

# FIITJEE

## Solutions to JEE (Main)-2021

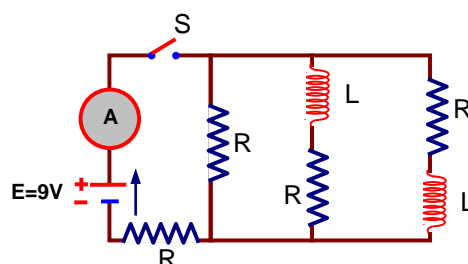
JEE–Main–2021 –Feb–24–Second–Shift  
PHYSICS, CHEMISTRY & MATHEMATICS

### PART –A (PHYSICS)

#### SECTION A

- Q1.** On the basis of kinetic theory of gases, the gas exerts pressure because its molecules:  
(A) Continuously lose their energy till it reaches wall.  
(B) Suffer change in momentum when impinge on the walls of container.  
(C) Are attracted by the walls of container.  
(D) Continuously stick to the walls of container.

- Q2.** Figure shows a circuit that contains four identical resistors with resistance  $R = 2.0\Omega$ , two identical inductors with inductance  $L = 2.0\text{mH}$  and an ideal battery with emf  $E = 9\text{ V}$ . The current 'i' just after switch 'S' is closed will be:



- (A) 2.25 A  
(B) 3.0 A  
(C) 9 A  
(D) 3.37 A

- Q3.** The period of oscillation of a simple pendulum is  $T = 2\pi\sqrt{\frac{L}{g}}$ . Measured value of 'L' is 1.0 m from meter scale having a minimum division of 1 mm and time of one- complete oscillation is 1.95s measured from stopwatch of 0.01s resolution. The percentage error in the determination of 'g' will be:  
(A) 1.33%  
(B) 1.13%  
(C) 1.03%  
(D) 1.30%

- Q4.** Zener breakdown occurs in a P– n junction having P and n both:  
(A) Lightly doped and have wide depletion layer.  
(B) Heavily doped and have wide depletion layer.  
(C) Lightly doped and have narrow depletion layer.  
(D) Heavily doped and have narrow depletion layer.

- Q5.** A body weighs 49 N on a spring balance at the north pole. What will be its weight recorded on the same weighing machine, if it is shifted to the equator?

[ use  $g = \frac{Gm}{R^2} = 9.8\text{ ms}^{-2}$  and radius of earth,  $R = 6400\text{ km}$  ].

- (A) 49.83 N  
(B) 48.83 N  
(C) 49 N  
(D) 49.17 N

- Q6.** A soft ferromagnetic material is placed in an external magnetic field. The magnetic domains:  
(A) Decrease in size and change orientation.  
(B) Increases in size but no change in orientation.  
(C) May increase or decrease in size and change its orientation.  
(D) Have no relation with external magnetic field.

Q7. Given below are two statements:

**Statement I :** PN junction diodes can be used to function as transistor simply by connecting two diodes, back to back, which acts as the base terminal.

**Statement II :** In the study of transistor, the amplification factor  $\beta$  indicates ratio of the collector current to the base current.

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

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

Q8. A particle is projected with velocity  $v_0$  along x-axis. A damping force is acting on the particle which is proportional to the square of the distance from the origin i.e.  $ma = -\alpha x^2$ . The distance at which the particle stops:

- (A)  $\left(\frac{2v_0}{3\alpha}\right)^{\frac{1}{3}}$
- (B)  $\left(\frac{3v_0^2}{2\alpha}\right)^{\frac{1}{2}}$
- (C)  $\left(\frac{2v_0^2}{3\alpha}\right)^{\frac{1}{2}}$
- (D)  $\left(\frac{3v_0^2}{2\alpha}\right)^{\frac{1}{3}}$

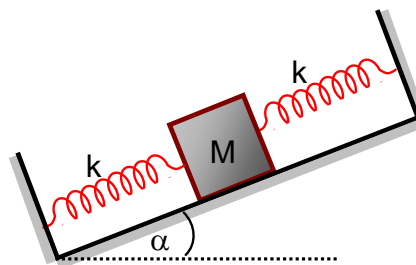
Q9. Two electrons each are fixed at a distance '2d'. A third charge proton placed at the midpoint is displaced slightly by a distance x ( $x \ll d$ ) perpendicular to the line joining the two fixed charges. Proton will execute simple harmonic motion having angular frequency: (m = mass of charged particle)

- (A)  $\left(\frac{2q^2}{\pi\epsilon_0 md^3}\right)^{\frac{1}{2}}$
- (B)  $\left(\frac{2\pi\epsilon_0 md^3}{q^2}\right)^{\frac{1}{2}}$
- (C)  $\left(\frac{q^2}{2\pi\epsilon_0 md^3}\right)^{\frac{1}{2}}$
- (D)  $\left(\frac{2\pi\epsilon_0 md^3}{2q^2}\right)^{\frac{1}{2}}$

Q10. According to Bohr atom model, in which of the following transitions will the frequency be maximum ?

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

Q11. In the given figure, a body of mass M is held between two massless springs, on a smooth inclined plane. The free ends of the springs are attached to firm supports. If each spring has spring constant k, the frequency of oscillation of given body is:



- (A)  $\frac{1}{2\pi} \sqrt{\frac{k}{2m}}$
- (B)  $\frac{1}{2\pi} \sqrt{\frac{k}{Mg \sin \alpha}}$
- (C)  $\frac{1}{2\pi} \sqrt{\frac{2k}{M}}$
- (D)  $\frac{1}{2\pi} \sqrt{\frac{2k}{Mg \sin \alpha}}$

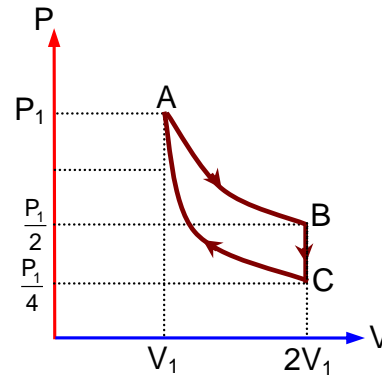
Q12. An X-ray tube is operated at 1.24 million volt. The shortest wavelength of the produced photon will be:

- (A)  $10^{-4}$  nm
- (B)  $10^{-3}$  nm
- (C)  $10^{-1}$  nm
- (D)  $10^{-2}$  nm

Q13. When a particle executes SHM, the nature of graphical representation of velocity as a function of displacement is:

- (A) Circular
- (B) Straight line
- (C) Parabolic
- (D) Elliptical

**Q14.** If one mole of an ideal gas at  $(P_1, V_1)$  is allowed to expand reversibly and isothermally (A to B) its pressure is reduced to one-half of the original pressure (see figure). This is followed by a constant volume cooling till its pressure is reduced to one-fourth of the initial value (B → C). Then it is restored to its initial state by a reversible adiabatic compression (C to A). The net work done by the gas is equal to:



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

**Q15.** Match List – I with List –II

- List – I
- (a) Source of microwave frequency
  - (b) Source of infrared frequency
  - (c) Source of Gamma Rays
  - (d) Source of X-rays

- List – II
- (i) Radioactive decay of nucleus
  - (ii) Magnetron
  - (iii) Inner shell electrons
  - (iv) Vibration of atoms and molecules
  - (v) LASER
  - (vi) RC circuit

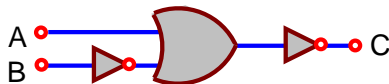
Choose the correct answer from the option given below:

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

**Q16.** If the source of light used in a Young’s double slit experiment is changed from red to violet:

- (A) The fringes will become brighter.
- (B) Consecutive fringe lines will come closer
- (C) The central bright fringe will become a dark fringe
- (D) The intensity of minima will increase

**Q17.**



The logic circuit shown above is equivalent to:

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

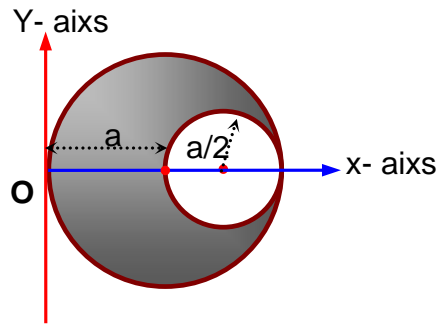
**Q18.** The de Broglie wavelength of a proton and  $\alpha$  - particle are equal. The ratio of their velocities is:

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

**Q19.** Which of the following equations represents a traveling wave?

- (A)  $y = A \sin x \cos \omega t$
- (B)  $y = A \sin(15x - 2t)$
- (C)  $y = Ae^x \cos(\omega t - \theta)$
- (D)  $y = Ae^{-x^2} (vt + \theta)$

**Q20.** A circular hole of radius  $\left(\frac{a}{2}\right)$  is cut of a circular disc of radius 'a' as shown in figure. The centre of mass of the remaining circular portion with respect to point 'O' will be:

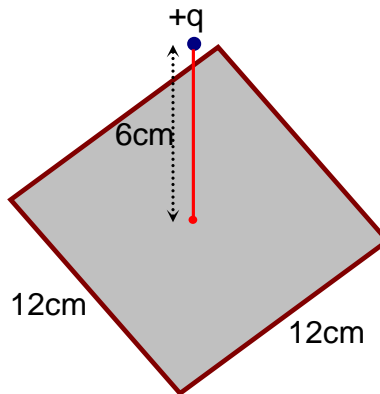


- (A)  $\frac{5}{6} a$  (B)  $\frac{1}{6} a$   
 (C)  $\frac{10}{11} a$  (D)  $\frac{2}{3} a$

**SECTION B**

**Q1.** The root mean square speed of molecules of a given mass of a gas at 27°C and 1 atmosphere pressure is 200 ms<sup>-1</sup>. The root mean square speed of molecules of the gas at 127°C and 2 atmosphere pressure is  $\frac{x}{\sqrt{3}}$  ms<sup>-1</sup>. The value of x will be.....

**Q2.** A point charge of + 12μC is at a distance 6 cm vertically above the centre of a squared of side 12cm as shown in figure. The magnitude of the electric flux through the square will be..... ×10<sup>3</sup> Nm<sup>2</sup> / C.



- Q3.** A uniform thin bar of mass 6 kg and length 2.4 meter is bent to make an equilateral hexagon. The moment of inertia about an axis passing through the centre of mass and perpendicular to the plane of hexagon is.....×10<sup>-1</sup> kg m<sup>2</sup>.
- Q4.** A uniform metallic wire is elongated by 0.04 m when subjected to a linear force F. The elongation, if its length and diameter is doubled and subjected to the same force will be .....cm.
- Q5.** A series LCR circuit is designed to resonate at an angular frequency  $\omega_0 = 10^5$  rad/s. The circuit draws 16 W power from 120 V source at resonance. The value of resistance 'R' in the circuit is .....Ω.
- Q6.** A signal of 0.1 kW is transmitted in a cable. The attenuation of cable is -5dB per km and cable length is 20 km. The power received at receiver is 10<sup>-x</sup>W. The value of x is.....  
 [ Given in dB =  $10 \log_{10} \left( \frac{P_0}{P_i} \right) ]$
- Q7.** An electromagnetic wave of frequency 3GHz enters a dielectric medium of relative electric permittivity 2.25 from vacuum. The wavelength of this wave in that medium will be.....×10<sup>-2</sup>cm.
- Q8.** A cylindrical wire of radius 0.5 mm and conductivity  $5 \times 10^7$  S / m is subjected to an electric field of 10mV/m. The expected value of current in the wire will be x<sup>3</sup>πmA. The value of x is .....

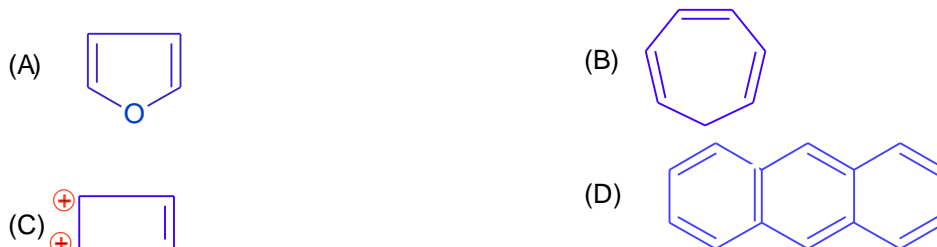
- Q9.** Two cars are approaching each other at an equal speed of 7.2 km / hr. When they see each other, both blow horns of 676 Hz. The beat frequency heard by each driver will be.....Hz. [Velocity of sound in air is 340 m/s]
- Q10.** Two solids A and B of mass 1kg and 2kg respectively are moving with equal linear momentum. The ratio of their kinetic energies  $(K.E)_A : (K.E)_B$  will be  $\frac{A}{1}$ , so the value of A will be.....

# PART – B (CHEMISTRY)

## SECTION A

- Q1.** What is the correct order of the following elements with respect to their density?  
 (A)  $Zn < Cr < Fe < Co < Cu$  (B)  $Zn < Cu < Co < Fe < Cr$   
 (C)  $Cr < Fe < Co < Cu < Zn$  (D)  $Cr < Zn < Co < Cu < Fe$
- Q2.** Match List – I and list – II.  
**List – I**  
 (a) Valium  
 (b) Morphine  
 (c) Norethindrone  
 (d) Vitamin B<sub>12</sub>  
 (A) (a) – (iv), (b) – (iii), (c) – (i), (d) – (ii)  
 (C) (a) – (ii), (b) – (iv), (c) – (iii), (d) – (i)
- List – II**  
 (i) Antifertility drug  
 (ii) Pernicious anaemia  
 (iii) Analgesic  
 (iv) Tranquilizer  
 (B) (a) – (i), (b) – (iii), (c) – (iv), (d) – (ii)  
 (D) (a) – (iv), (b) – (iii), (c) – (ii), (d) – (i)
- Q3.** Most suitable salt which can be used for efficient clotting of blood will be:  
 (A)  $Mg(HCO_3)_2$  (B)  $FeSO_4$   
 (C)  $NaHCO_3$  (D)  $FeCl_3$
- Q4.** Match List – I with List – II  
**List – I (Metal)**  
 (a) Aluminium  
 (b) Iron  
 (c) Copper  
 (d) Zinc
- List – II (Ores)**  
 (i) Siderite  
 (ii) Calamine  
 (iii) Kaolinite  
 (iv) Malachite
- Choose the correct answer from the options given below:  
 (A) (a) – (iii), (b) – (i), (c) – (iv), (d) – (ii) (B) (a) – (iv), (b) – (iii), (c) – (ii), (d) – (i)  
 (C) (a) – (ii), (b) – (iv), (c) – (i), (d) – (iii) (D) (a) – (i), (b) – (ii), (c) – (iii), (d) – (iv)
- Q5.** Match List – I and List – II  
**List – I**  
 (a)  $R-\overset{\overset{O}{\parallel}}{C}-Cl \longrightarrow R-CHO$   
 (b)  $R-CH_2-COOH \longrightarrow R-\underset{\underset{Cl}{|}}{HC}-COOH$   
 (c)  $R-\overset{\overset{O}{\parallel}}{C}-NH_2 \longrightarrow R-NH_2$   
 (d)  $R-\overset{\overset{O}{\parallel}}{C}-CH_3 \longrightarrow R-CH_2-CH_3$
- List – II**  
 (i)  $Br_2 / NaOH$   
 (ii)  $H_2 / Pd - BaSO_4$   
 (iii)  $Zn(Hg) / Conc. HCl$   
 (iv)  $Cl_2 / Red P, H_2O$
- Choose the correct answer from the options given below:  
 (A) (a) – (iii), (b) – (i), (c) – (iv), (d) – (ii) (B) (a) – (iii), (b) – (iv), (c) – (i), (d) – (ii)  
 (C) (a) – (ii), (b) – (i), (c) – (iv), (d) – (iii) (D) (a) – (ii), (b) – (iv), (c) – (i), (d) – (iii)
- Q6.** The incorrect statement among the following is:  
 (A)  $VOSO_4$  is a reducing agent  
 (B)  $RuO_4$  is an oxidizing agent  
 (C)  $Cr_2O_3$  is an amphoteric oxide  
 (D) Red colour of ruby is due to the presence of  $Co^{3+}$

Q7. Which one of the following compounds is non- aromatic?



Q8. Given below are two statements : one is labelled as **Assertion A** and the other is labelled as **Reason R**.

**Assertion A** : Hydrogen is the most abundant element in the Universe, but it is not the most abundant gas in the troposphere.

**Reason R** : Hydrogen is the lightest element

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

- (A) Both **A** and **R** are true but **R** is NOT the correct explanation of **A**  
 (B) **A** is false but **R** is true  
 (C) Both **A** and **R** are true and **R** is the correct explanation of **A**  
 (D) **A** is true but **R** is false

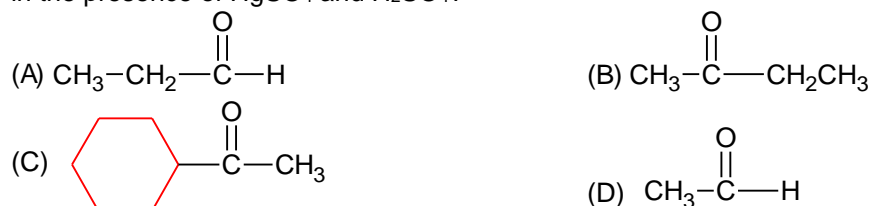
Q9. The correct set from the following in which both pairs are in correct order of melting point is :

- (A) LiF > LiCl ; MgO > NaCl  
 (B) LiCl > LiF; NaCl > MgO  
 (C) LiF > LiCl; NaCl > MgO  
 (D) LiCl > LiF; MgO > NaCl

Q10. The calculated magnetic moments (spin only value) for species  $[\text{FeCl}_4]^{2-}$ ,  $[\text{Co}(\text{C}_2\text{O}_4)_3]^{3-}$  and  $\text{MnO}_4^{2-}$  respectively are:

- (A) 4.90, 0 and 1.73 BM  
 (B) 5.92, 4.90 and 0 BM  
 (C) 4.90, 0 and 2.83 BM  
 (D) 5.82, 0 and 0 BM

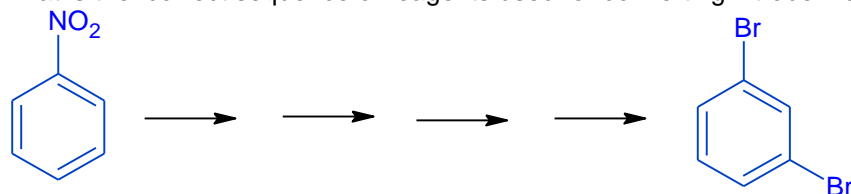
Q11. Which one of the following carbonyl compound cannot be prepared by addition of water on an alkyne in the presence of  $\text{HgSO}_4$  and  $\text{H}_2\text{SO}_4$ ?



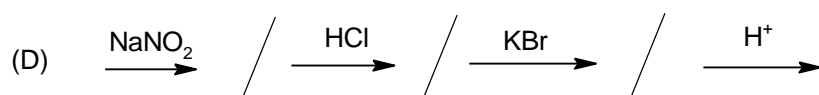
Q12. In polymer Buna – S: 'S' stands for:

- (A) Sulphonation  
 (B) Strength  
 (C) Sulphur  
 (D) Styrene

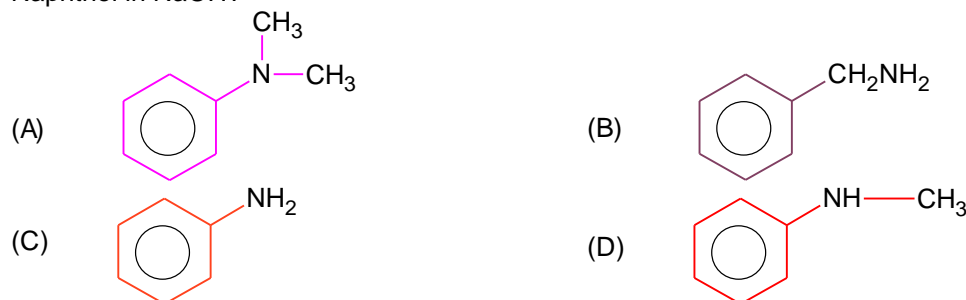
Q13. What is the correct sequence of reagents used for converting nitrobenzene into m- dibromobenzene?



- (A)  $\xrightarrow{\text{Sn / HCl}}$  /  $\xrightarrow{\text{Br}_2}$  /  $\xrightarrow{\text{NaNO}_2}$  /  $\xrightarrow{\text{NaBr}}$
- (B)  $\xrightarrow{\text{Sn / HCl}}$  /  $\xrightarrow{\text{KBr}}$  /  $\xrightarrow{\text{Br}_2}$  /  $\xrightarrow{\text{H}^+}$
- (C)  $\xrightarrow{\text{Br}_2 / \text{Fe}}$  /  $\xrightarrow{\text{Sn / HCl}}$  /  $\xrightarrow{\text{NaNO}_2 / \text{HCl}}$  /  $\xrightarrow{\text{CuBr / HBr}}$



Q14. The diazonium salt of which of the following compounds will form a coloured dye on reaction with  $\beta$ -Naphthol in NaOH?



Q15. Given below are two statements:

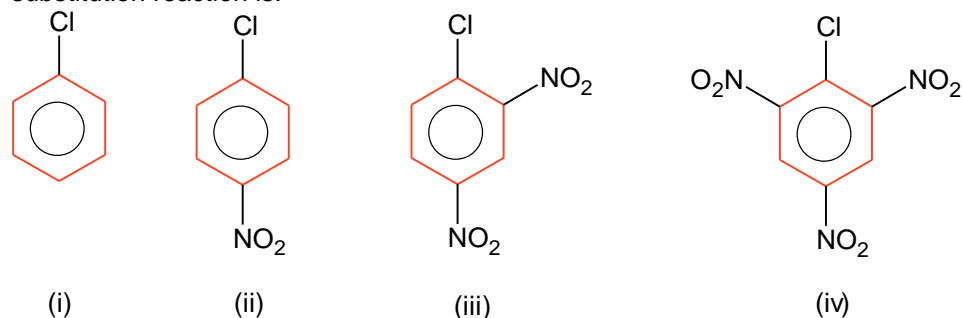
**Statement I:** The value of the parameter " Biochemical Oxygen Demand (BOD)' is important for survival of aquatic life.

**Statement II :** The optimum value of BOD is 6.5 ppm.

In the light of the above statements, choose the most appropriate 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) **Statement I** is true but **Statement II** is false  
 (D) Both **Statement I** and **Statement II** are true

Q16. The correct order of the following compounds showing increasing tendency towards nucleophilic substitution reaction is:



- (A) (iv) < (i) < (iii) < (ii) (B) (iv) < (iii) < (ii) < (i)  
 (C) (i) < (ii) < (iii) < (iv) (D) (iv) < (i) < (ii) < (iii)

Q17. According to Bohr's atomic theory:

- (A) Kinetic energy of electron is  $\propto \frac{Z^2}{n^2}$   
 (B) The product of velocity (v) of electron and principal quantum number (n) 'vn'  $\propto Z^2$   
 (C) Frequency of revolution of electron in an orbit is  $\propto \frac{Z^3}{n^3}$   
 (D) Coulombic force of attraction on the electron is  $\propto \frac{Z^3}{n^4}$

Choose the most appropriate answer from the options given below:

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

Q18. Match List – I with List – II

List – I (salt)	List – II (Flame colour wavelength)
(a) LiCl	(i) 455.5 nm
(b) NaCl	(ii) 670.8 nm
(c) RbCl	(iii) 780.0 nm
(d) CsCl	(iv) 589.2 nm

Choose the correct answer from the options given below:

- (A) (a) – (ii), (b) – (iv), (c) – (iii), (d) – (i)

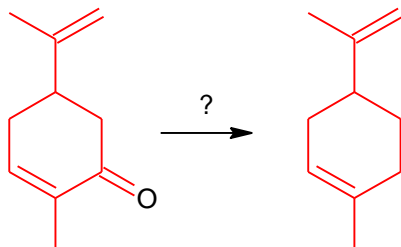


- (B) (a) – (ii), (b) – (i), (c) – (iv), (d) – (iii)  
 (C) (a) – (i), (b) – (iv), (c) – (ii), (d) – (iii)  
 (D) (a) – (iv), (b) – (ii), (c) – (iii), (d) – (i)

**Q19.** The correct shape and I – I – I bond angles respectively in  $I_3^-$  ion are:

- (A) Linear;  $180^\circ$   
 (B) T- shaped ;  $180^\circ$  and  $90^\circ$   
 (C) Trigonal planar;  $120^\circ$   
 (D) Distorted trigonal planar;  $135^\circ$  and  $90^\circ$

**Q20.**

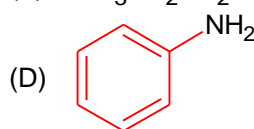
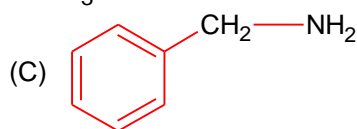
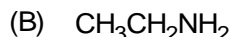
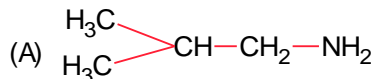


Which of the following reagent is suitable for the preparation of the product in the above reaction?

- (A) Red P +  $Cl_2$  (B) Ni /  $H_2$   
 (C)  $NH_2-NH_2 / C_2H_5O^-Na^+$  (D)  $NaBH_4$

### SECTION B

**Q1.** The total number of amines among the following which can be synthesized by Gabriel synthesis is.....



**Q2.** Sucrose hydrolyses in acid solution into glucose and fructose following first order rate law with a half-life of 3.33 h at  $25^\circ C$ . After 9h, the fraction of sucrose remaining is f. The value of  $\log_{10} \left( \frac{1}{f} \right)$  is ..... $\times 10^{-2}$ . (Rounded off to the nearest integer)  
 [Assume:  $\ln 10 = 2.303$ ,  $\ln 2 = 0.693$ ]

**Q3.** The solubility product of  $PbI_2$  is  $8.0 \times 10^{-9}$ . The solubility of lead iodide in 0.1 molar solution of lead nitrate is  $x \times 10^{-6}$  mol / L. The value of x is ..... (Rounded off to the nearest integer)  
 [Given  $\sqrt{2} = 1.41$ ]

**Q4.** The formula of a gaseous hydrocarbon which requires 6 times of its own volume of  $O_2$  for complete oxidation and produces 4 times its own volume of  $CO_2$  is  $C_xH_y$ . The value of y is .....

**Q5.** 1.86 g of aniline completely reacts to form acetanilide. 10% of the product is lost during purification. Amount of acetanilide obtained after purification (in g) is ..... $\times 10^{-2}$ .

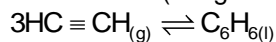
**Q6.** The volume occupied by 4.75 g of acetylene gas at  $50^\circ C$  and 740 mmHg pressure is.....L  
 (Rounded off to the nearest integer)  
 [Given  $R = 0.0826 \text{ L atm K}^{-1} \text{ mol}^{-1}$ ]

**JEE-MAIN-PCM-2021-10**

**Q7.** The magnitude of the change in oxidising power of the  $\text{MnO}_4^-/\text{Mn}^{2+}$  couple is  $x \times 10^{-4}$  V, if the  $\text{H}^+$  concentration is decreased from 1M to  $10^{-4}$  M at  $25^\circ\text{C}$  (Assume concentration of  $\text{MnO}_4^-$  and  $\text{Mn}^{2+}$  to be same on change in  $\text{H}^+$  concentration). The value of  $x$  is ..... (Rounded off to the nearest integer)

[ Given :  $\frac{2.303RT}{F} = 0.059$  ]

**Q8.** Assuming ideal behaviour, the magnitude of  $\log K$  for the following reaction at  $25^\circ\text{C}$  is  $x \times 10^{-1}$ . The value of  $x$  is ..... (integer answer)



[Given :  $\Delta_f G^\circ(\text{HC}\equiv\text{CH}) = -2.04 \times 10^5 \text{ J mol}^{-1}$  ;  $\Delta_f G^\circ(\text{C}_6\text{H}_6) = -1.24 \times 10^5 \text{ J mol}^{-1}$ ;  
 $R = 8.314 \text{ JK}^{-1}\text{mol}^{-1}$ ]

**Q9.**  $\text{C}_6\text{H}_6$  freezes at  $5.5^\circ\text{C}$ . The temperature at which a solution of 10 g of  $\text{C}_4\text{H}_{10}$  in 200g of  $\text{C}_6\text{H}_6$  freeze is ..... $^\circ\text{C}$  (The molal freezing point depression constant of  $\text{C}_6\text{H}_6$  is  $5.12^\circ\text{C} / \text{m}$ )

**Q10.** Among the following allotropic forms of sulphur, the number of allotropic forms, which will show paramagnetism is .....

- (A)  $\alpha$  - sulphur                      (B)  $\beta$ - sulphur                      (C)  $\text{S}_2$  - form

# PART-C (MATHEMATICS)

## SECTION A

- Q1.** Let  $f(x)$  be a differentiable function defined on  $[0, 2]$  such that  $f'(x) = f'(2-x)$  for all  $x \in (0, 2)$ ,  $f(0) = 1$  and  $f(2) = e^2$ . Then the value of  $\int_0^2 f(x) dx$  is
- (A)  $2(1+e^2)$  (B)  $1 - e^2$   
 (C)  $1 + e^2$  (D)  $2(1-e^2)$
- Q2.** The value of the integral  $\int_1^3 [x^2 - 2x - 2] dx$ , where  $[x]$  denotes the greatest integer less than or equal to  $x$ , is
- (A)  $-\sqrt{2} - \sqrt{3} - 1$  (B)  $-\sqrt{2} - \sqrt{3} + 1$   
 (C)  $-5$  (D)  $-4$
- Q3.** For the system of linear equations:  
 $x - 2y = 1$ ,  $x - y + kz = -2$ ,  $ky + 4z = 6$ ,  $k \in \mathbb{R}$ ,  
 Consider the following statements:  
 (A) The system has unique solution if  $k \neq 2$ ,  $k \neq -2$ .  
 (B) The system has unique solution if  $k = -2$ .  
 (C) The system has unique solution if  $k = 2$ .  
 (D) The system has no solution if  $k = 2$ .  
 (E) The system has infinite number of solutions if  $k \neq -2$ .  
 Which of the following statements are correct?  
 (A) (B) and (E) only (B) (A) and (E) only  
 (C) (C) and (D) only (D) (A) and (D) only
- Q4.** Let  $a, b \in \mathbb{R}$ . If the mirror image of the point  $P(a, 6, 9)$  with respect to the line  $\frac{x-3}{7} = \frac{y-2}{5} = \frac{z-1}{-9}$  is  $(20, b, -a-9)$ , then  $|a+b|$  is equal to:
- (A) 90 (B) 86  
 (C) 84 (D) 88
- Q5.** Let  $a, b, c$  be in arithmetic progression. Let the centroid of the triangle with vertices  $(a, c)$ ,  $(2, b)$  and  $(a, b)$  be  $(\frac{10}{3}, \frac{7}{3})$ . If  $\alpha, \beta$  are the roots of the equation  $ax^2 + bx + 1 = 0$ , then the value of  $\alpha^2 + \beta^2 - \alpha\beta$  is:
- (A)  $-\frac{69}{256}$  (B)  $\frac{69}{256}$   
 (C)  $\frac{27}{256}$  (D)  $-\frac{71}{256}$
- Q6.** Let  $f: \mathbb{R} \rightarrow \mathbb{R}$  be defined as
- $$f(x) = \begin{cases} -55x, & \text{if } x < -5 \\ 2x^3 - 3x^2 - 120x, & \text{if } -5 \leq x \leq 4 \\ 2x^3 - 3x^2 - 36x - 336, & \text{if } x > 4, \end{cases}$$
- Let  $A = \{x \in \mathbb{R} : f \text{ is increasing}\}$ . Then  $A$  is equal to:
- (A)  $(-5, -4) \cup (4, \infty)$  (B)  $(-\infty, -5) \cup (4, \infty)$   
 (C)  $(-\infty, -5) \cup (-4, \infty)$  (D)  $(-5, \infty)$

- Q7.** The probability that two randomly selected subsets of the set  $\{1, 2, 3, 4, 5\}$  have exactly two elements in their intersection is:
- (A)  $\frac{65}{2^7}$  (B)  $\frac{35}{2^7}$   
 (C)  $\frac{135}{2^9}$  (D)  $\frac{65}{2^8}$
- Q8.** The area of the region :  $R = \{(x, y) : 5x^2 \leq y \leq 2x^2 + 9\}$  is:
- (A)  $9\sqrt{3}$  square units (B)  $12\sqrt{3}$  square units  
 (C)  $6\sqrt{3}$  square units (D)  $11\sqrt{3}$  square units
- Q9.** Let A and B are  $3 \times 3$  real matrices such that A is symmetric matrix and B is skew-symmetric matrix. Then the system of linear equations  $(A^2B^2 - B^2A^2)X = O$ , where X is a  $3 \times 1$  column matrix of unknown variables and O is a  $3 \times 1$  null matrix has:
- (A) a unique solution (B) exactly two solutions  
 (C) infinitely many solutions (D) no solution
- Q10.** For which of the following curves, the line  $x + \sqrt{3}y = 2\sqrt{3}$  is the tangent at the point  $\left(\frac{3\sqrt{3}}{2}, \frac{1}{2}\right)$ ?
- (A)  $2x^2 - 18y^2 = 9$  (B)  $y^2 = \frac{1}{6\sqrt{3}}x$   
 (C)  $x^2 + y^2 = 7$  (D)  $x^2 + 9y^2 = 9$
- Q11.** If  $n \geq 2$  is a positive integer, then the sum of the series  ${}^{n+1}C_2 + 2({}^2C_2 + {}^3C_2 + {}^4C_2 + \dots + {}^nC_2)$  is:
- (A)  $\frac{n(n+1)^2(n+2)}{12}$  (B)  $\frac{n(n+1)(2n+1)}{6}$   
 (C)  $\frac{n(n-1)(2n+1)}{6}$  (D)  $\frac{n(2n+1)(3n+1)}{6}$
- Q12.** The vector equation of the plane passing through the intersection of the planes  $\vec{r} \cdot (\hat{i} + \hat{j} + \hat{k}) = 1$  and  $\vec{r} \cdot (\hat{i} - 2\hat{j}) = -2$ , and the point  $(1, 0, 2)$  is:
- (A)  $\vec{r} \cdot (\hat{i} + 7\hat{j} + 3\hat{k}) = \frac{7}{3}$  (B)  $\vec{r} \cdot (3\hat{i} + 7\hat{j} + 3\hat{k}) = 7$   
 (C)  $\vec{r} \cdot (\hat{i} - 7\hat{j} + 3\hat{k}) = \frac{7}{3}$  (D)  $\vec{r} \cdot (\hat{i} + 7\hat{j} + 3\hat{k}) = 7$
- Q13.** The negation of the statement  $\sim p \wedge (p \vee q)$  is:
- (A)  $\sim p \vee q$  (B)  $p \wedge \sim q$   
 (C)  $p \vee \sim q$  (D)  $\sim p \wedge q$
- Q14.** Let f be a twice differentiable function defined on R such that  $f(0)=1$ ,  $f'(0) = 2$  and  $f(x) \neq 0$  for all  $x \in R$ . If  $\begin{vmatrix} f(x) & f'(x) \\ f'(x) & f''(x) \end{vmatrix} = 0$ , for all  $x \in R$ , then the value of  $f(1)$  lies in the interval.
- (A) (3,6) (B) (6,9)  
 (C) (0,3) (D) (9,12)
- Q15.** If P is a point on the parabola  $y = x^2 + 4$  which is closest to the straight line  $y = 4x - 1$ , then the co-ordination of P are:
- (A) (2,8) (B) (3,13)  
 (C) (1,5) (D) (-2,8)

- Q16.** A possible value of  $\tan \left( \frac{1}{4} \sin^{-1} \frac{\sqrt{63}}{8} \right)$  is:
- (A)  $\frac{1}{\sqrt{7}}$  (B)  $2\sqrt{2} - 1$   
 (C)  $\frac{1}{2\sqrt{2}}$  (D)  $\sqrt{7} - 1$
- Q17.** For the statements p and q, consider the following compound statements:  
 (a)  $(\sim q \wedge (p \rightarrow q)) \rightarrow \sim p$   
 (b)  $((p \vee q) \wedge \sim p) \rightarrow q$   
 Then which of the following statements is correct?  
 (A) (b) is a tautology but not (a) (B) (a) is a tautology but not (b)  
 (C) (a) and (b) both are tautologies (D) (a) and (b) both are not tautologies
- Q18.** If the curve  $y = ax^2 + bx + c$ ,  $x \in \mathbb{R}$  passes through the point (1, 2) and the tangent line to this curve at origin is  $y = x$ , then the possible values of a, b, c are:  
 (A)  $a = \frac{1}{2}, b = \frac{1}{2}, c = 1$  (B)  $a = -1, b = 1, c = 1$   
 (C)  $a = 1, b = 1, c = 0$  (D)  $a = 1, b = 0, c = 1$
- Q19.** The angle of elevation of a jet plane from a point A on the ground is  $60^\circ$ . After a flight of 20 seconds at the speed of 432 km / hour, the angle of elevation changes to  $30^\circ$ . If the jet plane is flying at a constant height, then its height is:  
 (A)  $3600\sqrt{3}$  m (B)  $2400\sqrt{3}$  m  
 (C)  $1200\sqrt{3}$  m (D)  $1800\sqrt{3}$  m
- Q20.** If a curve  $y = f(x)$  passes through the point (1,2) and satisfies  $x \frac{dy}{dx} + y = bx^4$ , then for what value of b,  $\int_1^2 f(x) dx = \frac{62}{5}$ ?
- (A) 5 (B)  $\frac{62}{5}$   
 (C) 10 (D)  $\frac{31}{5}$

**SECTION B**

- Q1.** Let  $\lambda$  be an integer. If the shortest distance between the lines  $x - \lambda = 2y - 1 = -2z$  and  $x = y + 2\lambda = z - \lambda$  is  $\frac{\sqrt{7}}{2\sqrt{2}}$ , then the value of  $|\lambda|$  is.....
- Q2.** For integers n and r, let  $\binom{n}{r} = \begin{cases} {}^n C_r, & \text{if } n \geq r \geq 0 \\ 0, & \text{otherwise} \end{cases}$   
 The maximum value of k for which the sum  $\sum_{i=0}^k \binom{10}{i} \binom{15}{k-i} + \sum_{i=0}^{k+1} \binom{12}{i} \binom{13}{k+1-i}$  exists, is equal to.....
- Q3.** Let  $i = \sqrt{-1}$ . If  $\frac{(-1+i\sqrt{3})^{21}}{(1-i)^{24}} + \frac{(1+i\sqrt{3})^{21}}{(1+i)^{24}} = k$ , and  $n = \llbracket |k| \rrbracket$  be the greatest integral part of  $|k|$ . Then  $\sum_{j=0}^{n+5} (j+5)^2 - \sum_{j=0}^{n+5} (j+5)$  is equal to.....

- Q4.** The number of the real roots of the equation  $(x + 1)^2 + |x - 5| = \frac{27}{4}$  is .....
- Q5.** Let a point P be such that its distance from the point (5,0) is thrice the distance of P from the point (-5,0). If the locus of the point P is a circle of radius r, then  $4r^2$  is equal to.....
- Q6.** The sum of first four terms of a geometric progression (G.P) is  $\frac{65}{12}$  and the sum of their respective reciprocals is  $\frac{65}{18}$ . If the product of first three terms of the G.P is 1, and the third term is  $\alpha$ , then  $2\alpha$  is.....
- Q7.** The students  $S_1, S_2, \dots, S_{10}$  are to be divided into 3 groups A, B and C such that each group has at least one student and the group C has at most 3 students. Then the total number of possibilities of forming such groups is.....
- Q8.** If  $a + \alpha = 1$ ,  $b + \beta = 2$  and  $af(x) + \alpha f\left(\frac{1}{x}\right) = bx + \frac{\beta}{x}, x \neq 0$ , then the value of the equation  $\frac{f(x) + f\left(\frac{1}{x}\right)}{x + \frac{1}{x}}$  is.....
- Q9.** If the variance of 10 natural numbers  $1, 1, 1, \dots, 1, k$  is less than 10, then the maximum possible value of k is.....
- Q10.** If the area of the triangle formed by the positive x-axis, the normal and the tangent to the circle  $(x-2)^2 + (y-3)^2 = 25$  at the point (5, 7) is A, then  $24A$  is equal to.....