



# SYNAPSE

## Academy Of Science

Date: 02-04-2017

Max. Marks: 360

Max. Time : 3 Hrs

JEE Mains 2017

CODE : B

Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose

### -: General Instructions :-

1. The Test is of **3 hours** duration.
2. The Test Booklet consists of **90** questions. The maximum marks are **360**.
3. There are **THREE parts** in the question paper **A, B, C** consisting of **PHYSICS, MATHEMATICS and CHEMISTRY** having **30** questions in each part of equal weightage. Each question is allotted **4(four) marks** for each correct response.
4. Candidates will be awarded marks as stated above in instruction No. 3 for correct response of each question. **1/4th MARKS (ONE MINUS)** will be deducted for indicating incorrect response of each question. No deduction from the total score will be made if no response is indicated for an item in the answer sheet.

#### Atomic Numbers

H = 1, D = 1, Li = 3, Na = 11, K = 19, Rb = 37, Cs = 55, F = 9,  
Ca = 20, He = 2, O = 8, Au = 79, Ni = 28, Zn = 30, Cu = 29, Cl = 17,  
Br = 35, Cr = 24, Mn = 25, Fe = 26, S = 16, P = 15, C = 6, N = 7, Ag = 47.

#### Atomic Masses

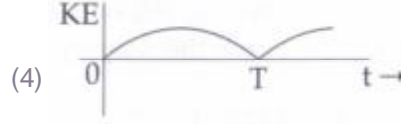
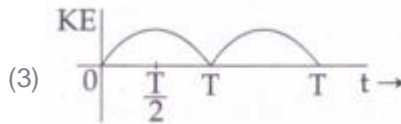
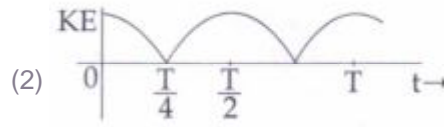
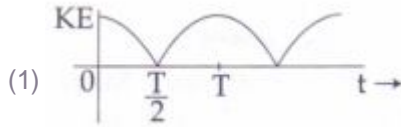
He = 4, Mg = 24, C = 12, O = 16, N = 14, P = 31, Br = 80, Cu = 63.5,  
Fe = 56, Mn = 55, Pb = 207, Au = 197, Ag = 108, F = 19, H = 1, Cl = 35.5,  
Sn = 118.6, Na = 23, D = 2, Cr = 52, K = 39, Ca = 40, Li = 7, Be = 4, Al = 27, S = 32.1

Name of the Student

Roll Number

**PART A – PHYSICS**

1. 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 :



2. 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)  $-2.5 \times 10^{25}$                       (3)  $-1.61 \times 10^{23}$                       (4)  $1.38 \times 10^{23}$

3. Which of the following statements is false ?

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

4. The following observations were taken for determining surface tension  $T$  of water by capillary method :

diameter of capillary,  $D = 1.25 \times 10^{-2} \text{ m}$  rise of water ,  $h = 1.45 \times 10^{-2} \text{ m}$ .

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

5. 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)  $\omega_m + \omega_c$                       (2)  $\omega_m - \omega_c$                       (3)  $\omega_m$                       (4)  $\omega_c$

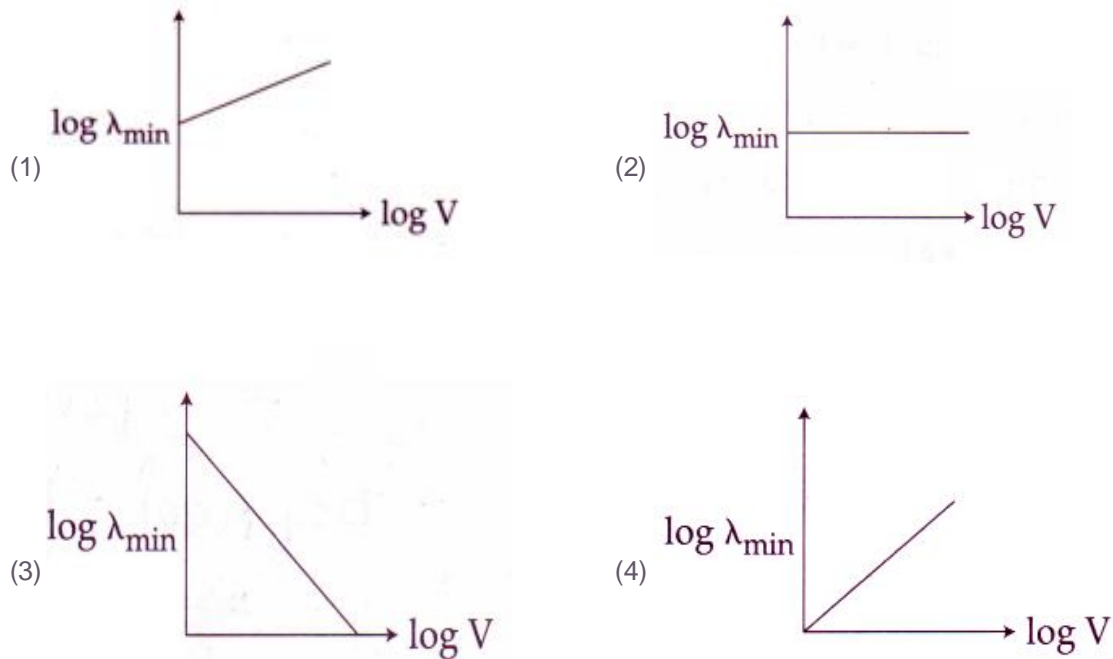
6. A diverging lens with magnitude of focal length  $25 \text{ cm}$  is placed at a distance of  $15 \text{ cm}$  from a converging lens of magnitude of focal length  $20 \text{ cm}$ . A beam of parallel light falls on the diverging lens. The final image formed is :

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

7. 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) 1                      (2)  $\frac{3}{\sqrt{2}}$                       (3)  $\sqrt{\frac{3}{2}}$                       (4)  $\frac{\sqrt{3}}{2}$

8. 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 :



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

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

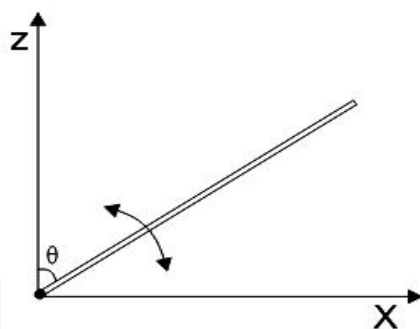
10. An electric dipole has a fixed dipole moment  $\vec{p}$ , which makes angle  $\theta$  with respect to x-axis.. When subjected to an electric field  $\vec{E}_1 = E\hat{i}$ , it experiences a torque  $\vec{T}_1 = \tau\hat{k}$ . When subjected to another electric field  $\vec{E}_2 = \sqrt{3}E_1\hat{j}$  it experiences a torque  $\vec{T}_2 = -\vec{T}_1$ . The angle  $\theta$  is :

- (1)  $60^\circ$                       (2)  $90^\circ$                       (3)  $30^\circ$                       (4)  $45^\circ$

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

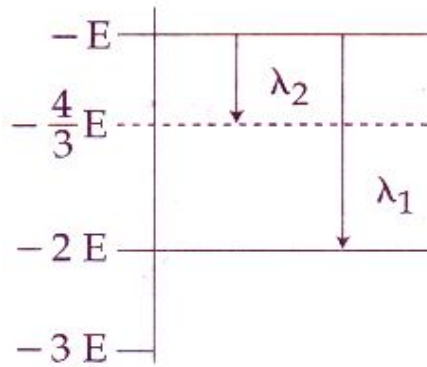
- (1)  $135^\circ$                       (2)  $180^\circ$                       (3)  $45^\circ$                       (4)  $90^\circ$

12.  $C_p$  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 and  $C_p - C_v = b$  for nitrogen gas. The correct relation between a and b is:
- (1)  $a = 14b$                       (2)  $a = 28b$                       (3)  $a = \frac{1}{14}b$                       (4)  $a = b$
13. 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)  $1250^\circ\text{C}$                       (2)  $825^\circ\text{C}$                       (3)  $800^\circ\text{C}$                       (4)  $885^\circ\text{C}$
14. 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)  $10^{-4} \text{ kg m}^{-1}$                       (2)  $10^{-1} \text{ kg m}^{-1} \text{ s}^{-1}$                       (3)  $10^{-3} \text{ kg m}^{-1}$                       (4)  $10^{-3} \text{ kg s}^{-1}$
15. 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 – 10 V is:
- (1)  $2.535 \times 10^{-3} \Omega$                       (2)  $4.005 \times 10^3 \Omega$                       (3)  $1.985 \times 10^3 \Omega$                       (4)  $2.045 \times 10^3 \Omega$
16. 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)  $\frac{3g}{2\ell} \cos \theta$                       (2)  $\frac{2g}{3\ell} \cos \theta$                       (3)  $\frac{3g}{2\ell} \sin \theta$                       (4)  $\frac{2g}{3\ell} \sin \theta$

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

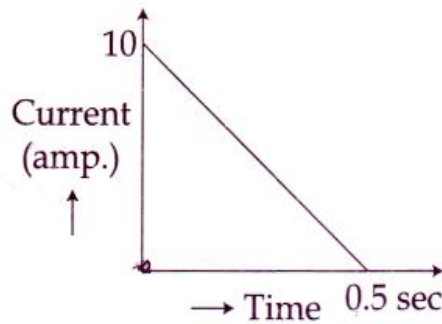


- (1)  $r = \frac{3}{4}$                       (2)  $r = \frac{1}{3}$                       (3)  $r = \frac{4}{3}$                       (4)  $r = \frac{2}{3}$

18. 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) 81                              (2)  $\frac{1}{81}$                               (3) 9                              (4)  $\frac{1}{9}$

19. 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) 250 Wb                      (2) 275 Wb                      (3) 200 Wb                      (4) 225 Wb

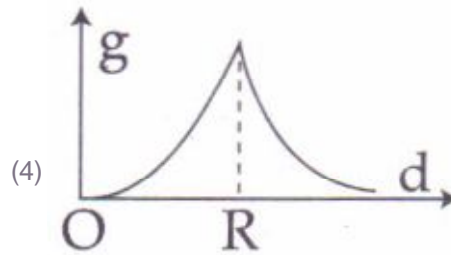
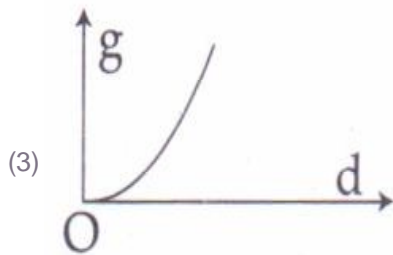
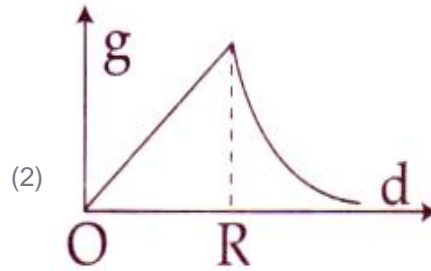
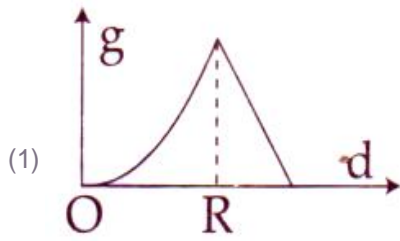
20. In a Young's double slit experiment, slits are separated by 0.5 mm, and the screen is placed 150 cm away. A beam of light consisting of two wavelengths, 650 nm and 520 nm, is used to obtain interference fringes on the screen. The least distance from the common central maximum to the point where the bright fringes due to both the wavelengths coincide is :

- (1) 9.75 mm                      (2) 15.6 mm                      (3) 1.56 mm                      (4) 7.8 mm

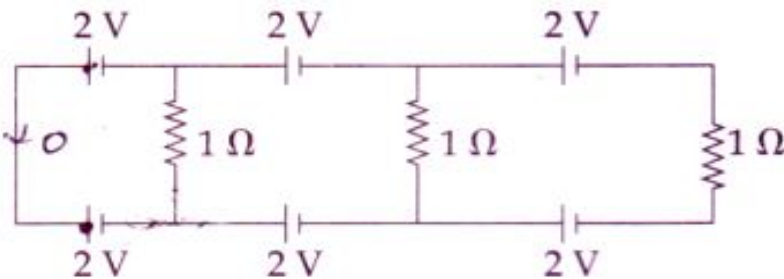
21. A magnetic needle of magnetic moment  $6.7 \times 10^{-2} \text{ Am}^2$  and moment of inertia  $7.5 \times 10^{-6} \text{ kg m}^2$  is performing simple harmonic oscillations in a magnetic field of 0.01 T. Time taken for 10 complete oscillations is :

- (1) 6.98 s                      (2) 8.76 s                      (3) 6.65 s                      (4) 8.89 s

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



23.



In the above circuit the current in each resistance is :

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

24. 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)  $\frac{\lambda_A}{\lambda_B} = \frac{2}{3}$                       (2)  $\frac{\lambda_A}{\lambda_B} = \frac{1}{2}$                       (3)  $\frac{\lambda_A}{\lambda_B} = \frac{1}{3}$                       (4)  $\frac{\lambda_A}{\lambda_B} = 2$

25. 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)  $\frac{3\alpha}{PK}$                       (2)  $3PK\alpha$                       (3)  $\frac{P}{3\alpha K}$                       (4)  $\frac{P}{\alpha K}$

26. 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 :

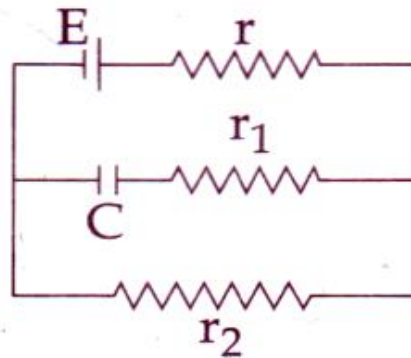
- (1) 9 J                      (2) 18 J                      (3) 4.5 J                      (4) 22 J

27. An observer is moving with half the speed of light towards a stationary microwave source emitting waves at frequency 10 GHz. What is the frequency of the microwave measured by the observer?

(speed of light =  $3 \times 10^8 \text{ ms}^{-1}$ )

- (1) 17.3 GHz                      (2) 15.3 GHz                      (3) 10.1 GHz                      (4) 12.1 GHz

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



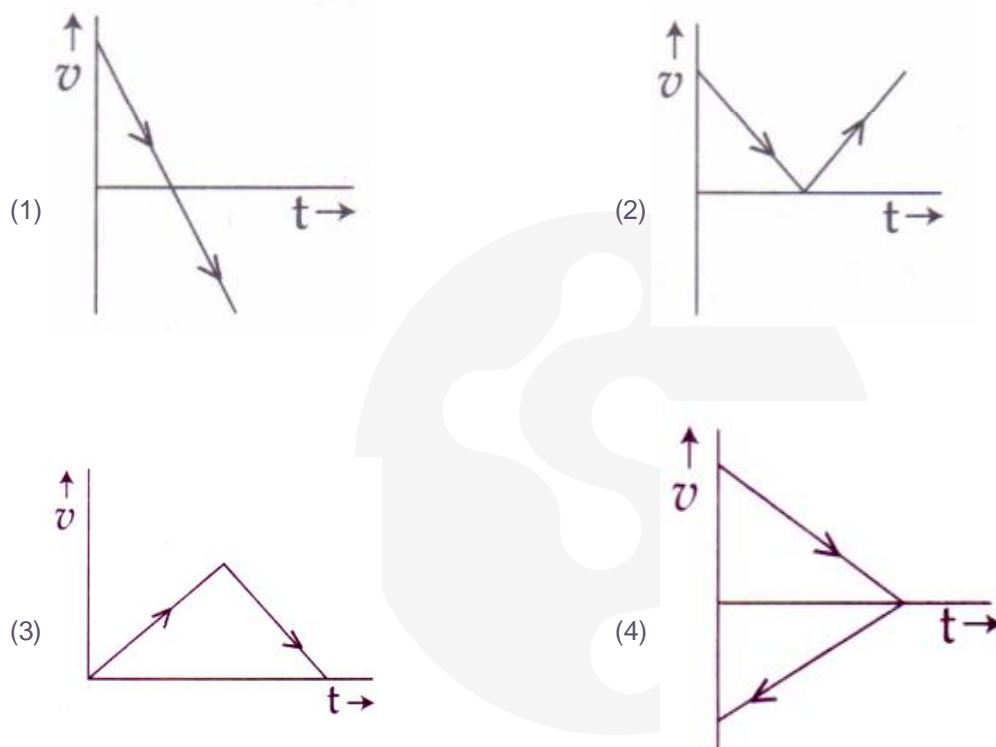
- (1)  $CE = \frac{r_2}{(r+r_2)}$                       (2)  $CE = \frac{r_1}{(r_1+r)}$                       (3) CE                      (4)  $CE = \frac{r_1}{(r_2+r)}$

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

The minimum number of capacitors required to achieve this is :

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

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



PART B – MATHEMATICES

31. 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)  $\left(2, -\frac{1}{2}\right)$                       (3)  $\left(1, \frac{3}{4}\right)$                       (4)  $\left(1, -\frac{3}{4}\right)$
32. 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 solution, then  $n$  is equal to :
- (1) 11                      (2) 12                      (3) 9                      (4) 10
33. 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) Neither injective nor surjective.                      (2) Invertible  
 (3) Injective but not surjective                      (4) Surjective but not injective
34. The following statement  $(p \rightarrow q) \rightarrow [(\sim p \rightarrow q) \rightarrow q]$  is:
- (1) A fallacy                      (2) A tautology                      (3) Equivalent to  $\sim p \rightarrow q$                       (4) Equivalent to  $p \rightarrow \sim q$
35. 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) A singleton                      (2) An empty set  
 (3) An infinite set                      (4) A finite set containing two or more elements
36. 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)  $\frac{5}{2}$                       (2)  $\frac{59}{12}$                       (3)  $\frac{3}{2}$                       (4)  $\frac{7}{3}$
37. For any three positive real numbers  $a, b$  and  $c$ ,  $9(25a^2 + b^2) + 25(c^2 - 3ac) = 15b(3a + c)$ . Then:
- (1)  $a, b$  and  $c$  are in G.P.                      (2)  $b, c$  and  $a$  are in G.P.  
 (3)  $b, c$  and  $a$  are in A.P.                      (4)  $a, b$  and  $c$  are in A.P.
38. 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) 484                      (2) 485                      (3) 468                      (4) 469
39. 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)  $\left(\frac{1}{2}, \frac{1}{3}\right)$                       (2)  $\left(-\frac{1}{2}, -\frac{1}{2}\right)$                       (3)  $\left(\frac{1}{2}, \frac{1}{2}\right)$                       (4)  $\left(\frac{1}{2}, -\frac{1}{3}\right)$



40. 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)  $(-\sqrt{2}, -\sqrt{3})$       (2)  $(3\sqrt{2}, 2\sqrt{3})$       (3)  $(2\sqrt{2}, 3\sqrt{3})$       (4)  $(\sqrt{3}, \sqrt{2})$
41. 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) 255      (2) 330      (3) 165      (4) 190
42. 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)  $\frac{1}{8}$       (2)  $\frac{25}{8}$       (3) 2      (4) 5
43. 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)  $\frac{4}{9}$       (2)  $\frac{6}{7}$       (3)  $\frac{1}{4}$       (4)  $\frac{2}{9}$
44. 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) 30      (2) 12.5      (3) 10      (4) 25
45. The integral  $\int_{\frac{\pi}{4}}^{\frac{3\pi}{4}} \frac{dx}{1 + \cos x}$  is equal to:
- (1) -1      (2) -2      (3) 2      (4) 4
46. 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)  $\frac{4}{3}$       (2)  $\frac{1}{3}$       (3)  $-\frac{2}{3}$       (4)  $-\frac{1}{3}$
47. Let  $I_n = \int \tan^n x dx, (n > 1)$ .  $I_4 + I_6 = a \tan^5 x + bx^5 + C$ , where C is a constant of integration, then the ordered pair (a, b) is equal to :
- (1)  $\left(-\frac{1}{5}, 0\right)$       (2)  $\left(-\frac{1}{5}, 1\right)$       (3)  $\left(\frac{1}{5}, 0\right)$       (4)  $\left(\frac{1}{5}, -1\right)$

48. Let  $\omega$  be a complex number such that  $2\omega + 1 = z$  where  $z = \sqrt{-3}$ . If

$$\begin{vmatrix} 1 & 1 & 1 \\ 1 & -\omega^2 - 1 & \omega^2 \\ 1 & \omega^2 & \omega \end{vmatrix} = 3k$$
 then k is equal to :

- (1) 1 (2)  $-z$  (3)  $z$  (4)  $-1$

49. The value of  $({}^{21}C_1 - {}^{10}C_1) + ({}^{21}C_2 - {}^{10}C_2) + ({}^{21}C_3 - {}^{10}C_3) + ({}^{21}C_4 - {}^{10}C_4) + \dots + ({}^{21}C_{10} - {}^{10}C_{10})$  is :

- (1)  $2^{20} - 2^{10}$  (2)  $2^{21} - 2^{11}$  (3)  $2^{21} - 2^{10}$  (4)  $2^{20} - 2^9$

50.  $\lim_{x \rightarrow \frac{\pi}{2}} \frac{\cot x - \cos x}{(\pi - 2x)^3}$  equal :

- (1)  $\frac{1}{4}$  (2)  $\frac{1}{24}$  (3)  $\frac{1}{16}$  (4)  $\frac{1}{8}$

51. If  $5(\tan^2 x - \cos^2 x) = 2\cos 2x + 9$ , then the value of  $\cos 4x$  is :

- (1)  $-\frac{7}{9}$  (2)  $-\frac{3}{5}$  (3)  $\frac{1}{3}$  (4)  $\frac{2}{9}$

52. 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)  $6\sqrt{5}$  (2)  $3\sqrt{5}$  (3)  $2\sqrt{42}$  (4)  $\sqrt{42}$

53. 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)  $\frac{10}{\sqrt{74}}$  (2)  $\frac{20}{\sqrt{74}}$  (3)  $\frac{10}{\sqrt{83}}$  (4)  $\frac{5}{\sqrt{83}}$

54. 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)  $\frac{3}{1+9x^3}$  (2)  $\frac{9}{1+9x^3}$  (3)  $\frac{3x\sqrt{x}}{1-9x^3}$  (4)  $\frac{3x}{1-9x^3}$

55. The radius of a circle, having minimum area, which touches the curve  $y = 4 - x^2$  and the lines,  $y = |x|$  is:

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

56. A box contains 15 green and 10 yellow balls. If 10 balls randomly drawn, one-by-one, with replacement, then the variance of the number of green balls drawn is :

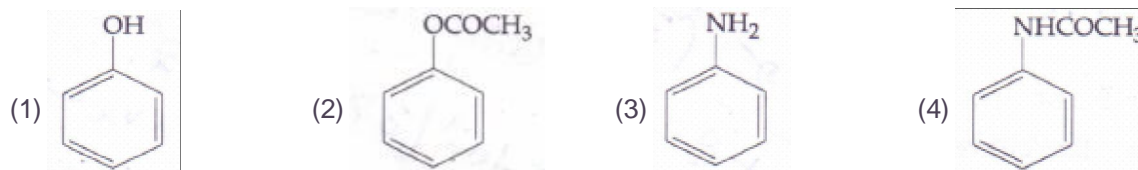
- (1)  $\frac{6}{25}$  (2)  $\frac{12}{5}$  (3) 6 (4) 4

57. 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)  $x + 2y = 4$                       (2)  $2y - x = 2$                       (3)  $4x - 2y = 1$                       (4)  $4x + 2y = 7$
58. 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)  $\frac{7}{55}$                                       (2)  $\frac{6}{55}$                                       (3)  $\frac{12}{55}$                                       (4)  $\frac{14}{45}$
59. For three events, A, B and C,  $P(\text{Exactly one of A or B occurs}) = P(\text{Exactly one of B or C occurs}) = P(\text{Exactly one of C or A occurs}) = \frac{1}{4}$  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)  $\frac{3}{16}$                                       (2)  $\frac{7}{32}$                                       (3)  $\frac{7}{16}$                                       (4)  $\frac{7}{64}$
60. If  $A = \begin{bmatrix} 2 & -3 \\ -4 & 1 \end{bmatrix}$ , then  $\text{adj}(3A^2 + 12A)$  is equal to :
- (1)  $\begin{bmatrix} 72 & -63 \\ -84 & 51 \end{bmatrix}$                       (2)  $\begin{bmatrix} 72 & -84 \\ -63 & 51 \end{bmatrix}$                       (3)  $\begin{bmatrix} 51 & 63 \\ 84 & 72 \end{bmatrix}$                       (4)  $\begin{bmatrix} 51 & 84 \\ 63 & 72 \end{bmatrix}$



**PART C – CHEMISTRY**

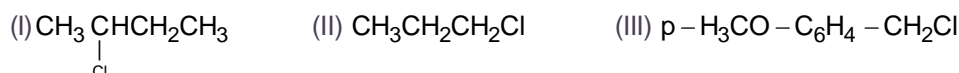
61. Which of the following compounds will form significant amount of *meta* product during mono-nitration reaction?



62.  $\Delta U$  is equal to:

- (1) Isochoric work (2) Isobaric work (3) Adiabatic work (4) Isothermal work

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



- (1) (III) < (II) < (I) (2) (II) < (I) < (III) (3) (I) < (III) < (II) (4) (II) < (III) < (I)

64. 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)  $1.65 \text{ \AA}$  (2)  $4.76 \text{ \AA}$  (3)  $0.529 \text{ \AA}$  (4)  $2.12 \text{ \AA}$

65.  $pK_a$  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) 7.2 (2) 6.9 (3) 7.0 (4) 1.0

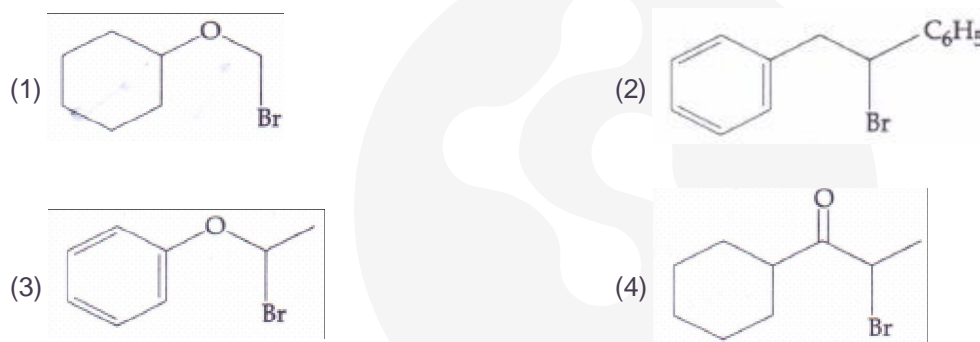
66. The formation of which of the following polymers involves hydrolysis reaction?

- (1) Nylon 6 (2) Bakelite (3) Nylon 6, 6 (4) Terylene

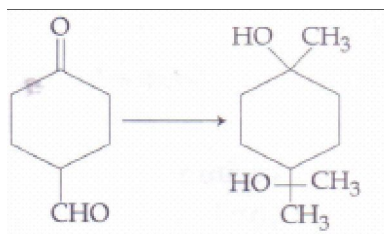
67. The most abundant elements by mass in the body of a healthy human adult are: Oxygen (61.4%); Carbon (22.9%), Hydrogen (10.0%); and Nitrogen (2.6%). The weight which a 75 kg person would gain if all  $^1\text{H}$  atoms are replaced by  $^2\text{H}$  atoms is:

- (1) 15 kg (2) 37.5 kg (3) 7.5 kg (4) 10 kg

68. Which of the following, upon treatment with *tert-BuONa* followed by addition of bromine water, fails to decolourize the colour of bromine ?

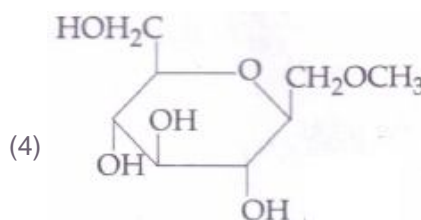
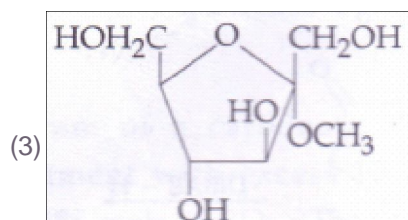
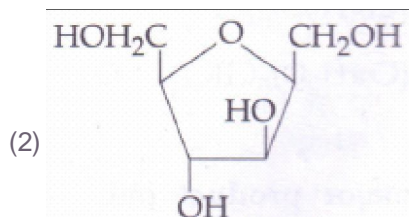
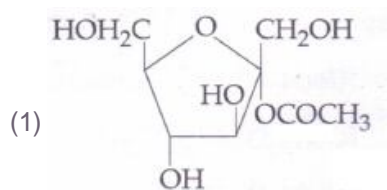


69. In the following reactions, ZnO is respectively acting as a/ an :
- (I)  $\text{ZnO} + \text{Na}_2\text{O} \rightarrow \text{Na}_2\text{ZnO}_2$  (II)  $\text{ZnO} + \text{CO}_2 \rightarrow \text{ZnCO}_3$
- (1) base and acid (2) base and base (3) acid and acid (4) acid and base
70. Both lithium and magnesium display several similar properties due to the diagonal relationship; however, the one which is incorrect, is :
- (1) both form basic carbonates  
 (2) both form soluble bicarbonates  
 (3) both form nitrides  
 (4) nitrates of both Li and Mg yield  $\text{NO}_2$  and  $\text{O}_2$  on heating
71. 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) Six (2) Zero (3) Two (4) Four
72. 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) 2a (2)  $2\sqrt{2}a$  (3)  $\sqrt{2}a$  (4)  $\frac{a}{\sqrt{2}}$
73. 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 K, then  $\ln (k_2/k_1)$  is equal to: ( $R = 8.314 \text{ J mol}^{-1}\text{K}^{-1}$ )
- (1) 8 (2) 12 (3) 6 (4) 4
74. The correct sequence of reagents for the following conversion will be:



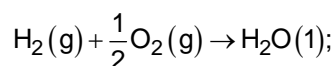
- (1)  $[\text{Ag}(\text{NH}_3)_2]^+ \text{OH}^-$ ,  $\text{H}^+/\text{CH}_3\text{OH}$ ,  $\text{CH}_3\text{MgBr}$  (2)  $\text{CH}_3\text{MgBr}$ ,  $\text{H}^+/\text{CH}_3\text{OH}$ ,  $[\text{Ag}(\text{NH}_3)_2]^+ \text{OH}^-$
- (3)  $\text{CH}_3\text{MgBr}$ ,  $[\text{Ag}(\text{NH}_3)_2]^+ \text{OH}^-$ ,  $\text{H}^+/\text{CH}_3\text{OH}$  (4)  $[\text{Ag}(\text{NH}_3)_2]^+ \text{OH}^-$ ,  $\text{CH}_3\text{MgBr}$ ,  $\text{H}^+/\text{CH}_3\text{OH}$
75. The Tyndall effect is observed only when following conditions are satisfied:
- (I) The diameter of the dispersed particles is much smaller than the wavelength of the light used.  
 (II) The diameter of the dispersed particle is not much smaller than the wavelength of the light used.  
 (III) The refractive indices of the dispersed phase and dispersion medium are almost similar in magnitude  
 (IV) The refractive indices of the dispersed phase and dispersion medium differ greatly in magnitude
- (1) (I) and (IV) (2) (II) and (IV) (3) (I) and (III) (4) (II) and (III)

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

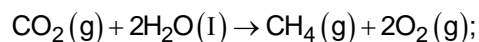


77. Given  $C_{(\text{graphite})} + O_2(g) \rightarrow CO_2(g)$ ;

$$\Delta_r H^\circ = -393.5 \text{ kJ mol}^{-1}$$

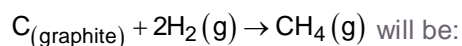


$$\Delta_r H^\circ = -285.8 \text{ kJ mol}^{-1}$$



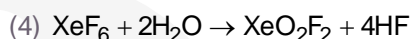
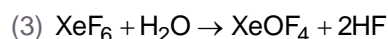
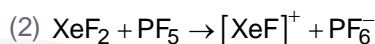
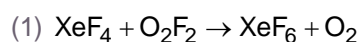
$$\Delta_r H^\circ = +890.3 \text{ kJ mol}^{-1}$$

Based on the above thermochemical equation, the value of  $\Delta_r H^\circ$  at 298 K for the reaction

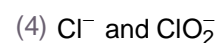
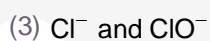
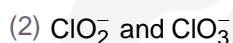
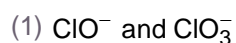


- (1)  $+74.8 \text{ kJ mol}^{-1}$       (2)  $+144.0 \text{ kJ mol}^{-1}$       (3)  $-74.8 \text{ kJ mol}^{-1}$       (4)  $-144.0 \text{ kJ mol}^{-1}$

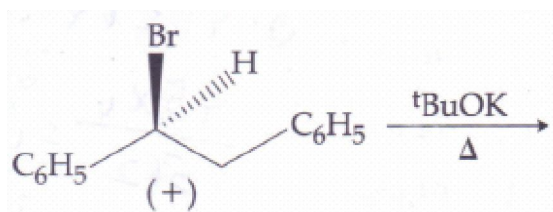
78. Which of the following reactions is an example of a redox reaction?



79. The products obtained when chlorine gas reacts with cold and dilute aqueous NaOH are:



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



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

81. Sodium salt of an organic acid 'X' produces effervescence with conc. H<sub>2</sub>SO<sub>4</sub>. 'X' reacts with the acidified aqueous CaCl<sub>2</sub> solution to give a white precipitate which decolourises acidic solution of KMnO<sub>4</sub>. 'X' is:

- (1) C<sub>6</sub>H<sub>5</sub>COONa                      (2) HCOONa                      (3) CH<sub>3</sub>COONa                      (4) Na<sub>2</sub>C<sub>2</sub>O<sub>4</sub>

82. Which of the following species is not paramagnetic?

- (1) NO                      (2) CO                      (3) O<sub>2</sub>                      (4) B<sub>2</sub>

83. The freezing point of benzene decreases by 0.45°C when 0.2 g of acetic acid is added to 20 g of benzene. If acetic acid associates to form a dimer in benzene, percentage association of acetic acid in benzene will be:

(K<sub>f</sub> for benzene = 5.12 K kg mol<sup>-1</sup>)

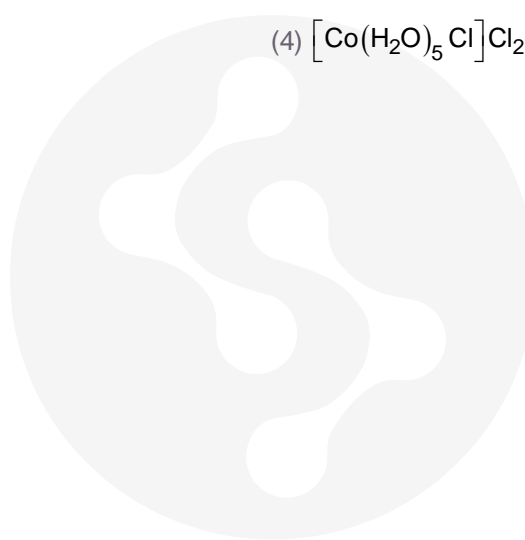
- (1) 64.6%                      (2) 80.4%                      (3) 74.6%                      (4) 94.6%

84. Which of the following molecules is least resonance stabilized?

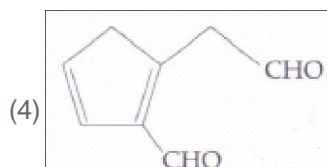
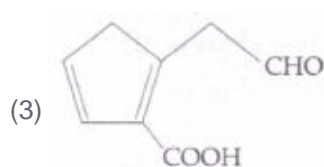
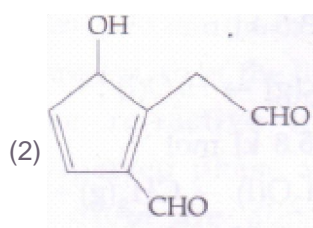
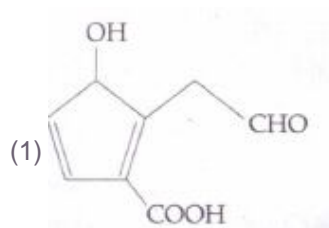
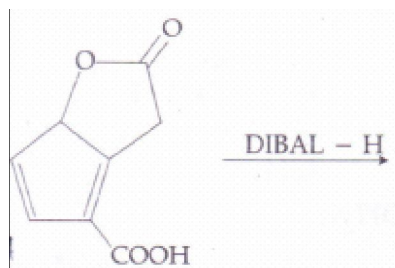


85. On treatment of 100 mL of 0.1 M solution of CoCl<sub>3</sub> · 6H<sub>2</sub>O with excess AgNO<sub>3</sub>; 1.2 × 10<sup>22</sup> ions are precipitated. The complex is:

- (1) [Co(H<sub>2</sub>O)<sub>4</sub>Cl<sub>2</sub>]Cl · 2H<sub>2</sub>O                      (2) [Co(H<sub>2</sub>O)<sub>3</sub>Cl<sub>3</sub>] · 3H<sub>2</sub>O  
 (3) [Co(H<sub>2</sub>O)<sub>6</sub>]Cl<sub>3</sub>                      (4) [Co(H<sub>2</sub>O)<sub>5</sub>Cl]Cl<sub>2</sub> · H<sub>2</sub>O



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



87. A water sample has ppm level concentration of following anions

$$F^- = 10; SO_4^{2-} = 100; NO_3^- = 50$$

The anion/anions that make/makes the water sample unsuitable for drinking is/are:

- (1) Only  $NO_3^-$                       (2) Both  $SO_4^{2-}$  and  $NO_3^-$                       (3) Only  $F^-$                       (4) Only  $SO_4^{2-}$

88. 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) 1186                      (B) 84.3                      (C) 118.6                      (D) 11.86

89. Given

$$E^\circ_{Cl_2/Cl^-} = 1.36V, E^\circ_{Cr^{3+}/Cr} = -0.74V$$

$$E^\circ_{Cr_2O_7^{2-}/Cr^{3+}} = 1.33V, E^\circ_{MnO_4^-/Mn^{2+}} = 1.51V$$

Among the following, the strongest reducing agent is:

- (1) Cr                      (2)  $Mn^{2+}$                       (3)  $Cr^{3+}$                       (4)  $Cl^-$

90. The group having isoelectronic species is:

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