7.8 \text{ mm}$$

41.  $mv = mv_A + \frac{m}{2} v_B$  (conservation of linear momentum)

$$\therefore v = v_A + \frac{v_B}{2} = v_B - v_A \text{ (elastic collision)}$$

$$\therefore \frac{v_B}{v_A} = 4$$

$$\therefore \frac{\lambda_A}{\lambda_B} = \frac{m_B v_B}{m_A v_A} = 2$$

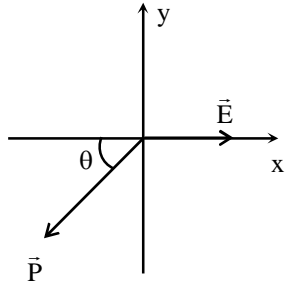




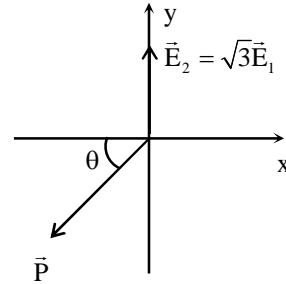
42. 
$$T = 2\pi\sqrt{\frac{I}{MB}}$$

$$= 2\pi\sqrt{\frac{7.5 \times 10^{-6}}{6.7 \times 10^{-2} \times 0.01}} = 0.665 \text{ sec}$$
 So, time of 10 oscillations = 6.65 sec

43. From the given information



Case - I



Case - II

$$\therefore PE_1 \sin \theta = \sqrt{3}PE_1 \sin\left(\frac{\pi}{2} + \theta\right)$$

$$\therefore \theta = 60^\circ$$

44. Change in flux =  $R \int i dt = 250 \text{ Wb}$

45. From impulse momentum theorem

$$\int_0^1 6t dt = mv$$

$$\therefore v = 3 \text{ m/s}$$

So, work done by the force =  $\Delta K.E. = \frac{1}{2}(1)(3)^2 = 4.5 \text{ J}$

46.  $\Delta E \propto \frac{1}{\lambda}$   

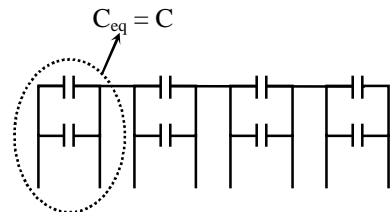
$$\Rightarrow \frac{\lambda_1}{\lambda_2} = \frac{\Delta E_2}{\Delta E_1} = \frac{1}{3}$$

47. Potential difference across each resistor is zero.

48.  $v = u - gt$

49.  $\frac{C}{4} = 2 \Rightarrow C = 8 \mu\text{F}$

Which requires eight  $1 \mu\text{F}$  capacitors in parallel.  
 $\Rightarrow$  Minimum number of capacitors required is 32.



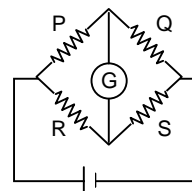
50.  $q = CV$   

$$= \frac{CEr_2}{r + r_2}$$

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51. In common emitter amplifier circuit the output voltage is out of phase w.r.t. input voltage.

52. The balanced condition is given by  $\frac{P}{Q} = \frac{R}{S}$ ; When battery and Galvanometer are exchanged, it become  $\frac{P}{R} = \frac{Q}{S}$ ; which is same as previous



53. For given SHM  $x = A \sin \omega t$

$$v = \frac{dx}{dt} = A\omega \cos \omega t$$

$$KE = \frac{1}{2}mv^2 = \frac{1}{2}mA^2\omega^2 \cos^2 \omega t = KE_{\max} \left( \frac{1 + \cos 2\omega t}{2} \right)$$

54.  $f' = \left( \sqrt{\frac{1+\beta}{1-\beta}} \right) f$ , where  $\beta = \frac{v}{c}$

So,  $f' = 17.3 \text{ GHz}$

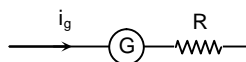
55. Stress =  $\frac{F}{A} = \frac{mg}{A} = \frac{\rho l Ag}{A} = \rho l g$

So,  $\frac{\text{Stress}_f}{\text{Stress}_i} = 9$

56.  $i_g (R + R_g) = V$

$$R = \frac{V}{i_g} - R_g$$

$$R = \frac{10}{5 \times 10^{-3}} - 15 = 1.985 \times 10^3 \Omega$$



57. The variation of magnitude of acceleration due to gravity is given by

$$g = \left( \frac{GM}{R^3} \right) d, \text{ where } 0 \leq d \leq R$$

$$= \frac{GM}{d^2}, \text{ where } d > R$$

58. By applying pressure,  $\Delta P = -\frac{B\Delta V}{V}$

$$\Rightarrow -\frac{\Delta V}{V} = \frac{\Delta P}{B} = \frac{P}{K} \text{ (given } B = K \text{)}$$

By increasing temperature, fractional increase in volume

$$-\frac{\Delta V}{V} = 3\alpha\Delta\theta$$

$$\frac{P}{K} = 3\alpha\Delta\theta$$

$$\Delta\theta = \frac{P}{3\alpha K}$$

59. For diverging lens,  

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f} \Rightarrow \frac{1}{v} - \frac{1}{\infty} = \frac{1}{-25}$$

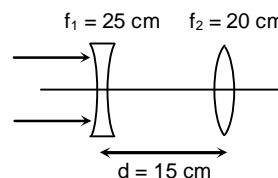
$$\Rightarrow v = -25 \text{ cm}$$

First image is formed at a distance 25cm left to the diverging lens.  
 For the converging lens.

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{v} - \frac{1}{-40} = \frac{1}{20} \Rightarrow \frac{1}{v} = \frac{1}{20} - \frac{1}{40}$$

$$\Rightarrow v = +40 \text{ cm}$$



60. 
$$\frac{1}{2}mv_f^2 = \frac{1}{8}mv_0^2 \Rightarrow v_f = \frac{v_0}{2}$$

Now, 
$$\frac{mdv}{dt} = -kv^2$$

$$\Rightarrow m \int_{v_0}^{\frac{v_0}{2}} \frac{dv}{v^2} = -k \int_0^{10} dt$$

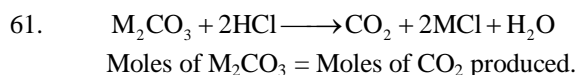
$$\Rightarrow m \left[ -\frac{1}{v} \right]_{v_0}^{\frac{v_0}{2}} = -k [t]_0^{10}$$

$$\Rightarrow m \left( \frac{2}{v_0} - \frac{1}{v_0} \right) = 10k$$

$$\Rightarrow \frac{m}{v_0} = 10k$$

$$\Rightarrow k = \frac{m}{10v_0} = \frac{10^{-2}}{10 \times 10} = 10^{-4} \text{ kg m}^{-1}$$

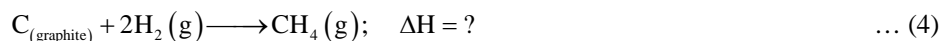
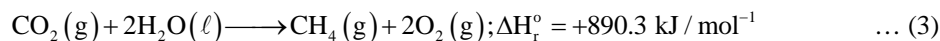
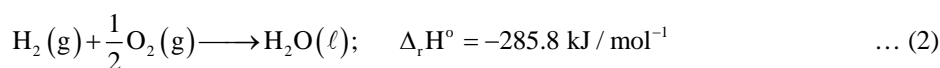
### PART C – CHEMISTRY



$$\text{moles of } \text{M}_2\text{CO}_3 = \frac{w}{\text{molar mass}} = 0.01186$$

$$\therefore \text{Molar mass} = 84.3 \text{ g mol}^{-1}$$

So, option (1) is correct.



$$[\text{Eq. (1)} + \text{Eq. (3)}] + [2 \times \text{Eq. (2)}] = \text{Eq. (4)}$$

$$\therefore [\Delta H_1 + \Delta H_3] + [2 \times \Delta H_2] = \Delta H_4$$

$$[(-393.5) + (890.3)] + [2(-285.8)] = -74.8 \text{ kJ / mol}$$

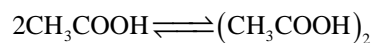
$$= -74.8 \text{ kJ/mol}^{-1}$$

**JEE-MAIN-MPC-2017-28**

63.  $\Delta T_f = i \times K_f \times m$

$$\Rightarrow 0.45 = i \times 5.12 \times \frac{0.2 \times 1000}{60 \times 20}$$

$$i = 0.527$$



$$1 - \alpha \qquad \frac{\alpha}{2}$$

$$i = 1 - \alpha + \frac{\alpha}{2}$$

$$\alpha = 0.946$$

$\therefore$  % dissociation is 94.6%.

64. Total hydrogen ( ${}_1\text{H}^1$ ) =  $\frac{10}{100} \times 75 = 7.5$  kg

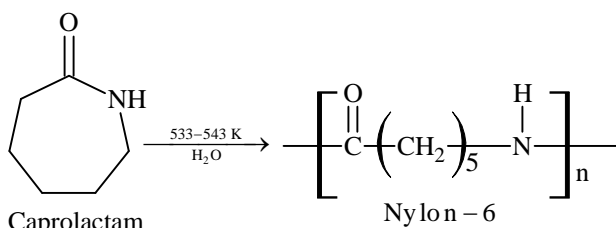
If it is replaced by  ${}_1\text{H}^2$  then mass will be doubled so now hydrogen mass = 15 kg  
So, mass of person will be increased by 7.5 kg.

65.  $\Delta U = q + w$

$q = 0$  in adiabatic process.

So,  $\Delta U = w$

66.



67. Reduction potential of

$$E_{\text{Cr}^{3+}/\text{Cr}}^\circ = -0.74 \text{ V}$$

So,  $E_{\text{Cr}/\text{Cr}^{3+}} = +0.74 \text{ V}$

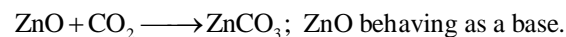
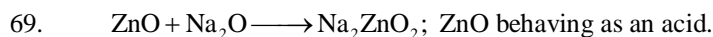
$\therefore$  Cr would be strongest reducing agent.

68. Tyndall effect is observed only when

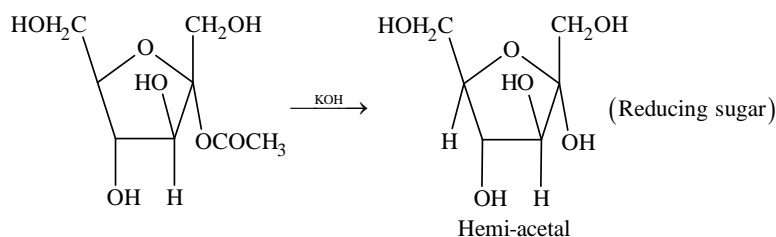
(i) The diameter of the dispersed particle is not much smaller than the wavelength of the light used.

(ii) The refractive indices of the dispersed phase and dispersion medium differ greatly in magnitude.

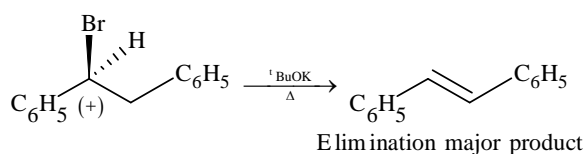
So, (b) and (d) are correct.



70.



71.



72.

- (14) CO – diamagnetic
- (16) O<sub>2</sub> – paramagnetic
- (10) B<sub>2</sub> – paramagnetic
- (15) NO – paramagnetic

73.

Moles of CoCl<sub>3</sub>·6H<sub>2</sub>O → 100 mL × 0.1M = 10 × 10<sup>-3</sup> moles  
 Ions → 6.023 × 10<sup>23</sup> × 0.01  
 = 6.023 × 10<sup>21</sup> ions  
 Precipitated ions = 1.2 × 10<sup>22</sup>  
 ∴ 1 Ag<sup>+</sup> ion and 1 Cl<sup>-</sup> ion.  
 So [Co(H<sub>2</sub>O)<sub>5</sub>Cl<sub>2</sub>]Cl·H<sub>2</sub>O is correct.

74.

$$\text{pH} = 7 + \frac{\text{pK}_a}{2} - \frac{\text{pK}_b}{2}$$

$$= 7 + \frac{3.2}{2} - \frac{3.4}{2}$$

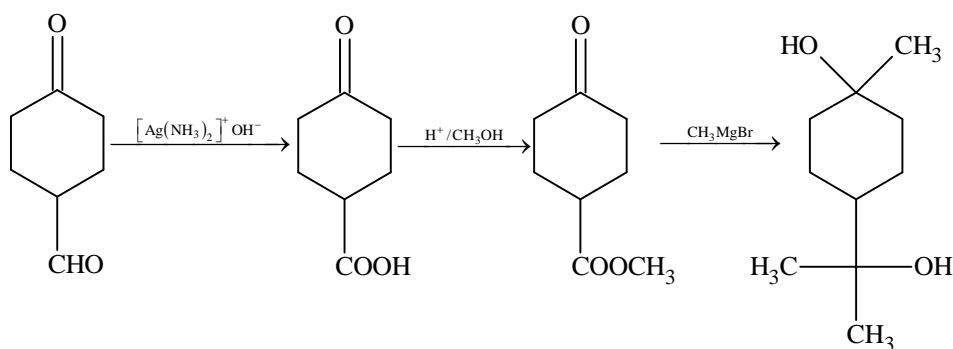
$$= 6.9$$

75.

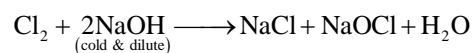
Rate of S<sub>N</sub>1 ∝ carbocation stability

$\text{CH}_3\text{CH}^+\text{CH}_2\text{CH}_3$        $\text{CH}_3\text{CH}_2\text{CH}_2^+$        $\text{p-CH}_3\text{O-C}_6\text{H}_5\text{-CH}_2^+$   
 (I)                                  (II)                                  (III)  
 ∴ II < I < III

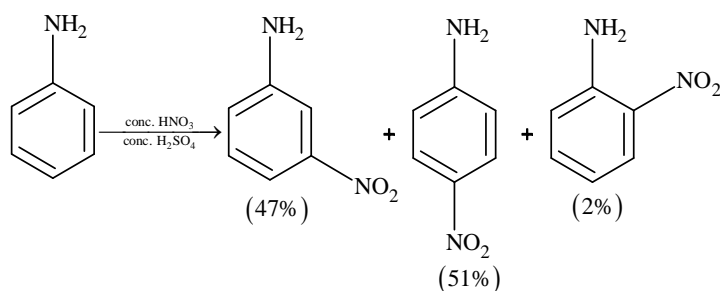
77.



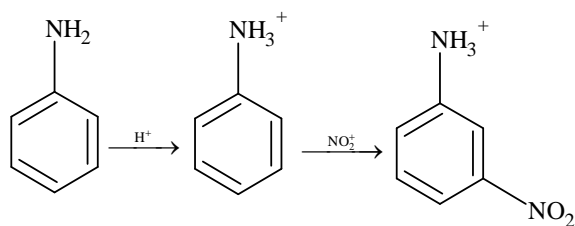
78.



79.



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80.



Stereoisomers =  $2^n = 2^2 = 4$

81.

$$k_1 = Ae^{-E_{a1}/RT}$$

$$k_2 = Ae^{-E_{a2}/RT}$$

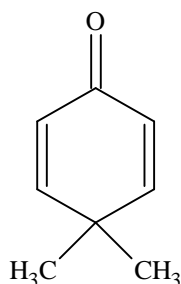
$$\frac{k_2}{k_1} = e^{-\frac{(E_{a2} - E_{a1})}{RT}}$$

$$\frac{k_2}{k_1} = e^{-\frac{10 \times 10^3}{8.314 \times 300}}$$

$$\ln \frac{k_2}{k_1} = 4$$

82.

Except



, all are aromatic in nature, so it has least resonance energy.

83.

$O^{2-}$ ,  $F^-$ ,  $Na^+$  and  $Mg^{2+}$ , all have 10 electrons each.

84.

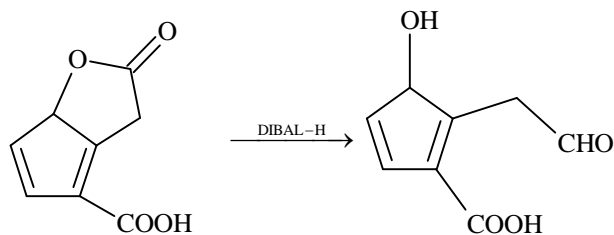
$$r_n = \frac{0.53n^2}{Z} \text{ \AA}$$

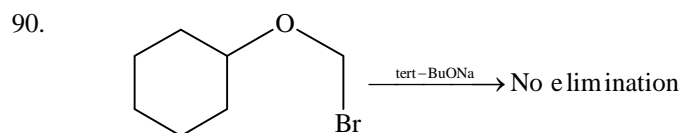
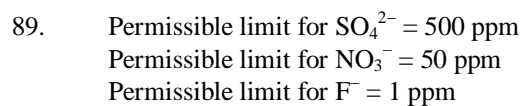
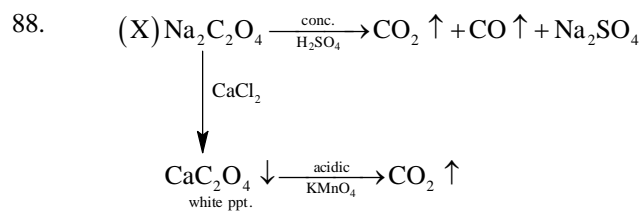
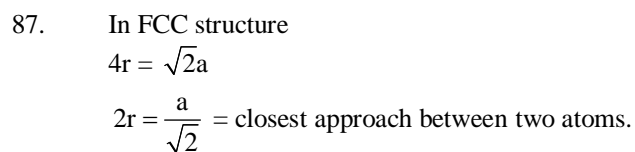
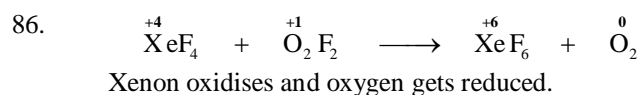
$$n = 2$$

$$Z = 1$$

$$r_2 = 0.53 \times 4 \text{ \AA} = 2.12 \text{ \AA}$$

85.





*Read the following instructions carefully: (Instructions as printed on question paper)*

1. The candidates should fill in the required particulars on the Test Booklet and Answer Sheet (*Side-1*) with **Black Ball Point Pen**.
2. For writing/marking particulars on *Side-2* of the Answer Sheet, use **Blue/Black Ball Point Pen only**.
3. The candidates should not write their Roll Numbers anywhere else (except in the specified space) on the Test Booklet/Answer Sheet.
4. Out of the four options given for each question, only one option is the correct answer.
5. For each **incorrect response**, ( $\frac{1}{4}$ ) (**one-fourth**) marks of the total marks allotted to the question (i.e. 1 marks) will be deducted from the total score. **No deduction** from the total score, however, will be made **if no response** is indicated for an item in the Answer Sheet.
6. Handle the Test Booklet and Answer Sheet with care, *as under no circumstances (except for discrepancy in Test Booklet Code and Answer Sheet Code), another set will be provided.*
7. The candidates are not allowed to do any rough work or writing work on the Answer Sheet. All calculations/writing work are to be done in the space provided for this purpose in the Test Booklet itself, marked 'Space for Rough Work'. This space is given at the bottom of each page and in four pages (Pages 20 – 23) at the end of the booklet.
8. On completion of the test, the candidates must hand over the Answer Sheet to the Invigilator on duty in the Room/Hall. **However, the candidates are allowed to take away this Test Booklet with them.**
9. Each candidate must show on demand his/her Admit Card to the Invigilator.
10. No candidate, without special permission of the Superintendent or Invigilator, should leave his/her seat.
11. The candidates should not leave the Examination Hall without handing over their Answer Sheet to the Invigilator on duty and sign the Attendance Sheet again. Cases where a candidate has not signed the Attendance Sheet a second time will be deemed not to have handed over the Answer Sheet and dealt with as an unfair means case. **The candidates are also required to put their left hand THUMB impression in the space provided in the Attendance Sheet.**
12. Use of Electronic/Manual Calculator and any Electronic device like mobile phone, pager etc. is prohibited.
13. The candidates are governed by all Rules and Regulations of the JAB/Board with regard to their conduct in the Examination Hall. All cases of unfair means will be dealt with as per Rules and Regulations of the JAB/Board.
14. No part of the Test Booklet and Answer Sheet shall be detached under any circumstance.
15. **Candidates are not allowed to carry any textual material, printed or written, bits of papers, pager, mobile phone, electronic device or any other material except the Admit Card inside the examination room/hall.**