



Paper 4
ENTRANCE EXAM - JEE MAIN

Time Allowed: 3 hours

Maximum Marks : 300

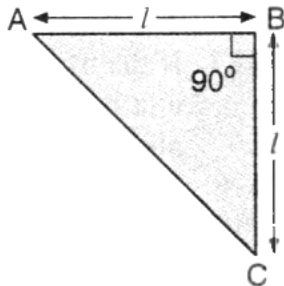
General Instructions:

- All questions are compulsory.
- There are three parts and each part carries 25 questions where the first 20 questions are MCQs and the next 5 questions are numerical.
- You will get 4 marks for each correct response and 1 mark will be deducted for an incorrect answer.

PHYSICS

- If the time period t of the oscillation of a drop of liquid of density d , radius r , vibrating under surface tension s is given by the formula $t = \sqrt{r^{2b} s^c d^{a/2}}$. It is observed that the time period is directly proportional to $\sqrt{\frac{d}{s}}$. The value of b should therefore be: [4]
 - $\frac{2}{3}$
 - $\frac{3}{2}$
 - $\frac{3}{4}$
 - $\sqrt{3}$
- A body falls from a height $h = 200$ m. The ratio of distance travelled in each 2 s, during $t = 0$ to $t = 6$ s of the journey is: [4]
 - 1 : 4 : 9
 - 1 : 3 : 5
 - 1 : 2 : 3
 - 1 : 2 : 4
- A shell is fired from a fixed artillery gun with an initial speed u such that it hits the target on the ground at a distance R from it. If t_1 and t_2 are the values of the time taken by it to hit the target in two possible ways, the product $t_1 t_2$ is: [4]
 - $\frac{R}{g}$
 - $\frac{R}{2g}$
 - $\frac{R}{4g}$
 - $\frac{2R}{g}$
- Two forces with equal magnitudes F act on a body and the magnitude of the resultant force is $F/3$. The angle between the two forces is [4]
 - $\cos^{-1}\left(-\frac{1}{3}\right)$
 - $\cos^{-1}\left(\frac{8}{9}\right)$
 - $\cos^{-1}\left(\frac{2}{3}\right)$
 - $\cos^{-1}\left(-\frac{17}{18}\right)$
- The speed v reached by a car of mass m , driven with constant power P , is given by: [4]
 - $v = \frac{3xP}{m}$
 - $v = \left(\frac{3xP}{m}\right)^2$
 - $v = \left(\frac{3xP}{m}\right)^{1/3}$
 - $v = \left(\frac{3xP}{m}\right)^{1/2}$

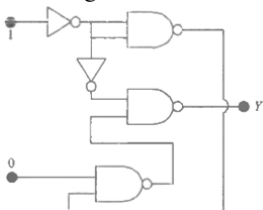
- Figure shows a thin metallic triangular sheet ABC. The mass of the sheet is M . The moment of inertia of the sheet about side AC is:



- $\frac{MI^2}{6}$
 - $\frac{MI^2}{12}$
 - $\frac{MI^2}{18}$
 - $\frac{MI^2}{4}$
- A hydrometer takes the form of a glass cylindrical tube soldered at both ends having a length 20 cm and an external diameter $D = 1.2$ cm. The thickness of the wall is $h = 1$ mm. The density of glass is 2.6 g/cm³. The lower part of the tube contains 1 cc of mercury. The minimum density that can be measured with the aid of this hydrometer is: [4]
 - 1.2 g/cc
 - 2 g/cc
 - 2.6 g/cc
 - 1.5 g/cc
 - If two metallic plates of equal thickness and thermal conductivities K_1 and K_2 are put together face to face and a common plate is constructed, then the equivalent thermal conductivity of this plate will be: [4]
 - $\frac{2K_1 K_2}{K_1 + K_2}$
 - $\frac{(K_1^2 + K_2^2)^{3/2}}{K_1 K_2}$
 - $\frac{(K_1^2 + K_2^2)^{3/2}}{2K_1 K_2}$
 - $\frac{K_1 K_2}{K_1 + K_2}$
 - The internal energy of an ideal gas depends on: [4]
 - Pressure
 - Size of the molecule
 - Temperature
 - Volume
 - Two springs of constants k_1 and k_2 have equal highest velocities, when executing SHM. Then, the ratio of their amplitudes (given their masses are equal) will be: [4]
 - $\left(\frac{k_2}{k_1}\right)^{1/2}$
 - $\frac{k_2}{k_1}$
 - $\frac{k_1}{k_2}$
 - $\left(\frac{k_1}{k_2}\right)^{1/2}$
 - The work of electric field done during the displacement of a negatively charged particle towards a fixed positively charged particle is 9 J. As a result the distance between the charges has been decreased by half. What work is done by the electric field over the first half of this distance? [4]
 - 6 J
 - 3 J
 - 1.5 J
 - 9 J
 - 10 mA current can pass through a galvanometer of resistance 25Ω . What resistance in series should be connected through it, so that it is converted into a voltmeter of 100 volt? [4]
 - 0.975Ω
 - 99.75Ω
 - 9975Ω
 - 975Ω

- 13) A current of 2 ampere produces a deflection of 30° in a tangent galvanometer. A deflection of 60° will be produced in it by a current of: [4]
 a) 3 amp b) 1 amp
 c) 6 amp d) 4 amp
- 14) Flux ϕ (in weber) in a closed circuit of resistance 10 ohm varies with time t (in sec) according to the equation:
 $\phi = 6t^2 - 5t + 1$
 What is the magnitude of the induced current at $t = 0.25$ sec? [4]
 a) 1.2 A b) 0.2 A
 c) 0.6 A d) 0.8 A
- 15) The output of a step - down transformer is measured to be 24 V when connected to 12 watt light bulb. The value of the peak current is: [4]
 a) 2 A b) $\sqrt{2}$ A
 c) $\frac{1}{\sqrt{2}}$ A d) $2\sqrt{2}$ A
- 16) Radio wave diffracts around building although light waves do not. The reason is that radio waves: [4]
 a) Are not electromagnetic waves
 b) Carry news
 c) Travel with speed larger than C
 d) Have much larger wavelength than light
- 17) Given that a photon of light of wavelength 10,000 angstrom has an energy equal to 1.23 eV. When light of wavelength 5000 angstrom and intensity I_0 falls on a photoelectric cell, the saturation current is 0.40×10^{-6} ampere and the stopping potential is 1.36 volt; then the work function is: [4]
 a) 1.36 eV b) 2.47 eV
 c) 0.43 eV d) 1.10 eV
- 18) Electrons are bombarded to excite hydrogen atom and six spectral lines are observed. If E_g is the ground state energy of hydrogen, the minimum energy the bombarding electron should possess is : [4]
 a) $\frac{48E_g}{49}$ b) $\frac{15E_g}{16}$
 c) $\frac{35E_g}{36}$ d) $\frac{8E_g}{9}$
- 19) Fission of nuclei is possible because the binding energy per nucleon in them: [4]
 a) Decreases with mass number at high mass numbers
 b) Increases with mass number at high mass numbers
 c) Decreases with mass number at low mass numbers
 d) Increases with mass number at low mass numbers

- 20) In the given circuit, the value of Y is:



[4]

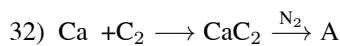
- a) Will not execute
 b) 1
 c) Toggles between 0 and 1
 d) 0
- 21) If 20 J of work has to be done to move an electric charge of 4 C from a point, where potential is 10 V to another point, where potential is V volt, find the value of V: [4]

- 22) The initial velocity v_i required to project a body vertically upward from the surface of the earth to reach a height of 10 R, where R is the radius of the earth, may be described in terms of escape velocity v_e such that $v_i = \sqrt{\frac{x}{y}} \times v_e$. The value of x will be _____. [4]
- 23) A ray of light is incident from air on a glass plate having thickness $\sqrt{3}$ cm and refractive index $\sqrt{2}$. The angle of incidence of a ray is equal to the critical angle for glass - air interface. The lateral displacement of the ray when it passes through the plate is $\text{_____} \times 10^{-2}$ cm. (given $\sin 15^\circ = 0.26$) [4]
- 24) When a resistance of 5Ω is shunted with a moving coil galvanometer, it shows a full scale deflection for a current of 250 mA, however when 1050Ω resistance is connected with it in series, it gives full scale deflection for 25 volt. The resistance of galvanometer is $\text{_____}\Omega$. [4]
- 25) In a thermodynamic process, pressure of a fixed mass of a gas is changed in such a manner that the gas releases 20 J of heat and 8 J of work is done on the gas. If initial internal energy of the gas was 30 J, the final internal energy will be _____ J. [4]

CHEMISTRY

- 26) The total energy of the electron in the hydrogen atom in the ground state is - 13.6 eV. The KE of this electron is: [4]
 a) - 13.6 eV b) 13.6eV
 c) 6.8 eV d) Zero
- 27) Which of the following order is wrong? [4]
 a) $\text{NH}_3 < \text{PH}_3 < \text{AsH}_3$ — acidic
 b) $\text{Al}_2\text{O}_3 < \text{MgO} < \text{Na}_2\text{O} < \text{K}_2\text{O}$ — basic
 c) $\text{Li} < \text{Be} < \text{B} < \text{C}$ — 1st IP
 d) $\text{Li}^+ < \text{Na}^+ < \text{K}^+ < \text{Cs}^+$ — ionic radius
- 28) Which of the following two are isostructural? [4]
 a) NH_3, BF_3
 b) $\text{XeF}_2, \text{IF}_2^-$
 c) $\text{PCl}_5, \text{ICl}_5$
 d) $\text{CO}_3^{2-}, \text{SO}_3^{2-}$
- 29) The direct conversion of A to B is difficult, hence it is carried out by the following shown path

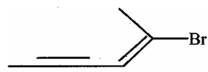
$$\begin{array}{ccc} C & \longrightarrow & D \\ \uparrow & & \downarrow \\ A & & B \end{array}$$
 Given that $\Delta S_{(A \rightarrow C)} = 50$ eu
 $\Delta S_{(C \rightarrow D)} = 30$ eu
 $\Delta S_{(D \rightarrow B)} = -20$ eu where, eu is entropy unit
 Then, $\Delta S_{(A \rightarrow B)}$ is [4]
 a) - 100 eu b) +100 eu
 c) +60 eu d) - 60 eu
- 30) The K_{sp} of Ag_2CrO_4 , AgCl , AgBr and AgI are respectively, 1.1×10^{-12} , 1.8×10^{-10} , 5.0×10^{-13} and 8.3×10^{-17} . Which one of the following salts will precipitate last if AgNO_3 solution is added to the solution containing equal moles of NaCl , NaBr , NaI and Na_2CrO_4 ? [4]
 a) AgCl b) AgI
 c) AgBr d) Ag_2CrO_4
- 31) How many mole of electrons are involved in the reduction of one mole of MnO_4^- ion in alkaline medium to MnO_3^- : [4]
 a) 2 b) 1
 c) 3 d) 4



Compound (A) is used as a/an: [4]

- a) Dehydrating agent b) Fertilizer
c) Oxidising agent d) Reducing agent

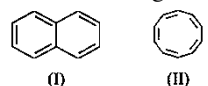
33) Choose the correct name for compound given below:



[4]

- a) (4E) - 5 - Bromohex - 2 - en - 4 - yne
b) (2E) - 2 - Bromohex - 4 - yn - 2 - ene
c) (4E) - 5 - Bromohex - 4 - en - 2 - yne
d) (2E) - 2 - Bromohex - 2 - en - 4 - yne

34) The following two compounds are:



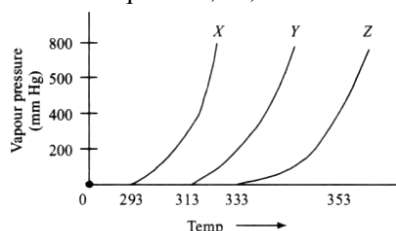
[4]

- a) Identical
b) Conformational isomers
c) Geometrical isomers
d) Structural isomers

35) A 5% solution (by mass) of cane sugar in water has freezing point of 271 K and freezing point of pure water is 273.15 K. The freezing point of a 5% solution (by mass) of glucose in water is [4]

- a) 271 K b) 269.07 K
c) 273.15 K d) 277.23 K

36) A graph of vapour pressure and temperature for three different liquids X, Y, and Z is shown below:



The following inferences are made:

- i. X has higher intermolecular interactions compared to Y.
ii. Y has lower intermolecular interactions compared to Y.
iii. Z has lower intermolecular interactions compared to Y.

The correct inference(s) is/are: [4]

- a) Option (i) b) Option (i) and (iii)
c) Option (ii) d) Option (iii)

37) In the electrolysis of aqueous sodium chloride solution which of the half cell reaction will occur at the anode? [4]

- a) $2\text{H}_2\text{O}(\text{l}) \rightarrow \text{O}_2(\text{g}) + 4\text{H}^+(\text{aq}) + 4\text{e}^-$; $E_{\text{cell}}^\ominus = 1.23 \text{ V}$
b) $\text{H}^+(\text{aq}) + \text{e}^- \rightarrow \frac{1}{2} \text{H}_2(\text{g})$; $E_{\text{cell}}^\ominus = 0.00 \text{ V}$
c) $\text{Na}^+(\text{aq}) + \text{e}^- \rightarrow \text{Na}(\text{s})$; $E_{\text{cell}}^\ominus = -2.71 \text{ V}$
d) $\text{Cl}^-(\text{aq}) \rightarrow \frac{1}{2} \text{Cl}_2(\text{g}) + \text{e}^-$; $E_{\text{cell}}^\ominus = 1.36 \text{ V}$

38) In a first order reaction, the concentration of reactant decreases from 800 mol/dm³ to 50 mol/dm³ in 2×10^4 sec. The rate constant of reaction in sec⁻¹ is: [4]

- a) 1.386×10^{-4} b) 3.45×10^{-5}
c) 2×10^{-4} d) 2×10^4

39) Select the correct statement about $[\text{CoF}_6]^{3-}$:

- i. It is labile complex
ii. It is low spin complex
iii. Spin only magnetic moment of complex is 3.87 B.M.
iv. All of the above

[4]

- a) Only (D) b) Only (A)
c) Only (B) d) Only (C)

40) Select CORRECT order of dissociation constant (K_a) in aqueous solution at 298K: [4]

- a) $\text{H}_2\text{O} > \text{H}_2\text{Te} > \text{H}_2\text{Se} > \text{H}_2\text{S}$
b) $\text{H}_2\text{Te} > \text{H}_2\text{O} > \text{H}_2\text{Se} > \text{H}_2\text{S}$
c) $\text{H}_2\text{O} > \text{H}_2\text{S} > \text{H}_2\text{Se} > \text{H}_2\text{Te}$
d) $\text{H}_2\text{Te} > \text{H}_2\text{Se} > \text{H}_2\text{S} > \text{H}_2\text{O}$

41) Which of the following statement is correct for complex $[\text{Cr}(\text{NH}_3)(\text{CN})_4(\text{NO})]^{2-}$ (given that $n = 1$)? [4]

- a) It is d^2sp^3 hybridized.
b) It is heteroleptic complex and its aqueous solution is coloured.
c) All of these
d) The chromium is in +1 oxidation state.

42) The alkane that will NOT be formed in Wurtz synthesis from isopropyl bromide and ethyl bromide together or separately with sodium in ether is _____. [4]

- a) 2, 3 - dimethylbutane b) N - hexane
c) Isopentane d) N - butane

43) $\text{H}_3\text{C} - \text{C}(\text{CH}_3) - \text{CH} = \text{CH}_2 \xrightarrow{\text{X}} \text{H}_3\text{C} - \text{C}(\text{CH}_3) - \text{C}(\text{OH})(\text{H}) - \text{CH}_3$. X can be: [4]

- a) All of these b) H_3O^+
c) $\text{Hg}(\text{OAc})_2/\text{NaBH}_4$, d) BH_3/THF , $\text{H}_2\text{O}_2/\text{OH}^-$, NaOH

44) Which one of the following is an example of Rosenmund's reduction? [4]

- a) $\text{CH}_3\text{COCl} \xrightarrow[\text{pd-BaSO}_4]{\text{H}_2} \text{CH}_3\text{CHO} + \text{HCl}$
b) $\text{CH}_3\text{C} \equiv \text{N} \xrightarrow[\text{(ii) } \frac{\text{H}_2\text{O}}{\Delta}]{\text{(i) } \text{SnCl}_2 - \text{HCl}} \text{CH}_3\text{CHO} + \text{NH}_4\text{Cl}$
c) $\text{CH}_3\text{COCl} \xrightarrow{\text{LiAlH}_4} \text{CH}_3\text{CH}_2\text{OH} + \text{HCl}$
d) $\text{CH}_3\text{COOH} \xrightarrow{\text{LiAlH}_4} \text{CH}_3\text{CH}_2\text{OH} + \text{H}_2\text{O}$

45) Consider the following three amines,

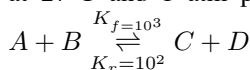
- i. $\text{CH}_3\text{CH}_2 - \ddot{\text{N}}\text{H}_2$
ii. $\text{CH}_2 = \text{CH} - \ddot{\text{N}}\text{H}_2$
iii.

Arrange C - N bond length of these compounds in decreasing order: [4]

- a) I > iii > ii b) I > ii > iii
c) ii > iii > i d) Iii > ii > i

46) The work function of sodium metal is $4.41 \times 10^{-19} \text{ J}$. If photons of wavelength 300 nm are incident on the metal, the kinetic energy of the ejected electrons will be ($h = 6.63 \times 10^{-34} \text{ Js}$; $c = 3 \times 10^8 \text{ m/s}$) _____ $\times 10^{-21} \text{ J}$. [4]

47) Consider the following reaction approaching equilibrium at 27°C and 1 atm pressure



The standard Gibb's energy change ($\Delta_r G^\ominus$) at 27°C is (-) _____ kJ mol⁻¹. (Nearest integer)

(Given: $R = 8.3 \text{ J K}^{-1} \text{ mol}^{-1}$ and $\ln 10 = 2.3$) [4]

- b) $(\frac{72}{5}, \frac{-21}{5})$
 c) $(\frac{72}{5}, \frac{21}{5})$
 d) $(\frac{-72}{5}, \frac{-21}{5})$

71) Let $f(x) = \begin{vmatrix} \sin^2 x & -2 + \cos^2 x & \cos 2x \\ 2 + \sin^2 x & \cos^2 x & \cos 2x \\ \sin^2 x & \cos^2 x & 1 + \cos 2x \end{vmatrix}$, $x \in$

$[0, \pi]$ Then the maximum value of $f(x)$ is equal to ____.

[4]

$$\frac{3^n \underbrace{\sin(\sin \dots \sin(x))}_{n \text{ times}} + (\sqrt{2} \cos x + 2)^n + 2^n \cos x}{3^n + \sin x (\sqrt{2} \cos x + 2)^n}$$

72) Let $f(x) = \lim_{n \rightarrow \infty} \frac{3^n \underbrace{\sin(\sin \dots \sin(x))}_{n \text{ times}} + (\sqrt{2} \cos x + 2)^n + 2^n \cos x}{3^n + \sin x (\sqrt{2} \cos x + 2)^n}$
 , if $l = \lim_{x \rightarrow \frac{\pi}{4}^+} f(x)$ and $m = \lim_{x \rightarrow \frac{\pi}{4}^-} f(x)$ then
 find the value of $l^2 + m^2$. [4]

73) Let the vectors $\vec{a}, \vec{b}, \vec{c}$ be such that $|\vec{a}| = 2$, $|\vec{b}| = 4$ and $|\vec{c}| = 4$. If the projection of \vec{b} on \vec{a} is equal to the projection of \vec{c} on \vec{a} and \vec{b} is perpendicular to \vec{c} , then the value of $|\vec{a} + \vec{b} - \vec{c}|$ is _____. [4]

74) If $\frac{\sqrt{2} \sin \alpha}{\sqrt{1 + \cos 2\alpha}} = \frac{1}{7}$ and $\sqrt{\frac{1 - \cos 2\beta}{2}} = \frac{1}{\sqrt{10}}$, $\alpha, \beta \in (0, \frac{\pi}{2})$, then $\tan(\alpha + 2\beta)$ is equal to _____. [4]

75) Let a, b and c be three real numbers satisfying

$$\begin{bmatrix} a & b & c \end{bmatrix} \begin{bmatrix} 1 & 9 & 7 \\ 8 & 2 & 7 \\ 7 & 3 & 7 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 \end{bmatrix} \dots (i)$$

Let $b = 6$, with a and c satisfying Eq. (i). If α and β are the roots of the quadratic equation $ax^2 - bx + c = 0$, then $\sum_{n=0}^{\infty} \left(\frac{1}{\alpha} + \frac{1}{\beta}\right)^n$ is equal to _____. [4]