

FIITJEE

Solutions to JEE (Main)-2021

JEE–Main–2021 –Feb–24–First–Shift
PHYSICS, CHEMISTRY & MATHEMATICS

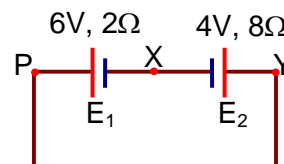
PART –A (PHYSICS)

SECTION A

- Q1.** Consider two satellites S_1 and S_2 with periods of revolution 1hr. and 8 hr. respectively revolving around a planet in circular orbits. The ratio of angular velocity of satellite S_1 to the angular velocity of satellites S_2 is:
- (A) 1:8 (B) 1:4
(C) 2:1 (D) 8:1

- Q2.** Given below are two statements:
Statements I: Two photons having equal linear momenta have equal wavelengths
Statements II: If the wavelength of photon is decreased, then the momentum and energy of a photon will also decrease.
In the light of the above statements, choose the correct answer from the options given below.
(A) Both Statement I and Statement II are false (B) Statement I is false but Statement II is true
(C) Both statement I and Statement II are true (D) Statement I is true but statement II is false.

- Q3.** A cell E_1 of emf 6V and internal resistance 2Ω is connected with another cell E_2 of emf 4V and internal resistance 8Ω (as shown in the figure). The potential difference across points X and Y is:



- (A) 10.0 V (B) 2.0 V
(C) 5.6 V (D) 3.6 V
- Q4.** Two equal capacitors are first connected in series and then in parallel. The ratio of the equivalent capacities in the two cases will be:
(A) 4:1 (B) 1:2
(C) 1:4 (D) 2:1

- Q5.** In the given figure, the energy levels of hydrogen atom have been shown along with some transitions marked A, B, C, D and E. The transitions A, B and C respectively represent:
-

- (A) The series limit of Lyman series, second member of Balmer series and second member of Paschen series.
(B) The first member of the Lyman series, third member of Balmer series and second member of Paschen series.
(C) The ionization potential of hydrogen, second member of Balmer series and third member of Paschen series.
(D) The series of Lyman series, third member of Balmer series and second member of Paschen series.

JEE-MAIN-PCM-2021-2

Q6. A current through a wire- depends on time as

$$i = \alpha_0 t + \beta t^2$$

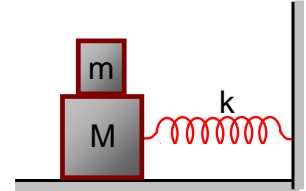
Where $\alpha_0 = 20 \text{ A / s}$ and $\beta = 8 \text{ A s}^{-2}$. Find the charge crossed through a section of the wire in 15s.

- (A) 2100 C (B) 2250 C
(C) 260 C (D) 11250 C

Q7. The work done by a gas molecule in an isolated system is given by $W = \alpha\beta^2 e^{-\frac{x^2}{\alpha kT}}$, where x is the displacement, k is the Boltzmann constant and T is the temperature. α and β are constants. Then the dimensions of β will be:

- (A) $[\text{MLT}^{-2}]$ (B) $[\text{ML}^2\text{T}^{-2}]$
(C) $[\text{M}^2\text{LT}^2]$ (D) $[\text{M}^0\text{LT}^0]$

Q8. In the given figure, a mass M is attached to a horizontal spring which is fixed on one side to a rigid support. The spring constant of the spring is k. The mass oscillates on a frictionless surface with time period T and amplitude A. When the mass is in equilibrium position, as shown in the figure, another mass m is gently fixed upon it. New amplitude of oscillation will be:

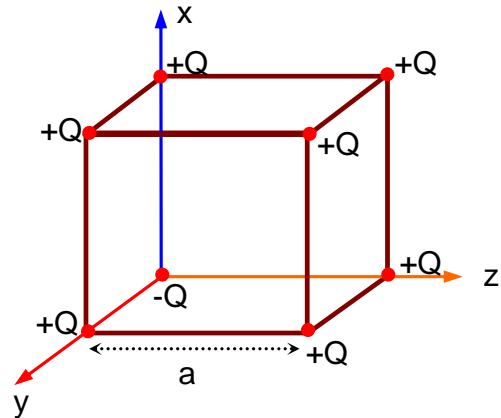


- (A) $A\sqrt{\frac{M}{M-m}}$ (B) $A\sqrt{\frac{M}{M+m}}$ (C) $A\sqrt{\frac{M-m}{M}}$ (D) $A\sqrt{\frac{M+m}{M}}$

Q9. Four identical particles of equal masses 1 kg made to move along the circumference of a circle of radius 1 m under the action of their own mutual gravitational attraction. The speed of each particle will be:

- (A) $\frac{\sqrt{(1+2\sqrt{2})G}}{2}$ (B) $\sqrt{\frac{G}{2}(1+2\sqrt{2})}$
(C) $\sqrt{\frac{G}{2}(2\sqrt{2}-1)}$ (D) $\sqrt{G(1+2\sqrt{2})}$

Q10. A cube of side 'a' has point charges +Q located at each of its vertices except at the origin where the charge is -Q. The electric field at the centre of cube is:

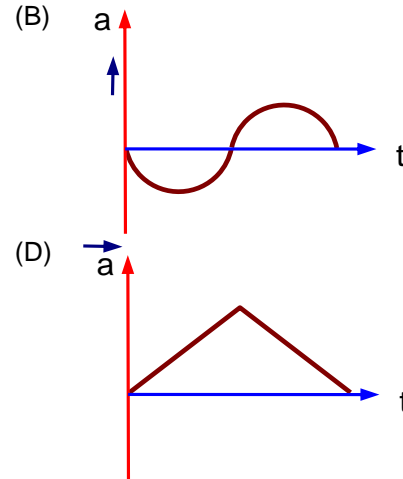
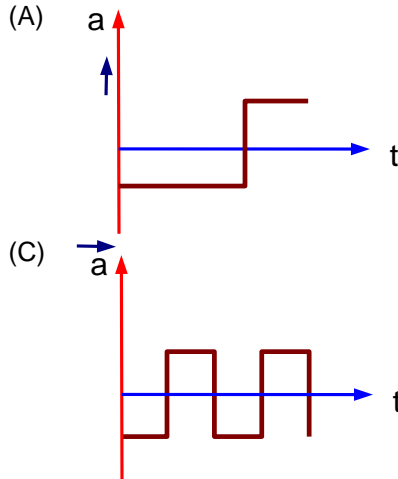
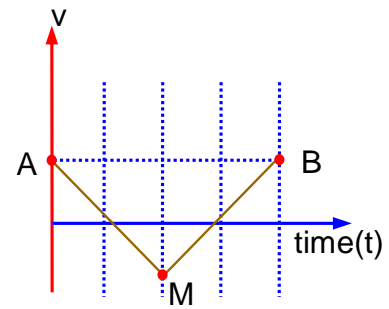


- (A) $\frac{2Q}{3\sqrt{3}\pi\epsilon_0 a^2}(\hat{x} + \hat{y} + \hat{z})$ (B) $\frac{Q}{3\sqrt{3}\pi\epsilon_0 a^2}(\hat{x} + \hat{y} + \hat{z})$
(C) $\frac{-2Q}{3\sqrt{3}\pi\epsilon_0 a^2}(\hat{x} + \hat{y} + \hat{z})$ (D) $\frac{-Q}{3\sqrt{3}\pi\epsilon_0 a^2}(\hat{x} + \hat{y} + \hat{z})$

Q11. Each side of a box made of metal sheet in cubic shape is 'a' at room temperature 'T', the coefficient of linear expansion of the metal sheet is ' α '. The metal sheet is heated uniformly, by a small temperature ΔT , so that its new temperature is $T + \Delta T$. Calculate the increase in the volume of the metal box.

- (A) $\frac{4}{3}\pi a^3 \alpha \Delta T$ (B) $3a^3 \alpha \Delta T$
(C) $4\pi a^3 \alpha \Delta T$ (D) $4a^3 \alpha \Delta T$

Q12. If the velocity- time graph has the shape AMB, what would be the shape of the corresponding acceleration- time graph?



Q13. Match List I with List II.

List I

- (a) Isothermal
- (b) Isochoric
- (c) Adiabatic
- (d) Isobaric

List II

- (i) Pressure constant
- (ii) Temperature constant
- (iii) Volume constant
- (iv) Heat content is constant

Choose the correct answer from the options given below:

- (A) (a) →(iii), (b) →(ii) , (c) → (i) , (d) →(iv)
- (B) (a) →(i), (b) →(iii), (c) →(ii) (d) →(iv)
- (C) (a) →(ii), (b) → (iv), (c) → (iii), (d) → (i)
- (D) (a) →(ii), (b) →(iii), (c) → (iv), (d) → (i)

Q14. The focal length f is related to the radius of curvature r of the spherical convex mirror by:

- (A) $f = r$
- (B) $f = -\frac{1}{2} r$
- (C) $f = -r$
- (D) $f = +\frac{1}{2} r$

Q15. If an emitter current is changed by 4mA, the collector current changes by 3.5mA. The value of β will be:

- (A) 0.5
- (B) 7
- (C) 3.5
- (D) 0.875

Q16. Two stars of masses m and $2m$ at a distance d rotate about their common centre of mass in free space. The period of revolution is:

- (A) $2\pi \sqrt{\frac{3Gm}{d^3}}$
- (B) $\frac{1}{2\pi} \sqrt{\frac{3Gm}{d^3}}$
- (C) $2\pi \sqrt{\frac{d^3}{3Gm}}$
- (D) $\frac{1}{2\pi} \sqrt{\frac{d^3}{3Gm}}$

- Q17.** Moment of inertia (M.I) of four bodies, having same mass and radius, are reported as:
 $I_1 =$ M.I. of thin circular ring about its diameter
 $I_2 =$ M.I. of circular disc about an axis perpendicular to disc and going through the centre,
 $I_3 =$ M.I of solid cylinder about its axis and
 $I_4 =$ M.I of solid sphere about its diameter.

Then

- (A) $I_1 + I_3 < I_2 + I_4$ (B) $I_1 = I_2 = I_3 < I_4$
 (C) $I_1 = I_2 = I_3 > I_4$ (D) $I_1 + I_2 = I_3 + \frac{5}{2} I_4$

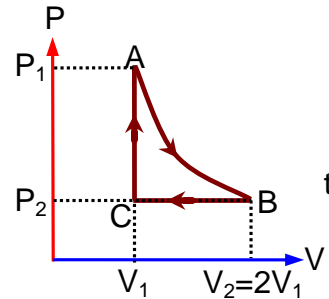
- Q18.** n mole of perfect gas undergoes a cyclic process ABCA (see figure) consisting of the following processes.

A→B : Isothermal expansion at temperature T so that the volume is doubled from V_1 to $V_2 = 2V_1$ and Pressure changes from P_1 to P_2 .

B→C : Isobaric compression at pressure P_2 to initial volume V_1 .

C→A : isochoric change leading to change of pressure from P_2 to P_1 .

Total work done in the complete cycle ABCA is:



- (A) $nRT \left(\ln 2 + \frac{1}{2} \right)$ (B) $nRT \left(\ln 2 - \frac{1}{2} \right)$
 (C) 0 (D) $nRT \ln 2$

- Q19.** If Y, K and η are the value of Young's moduls, bulk modulus of rigidity of any material respectively. Choose the correct relation for these parameters

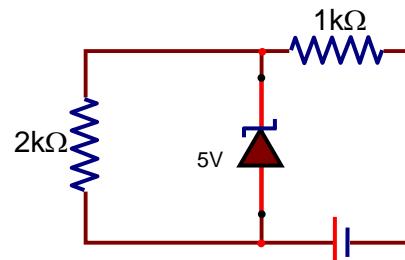
- (A) $Y = \frac{9K\eta}{2\eta + 3K} N/m^2$ (B) $K = \frac{Y\eta}{9\eta - 3Y} N/m^2$
 (C) $\eta = \frac{3YK}{9K + Y} N/m^2$ (D) $Y = \frac{9K\eta}{3K - \eta} N/m^2$

- Q20.** In a Young's double slit experiment, the width of the one of the slit is three times the other slit. The amplitude of the light coming from a slit is proportional to the slit-width. Find the ratio of the maximum to the minimum intensity in the interference pattern.

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

SECTION B

- Q1.** In connection with the circuit drawn below, the value of current flowing through 2 k Ω resistor is _____ $\times 10^{-4}A$.



- Q2.** An audio signal $V_m = 20 \sin 2\pi(1500t)$ amplitude modulates a carrier $V_c = 80 \sin 2\pi (100,000t)$ The value of percent modulation is _____.

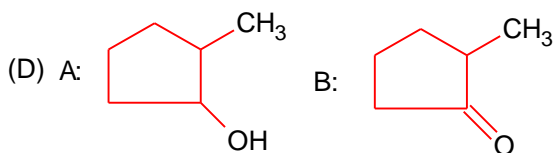
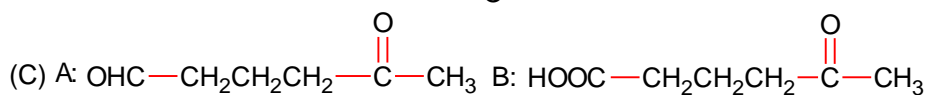
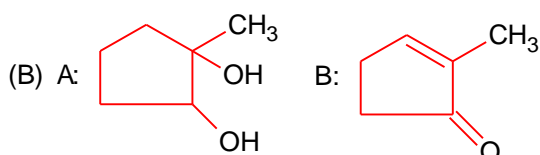
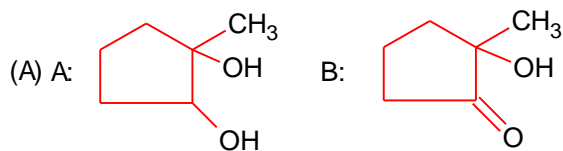
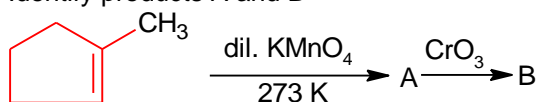
- Q3.** A hydraulic press can lift 100 kg when a mass 'm' is placed on the smaller piston. It can lift _____ kg when the diameter of the larger piston in increased by 4 times and that of the smaller piston is decreased by 4 times keeping the same mass 'm' on the smaller piston

- Q4.** The coefficient of static friction between a wooden block of mass 0.5 kg and a vertical rough wall is 0.2. The magnitude of horizontal force that should be applied on the block to keep it adhere to the wall be _____ N.
[$g = 10 \text{ms}^{-2}$]
- Q5.** A resonance circuit having inductance and resistance $2 \times 10^{-4} \text{ H}$ and 6.28Ω respectively oscillates at 10 MHz frequency. The value of quality factor of this resonator is_____.
[$\pi = 3.14$]
- Q6.** A ball with a speed of 9m/s collides with another identical ball at rest. After the collision the direction of each ball makes an angle of 30° with the original direction. The ratio of velocities of the balls after collision is $x : 1$, where x is_____.
- Q7.** An inclined plane is bent in such a way that the vertical cross- section is given by $y = \frac{x^2}{4}$ where y is in vertical and x in horizontal direction. If the upper surface of this curved plane is rough with coefficient of friction $\mu = 0.5$, the maximum height in cm at which a stationary block will not skip downward is _____cm.
- Q8.** An unpolarized light beam is incident on the polarizer of a polarization experiment and the intensity of light beam emerging from the analyzer is measured as 100 Lumens. Now , if the analyzer is rotated around the horizontal axis (direction of light) by 30° in clockwise direction, the intensity of emerging light will be_____ Lumens.
- Q9.** A common transistor radio set requires 12 V (D.C) for its operation. The D.C source is constructed by using a transformer and a rectifier circuit, which are operated at 220V (A.C) on standard domestic A.C, supply. The number of turns of secondary coil are 24, then the number of turns of primary are_____.
- Q10.** An electromagnetic wave of frequency 5 GHz, is travelling in a medium whose relative electric permittivity and relative magnetic permeability both are 2. Its velocity in the this medium is_____ $\times 10^7 \text{ m/s}$.

PART –B (CHEMISTRY)

SECTION A

Q1. Identify products A and B



Q2. The electrode potential of M^{2+} / M of 3d- series elements shows positive value for:

- (A) Cu (B) Co
(C) Zn (D) Fe

Q3. Consider the elements Mg, Al, S, P and Si, the correct increasing order of their first ionization enthalpy is:

- (A) $\text{Al} < \text{Mg} < \text{S} < \text{Si} < \text{P}$ (B) $\text{Al} < \text{Mg} < \text{Si} < \text{S} < \text{P}$
(C) $\text{Mg} < \text{Al} < \text{Si} < \text{P} < \text{S}$ (D) $\text{Mg} < \text{Al} < \text{Si} < \text{S} < \text{P}$

Q4. Given below are two statements:

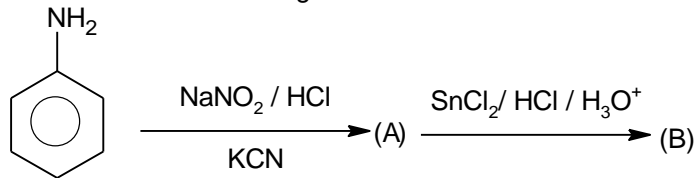
Statement I : Colourless cupric metaborate is reduced to cuprous metaborate in a luminous flame.

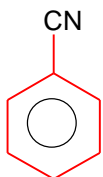
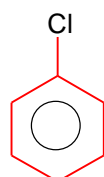
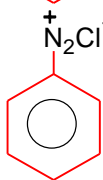
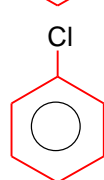
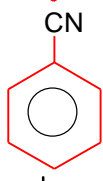
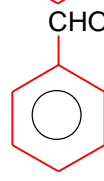
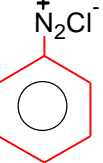
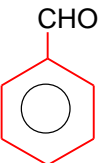
Statement II : Cuprous metaborate is obtained by heating boric anhydride and copper sulphate in a non- luminous flame.

In the light of the above statements, choose the most appropriate answer from the option given below

- (A) Statement I is false but Statement II is true
(B) Both statement I and Statement II are true
(C) Both Statement I and Statement II are false
(D) Statement I is true but Statement II is false

Q5. 'A' and 'B' in the following reactions are:



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

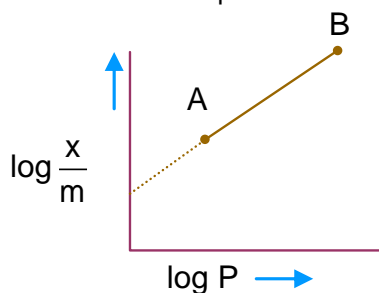
Q6. The major components in "Gun Metal" are:

- (A) Cu, Ni and Fe (B) Al, Cu, Mg and Mn
 (C) Cu, Sn and Zn (D) Cu, Zn and Ni

Q7. Which of the following ore is concentrated using group 1 cyanide salt?

- (A) Calamine (B) Sphalerite
 (C) Siderite (D) Malachite

Q8. In Freundlich adsorption isotherm, slope of AB line is:



- (A) $\frac{1}{n}$ with $\left(\frac{1}{n} = 0 \text{ to } 1\right)$ (B) $\log n$ with $(n > 1)$
 (C) $\log \frac{1}{n}$ with $(n < 1)$ (D) n with $(n, 0.1 \text{ to } 0.5)$

Q9. Match List I with List II.

List I (Monomer Unit)	List II (Polymer)
(a) Caprolactum	(i) Natural rubber
(b) 2-Chloro-1,3-butadiene	(ii) Buna-N
(c) Isoprene	(iii) Nylon 6
(d) Acrylonitrile	(iv) Neoprene

Choose the correct answer from the options given below:

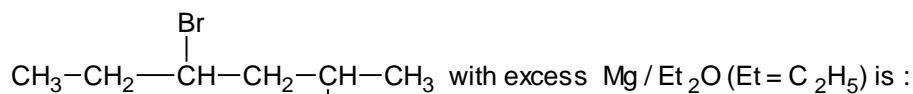
- (A) (a) → (iii), (b) → (iv), (c) → (i), (d) → (ii)
 (B) (a) → (iv), (b) → (iii), (c) → (ii), (d) → (i)
 (C) (a) → (ii), (b) → (i), (c) → (iv), (d) → (iii)
 (D) (a) → (i), (b) → (ii), (c) → (iii), (d) → (iv)

Q10. (A) $\text{HOCl} + \text{H}_2\text{O}_2 \rightarrow \text{H}_3\text{O}^+ + \text{Cl}^- + \text{O}_2$
 (B) $\text{I}_2 + \text{H}_2\text{O}_2 + 2\text{OH}^- \rightarrow 2\text{I}^- + 2\text{H}_2\text{O} + \text{O}_2$

Choose the correct option.

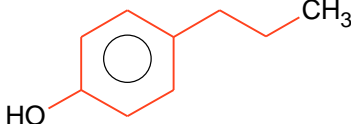
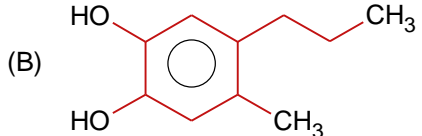
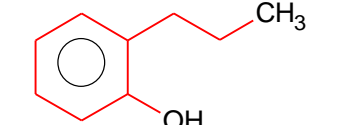
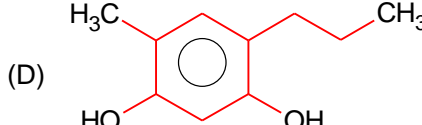
- (A) H_2O_2 acts as oxidizing agent in equations (A) and (B)
 (B) H_2O_2 act as oxidizing and reducing agent respectively in equations (A) and (B)
 (C) H_2O_2 acts as reducing and oxidizing agent respectively in equations (A) and (B)
 (D) H_2O_2 acts as reducing agent in equations (A) and (B)

Q11. The product formed in the first step of the reaction of

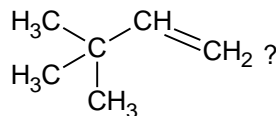


- (A) $\text{CH}_3-\text{CH}_2-\overset{\text{Br}}{\underset{|}{\text{CH}}}-\text{CH}_2-\overset{\text{Br}}{\underset{|}{\text{CH}}}-\text{CH}_3$
 $\text{H}_3\text{C}-\overset{\text{CH}_2}{\underset{|}{\text{CH}}}-\text{CH}_2-\overset{\text{CH}_2}{\underset{|}{\text{CH}}}-\text{CH}_2-\text{CH}_3$
 (B) $\text{CH}_3-\text{CH}-\begin{matrix} \text{CH}_2 \\ | \\ \text{CH}-\text{CH}_3 \end{matrix}$
 (C) $\text{CH}_3-\text{CH}_2-\overset{\text{CH}_2}{\underset{|}{\text{CH}}}-\text{CH}_2-\overset{\text{CH}_2}{\underset{|}{\text{CH}}}-\text{CH}_3$
 $\text{CH}_3-\text{CH}_2-\overset{\text{MgBr}}{\underset{|}{\text{CH}}}-\text{CH}_2-\overset{\text{MgBr}}{\underset{|}{\text{CH}}}-\text{CH}_3$
 (D) $\text{CH}_3\text{CH}_2-\overset{\text{MgBr}}{\underset{|}{\text{CH}}}-\text{CH}_2-\overset{\text{MgBr}}{\underset{|}{\text{CH}}}-\text{CH}_3$

Q12. Which of the following compound gives pink colour on reaction with phthalic anhydride in conc. H_2SO_4 followed by treatment with NaOH ?

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

Q13. What is the major product formed by HI on reaction with

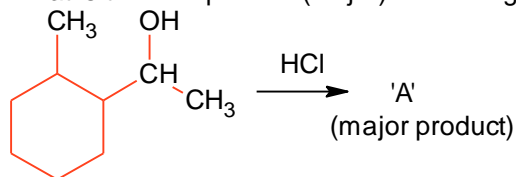


- (A) $\begin{array}{c} \text{CH}_3 \\ | \\ \text{CH}_3-\text{C}-\text{CH}-\text{CH}_3 \\ | \\ \text{CH}_3 \quad | \\ \quad \quad \text{I} \end{array}$
- (B) $\begin{array}{c} \text{CH}_3 \\ | \\ \text{CH}_3-\text{C}-\text{CH}-\text{CH}_3 \\ | \quad | \\ \text{I} \quad \text{CH}_3 \end{array}$
- (C) $\begin{array}{c} \text{CH}_3 \\ | \\ \text{CH}_3-\text{CH}-\text{CH}-\text{CH}_2-\text{CH}_3 \\ | \quad | \\ \text{CH}_3 \quad \text{I} \end{array}$
- (D) $\begin{array}{c} \text{CH}_3 \\ | \\ \text{CH}_3-\text{C}-\text{CH}-\text{CH}_2\text{I} \\ | \quad | \\ \text{CH}_3 \quad \text{H} \end{array}$

Q14. Al_2O_3 was leached with alkali to get X. The solution of X on passing of gas Y, forms Z. X, Y and Z respectively are:

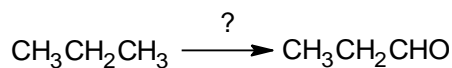
- (A) X = $\text{Na}[\text{Al}(\text{OH})_4]$, Y = SO_2 , Z = Al_2O_3
 (B) X = $\text{Al}(\text{OH})_3$, Y = CO_2 , Z = Al_2O_3
 (C) X = $\text{Al}(\text{OH})_3$, Y = SO_2 , Z = $\text{Al}_2\text{O}_3 \cdot x\text{H}_2\text{O}$
 (D) X = $\text{Na}[\text{Al}(\text{OH})_4]$, Y = CO_2 , Z = $\text{Al}_2\text{O}_3 \cdot x\text{H}_2\text{O}$

Q15. What is the final product (major) 'A' in the given reaction?



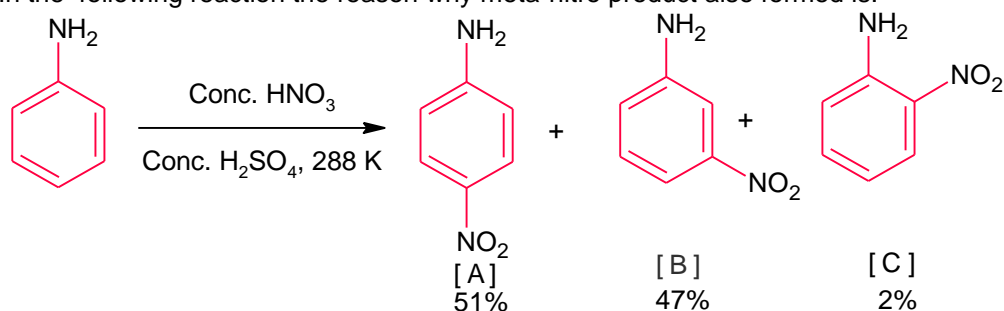
- (A)
- (B)
- (C)
- (D)

Q16. Which of the following reagent is used for the following reaction?



- (A) Manganese acetate
 (B) Molybdenum oxide
 (C) Potassium permanganate
 (D) Copper at high temperature and pressure

Q17. In the following reaction the reason why meta-nitro product also formed is:



- (A) Formation of anilinium ion
 (B) -NH₂ group is highly meta- directive
 (C) -NO₂ substitution always takes place at meta- position
 (D) low temperature

Q18. Which of the following are isostructural pairs ?

- A. SO₄²⁻ and CrO₄²⁻
 B. SiCl₄ and TiCl₄
 C. NH₃ and NO₃⁻
 D. BCl₃ and BrCl₃

- (A) C and D only
 (B) A and B only
 (C) A and C only
 (D) B and C only

Q19. Out of the following which type of interaction is responsible for the stabilization of α-helix structure of proteins?

- (A) Hydrogen bonding
 (B) Covalent bonding
 (C) Vander Waals forces
 (D) Ionic bonding

Q20. The gas released during anaerobic degradation of vegetation may lead to:

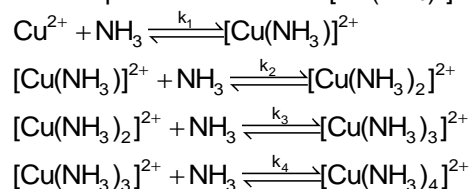
- (A) Ozone hole
 (B) Global warming and cancer
 (C) Corrosion of metals
 (D) Acid rain

SECTION B

Q1. Number of amphoteric compounds among the following is _____.

- (A) BeO
 (B) BaO
 (C) Be(OH)₂
 (D) Sr(OH)₂

Q2. The stepwise formation of [Cu(NH₃)₄]²⁺ is given below:



The value of stability constants k₁, k₂, k₃ and k₄ are 10⁴, 1.58 × 10³, 5 × 10² and 10² respectively. The overall equilibrium constants for dissociation of [Cu(NH₃)₄]²⁺ is x × 10⁻¹². The value of x is _____ (Rounded off to the nearest integer)

Q3. For the reaction A_(g) → B_(g) the value of the equilibrium constant at 300K and 1 atm is equal to 100.0. The Value of Δ_rG for the reaction at 300K and 1 atm in J mol⁻¹ is -xR, where x is _____. (Rounded off to the nearest integer)

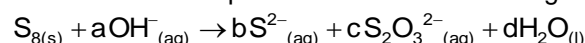
[R = 8.31 J mol⁻¹K⁻¹ and ln 10 = 2.3]

Q4. At 1990 K and 1 atm pressure, there are equal number of Cl₂ molecules and Cl atoms in the reaction mixture. The value of K_P for the the reaction Cl_{2(g)} ⇌ 2Cl_(g) under the above conditions is x × 10⁻¹. The value of x is _____. (Rounded off to the nearest integer)

Q5. When 9.45 g of ClCH₂COOH is added to 500 ml. of water, its freezing point drops by 0.5°C. The dissociation constant of ClCH₂COOH is x × 10⁻³. The value of x is _____. (Rounded off to the nearest integer)

[k_{f(H₂O)} = 1.86 K kg mol⁻¹]

Q6. The reaction of sulphur in alkaline medium is given below



The values of 'a' is _____. (Integer answer)

Q7. 4.5 g of compound A (MW = 90) was used to make 250 mL of its aqueous solution. The molarity of the solution in M is x × 10⁻¹. The value of x is _____. (Rounded off to the nearest integer)

- Q8.** A proton and a Li^{3+} nucleus are accelerated by the same potential. If λ_{Li} and λ_{P} denote the de Broglie wavelengths of Li^{3+} and proton respectively, then the value of $\frac{\lambda_{\text{Li}}}{\lambda_{\text{P}}}$ is $x \times 10^{-1}$.
The value of x is _____ (Rounded off to the nearest integer)
[Mass of Li^{3+} = 8.3 mass of proton]
- Q9.** The coordination number of an atom in a body- centred cubic structure is _____.
[Assume that the lattice is made up of atoms]
- Q10.** Gaseous cyclobutene isomerizes to butadiene in a first order process which has 'k' value of $3.3 \times 10^{-4} \text{ s}^{-1}$ at 153°C . The time in minutes it takes for the isomerization to proceed 40% to completion at this temperature is _____. (Rounded off the nearest integer)

PART-C (MATHEMATICS)

SECTION A

- Q1.** A scientific committee is to be formed from 6 Indians and 8 foreigners, which includes at least 2 Indians and double the number of foreigners as Indians. Then the number of ways the committee can be formed is:
 (A) 560 (B) 1625
 (C) 1050 (D) 575
- Q2.** An ordinary dice is rolled for a certain number of times. If the probability of getting an odd number 2 times is equal to the probability of getting an even number 3 times, then the probability of getting an odd number, odd number of times is:
 (A) $\frac{3}{16}$ (B) $\frac{5}{16}$
 (C) $\frac{1}{32}$ (D) $\frac{1}{2}$
- Q3.** The locus of the mid-point of the line segment joining the focus of the parabola $y^2 = 4ax$ to a moving point of the parabola, is another parabola whose directrix is:
 (A) $x = 0$ (B) $x = \frac{a}{2}$
 (C) $x = a$ (D) $x = -\frac{a}{2}$
- Q4.** The function $f(x) = \frac{4x^3 - 3x^2}{6} - 2\sin x + (2x - 1) \cos x$:
 (A) Decreases in $\left(-\infty, \frac{1}{2}\right]$ (B) Increases in $\left[\frac{1}{2}, \infty\right)$
 (C) Increases in $\left(-\infty, \frac{1}{2}\right]$ (D) Decreases in $\left[\frac{1}{2}, \infty\right)$
- Q5.** The population $P = P(t)$ at time 't' of a certain species follows the differential equation $\frac{dP}{dt} = 0.5P - 450$.
 If $P(0) = 850$, then the time at which population becomes zero is:
 (A) $\frac{1}{2} \log_e 18$ (B) $\log_e 9$
 (C) $2 \log_e 18$ (D) $\log_e 18$
- Q6.** If the tangent to the curve $y = x^3$ at the point $P(t, t^3)$ meets the curve again at Q, then the ordinate of the point which divides PQ internally in the ratio 1:2 is:
 (A) 0 (B) $-t^3$
 (C) $-2t^3$ (D) $2t^3$
- Q7.** The system of linear equations
 $3x - 2y - kz = 10$
 $2x - 4y - 2z = 6$
 $x + 2y - z = 5m$
 is inconsistent if
 (A) $k \neq 3, m \neq \frac{4}{5}$ (B) $k = 3, m \neq \frac{4}{5}$
 (C) $k \neq 3, m \in \mathbb{R}$ (D) $k = 3, m = \frac{4}{5}$

- Q8.** A man is walking on a straight line. The arithmetic mean of the reciprocals of the intercepts of the line on the coordinate axes is $\frac{1}{4}$. Three stones A, B and C are placed at the points (1,1), (2,2) and (4,4) respectively. Then which of these stones is / are on the path of the man?
 (A) A only (B) All the three
 (C) C only (D) B only
- Q9.** If $\int \frac{\cos x - \sin x}{\sqrt{8 - \sin 2x}} dx = a \sin^{-1} \left(\frac{\sin x + \cos x}{b} \right) + c$, where c is a constant of integration, then the ordered pair (a,b) is equal to:
 (A) (-1,3) (B) (1, -3)
 (C) (3,1) (D) (1,3)
- Q10.** The statement among the following that is a tautology is:
 (A) $A \wedge (A \vee B)$ (B) $A \vee (A \wedge B)$
 (C) $B \rightarrow [A \wedge (A \rightarrow B)]$ (D) $[A \wedge (A \rightarrow B)] \rightarrow B$
- Q11.** Let p and q be two positive numbers such that $p + q = 2$ and $p^4 + q^4 = 272$. Then p and q are roots of the equation:
 (A) $x^2 - 2x + 8 = 0$ (B) $x^2 - 2x + 136 = 0$
 (C) $x^2 - 2x + 16 = 0$ (D) $x^2 - 2x + 2 = 0$
- Q12.** $\lim_{x \rightarrow 0} \frac{\int_0^{x^2} (\sin \sqrt{t}) dt}{x^3}$ is equal to:
 (A) $\frac{3}{2}$ (B) $\frac{2}{3}$
 (C) $\frac{1}{15}$ (D) 0
- Q13.** Two vertical poles are 150 m apart and the height of one is three times that of other. If from the middle point of the line joining their feet, an observer finds the angles of elevation of their tops to be complementary, then the height of the shorter pole (in meters) is:
 (A) 25 (B) $20\sqrt{3}$
 (C) 30 (D) $25\sqrt{3}$
- Q14.** Let $f : \mathbb{R} \rightarrow \mathbb{R}$ be defined as $f(x) = 2x - 1$ and $g : \mathbb{R} - \{1\} \rightarrow \mathbb{R}$ be defined as $g(x) = \frac{x - 1}{x - 1}$. Then the composition function $f(g(x))$ is :
 (A) Neither one-one nor onto (B) onto but not one-one
 (C) both one-one and onto (D) one-one but not onto
- Q15.** If $f : \mathbb{R} \rightarrow \mathbb{R}$ is a function defined by $f(x) = [x - 1] \cos \left(\frac{2x - 1}{2} \right) \pi$, where [.] denotes the greatest integer function, then f is:
 (A) discontinuous only at $x = 1$
 (B) discontinuous at all integral values of x except at $x = 1$
 (C) continuous for every real x
 (D) continuous only at $x = 1$
- Q16.** The area (in sq. units) of the part of the circle $x^2 + y^2 = 36$, which is outside the parabola $y^2 = 9x$ is:
 (A) $24\pi + 3\sqrt{3}$ (B) $24\pi - 3\sqrt{3}$
 (C) $12\pi + 3\sqrt{3}$ (D) $12\pi - 3\sqrt{3}$

- Q17.** The distance of the point (1, 1, 9) from the point of intersection of the line $\frac{x-3}{1} = \frac{y-4}{2} = \frac{z-5}{2}$ and the plane $x + y + z = 17$ is:
 (A) $\sqrt{38}$ (B) $2\sqrt{19}$
 (C) 38 (D) $19\sqrt{2}$
- Q18.** If $e^{(\cos^2 x + \cos^4 x + \cos^6 x + \dots) \log_e 2}$ satisfies the equation $t^2 - 9t + 8 = 0$, then the value of $\frac{2 \sin x}{\sin x + \sqrt{3} \cos x} \left(0 < x < \frac{\pi}{2} \right)$ is
 (A) $\sqrt{3}$ (B) $\frac{1}{2}$
 (C) $2\sqrt{3}$ (D) $\frac{3}{2}$
- Q19.** The equation of the plane passing through the point (1,2,-3) and perpendicular to the planes $3x + y - 2z = 5$ and $2x - 5y - z = 7$, is:
 (A) $6x - 5y + 2z + 10 = 0$ (B) $3x - 10y - 2z + 11 = 0$
 (C) $11x + y + 17z + 38 = 0$ (D) $6x - 5y - 2z - 2 = 0$
- Q20.** The value of $-{}^{15}C_1 + 2.{}^{15}C_2 - 3.{}^{15}C_3 + \dots - 15.{}^{15}C_{15} + {}^{14}C_1 + {}^{14}C_3 + {}^{14}C_5 + \dots + {}^{14}C_{11}$ is :
 (A) $2^{13} - 14$ (B) $2^{13} - 13$
 (C) 2^{14} (D) $2^{16} - 1$

SECTION B

- Q1.** $\lim_{n \rightarrow \infty} \tan \left\{ \sum_{r=1}^n \tan^{-1} \left(\frac{1}{1+r+r^2} \right) \right\}$ is equal to _____.
- Q2.** If the least and the largest real values of α , for which the equation $z + \alpha |z-1| + 2i = 0$ ($z \in \mathbb{C}$ and $i = \sqrt{-1}$) has a solution, are p and q respectively, then $4(p^2 + q^2)$ is equal to _____.
- Q3.** Let M be any 3×3 matrix with entries from the set $\{0,1,2\}$. The maximum number of such matrices, for which the sum of diagonal elements of $M^T M$ is seven is _____.
- Q4.** The minimum value of α for which the equation $\frac{4}{\sin x} + \frac{1}{1 - \sin x} = \alpha$ has at least one solution in $\left(0, \frac{\pi}{2} \right)$ is _____.
- Q5.** Let $A = \{ n \in \mathbb{N} : n \text{ is a 3-digit number} \}$
 $B = \{ 9k + 2 : k \in \mathbb{N} \}$
 And $C = \{ 9k + \ell : k \in \mathbb{N} \}$ for some ℓ ($0 < \ell < 9$)
 If the sum of all the elements of the set $A \cap (B \cup C)$ is 274×400 , then ℓ is equal to _____.
- Q6.** If one of the diameters of the circle $x^2 + y^2 - 2x - 6y + 6 = 0$ is a chord of another circle 'C', whose centre is at (2,1), then its radius is _____.
- Q7.** Let B_i ($i = 1,2,3$) be three independent events in a sample space. The probability that only B_1 occur is α , only B_2 occurs is β and B_3 occurs is γ . Let p be the probability that none of the events B_i occurs and these 4 probabilities satisfy the equations $(\alpha - 2\beta)p = \alpha\beta$ and $(\beta - 3\gamma)p = 2\beta\gamma$ (All the probabilities are assumed to lie in the interval (0,1)). Then $\frac{P(B_1)}{P(B_3)}$ is equal to _____.

Q8. Let three vectors \vec{a}, \vec{b} and \vec{c} be such that \vec{c} is coplanar with \vec{a} and \vec{b} , $a \cdot \vec{c} = 7$ and \vec{b} is perpendicular to \vec{c} , where $\vec{a} = -\hat{i} + \hat{j} + \hat{k}$ and $\vec{b} = 2\hat{i} + \hat{k}$, then the value of $2|\vec{a} + \vec{b} + \vec{c}|^2$ is _____.

Q9. Let $P = \begin{bmatrix} 3 & -1 & -2 \\ 2 & 0 & \alpha \\ 3 & -5 & 0 \end{bmatrix}$ where $\alpha \in \mathbb{R}$. Suppose $Q = [q_{ij}]$ is a matrix satisfying $PQ = kI_3$ for some non-zero

$k \in \mathbb{R}$. If $q_{23} = \frac{-k}{8}$ and $|Q| = \frac{k^2}{2}$, then $\alpha^2 + k^2$ is equal to _____.

Q10. If $\int_{-a}^a (|x| + |x-2|) dx = 22, (a > 2)$ and $[x]$ denotes the greatest integer $\leq x$, then $\int_a^{-a} (x + [x]) dx$ is equal to _____.