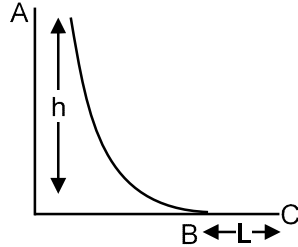


**JEE MAINS-2014****ONLINE 11-04-2014****IMPORTANT INSTRUCTIONS**

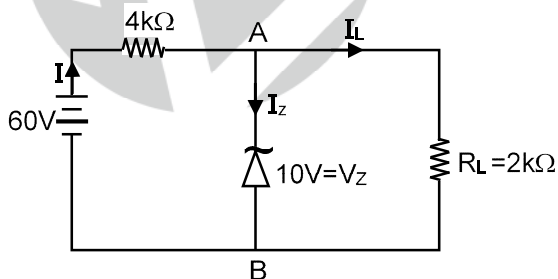
1. Immediately fill in the particulars on this page of the Test Booklet with **Blue/Black Ball Point Pen. Use of pencil is strictly prohibited.**
2. The test is of **3** hours duration.
3. The Test Booklet consists of **90** questions. The maximum marks are **360**.
4. There are **three** parts in the question paper A, B, C consisting of **Physics, Chemistry and Mathematics** having 30 questions in each part of equal weightage. Each question is allotted **4 (four)** marks for each correct response.
5. Candidates will be awarded marks as stated above in instruction No.5 for correct response of each question. $\frac{1}{4}$ (one fourth) marks 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.
6. There is only one correct response for each question. Filling up more than one response in each question will be treated as wrong response and marks for wrong response will be deducted accordingly as per instruction 5 above.

PART -A-PHYSICS

1. A small ball of mass m starts at point A with speed v_0 and moves along a frictionless track AB as shown. The track BC has coefficient of friction μ . The ball comes to stop at C after travelling a distance L which is:



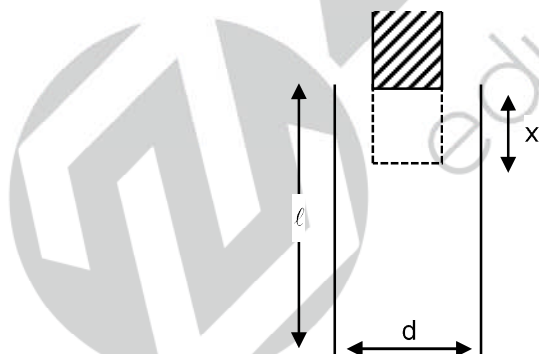
- (1*) $\frac{h}{\mu} + \frac{v_0^2}{2\mu g}$ (2) $\frac{h}{2\mu} + \frac{v_0^2}{\mu g}$ (3) $\frac{2h}{\mu} + \frac{v_0^2}{2\mu g}$ (4) $\frac{h}{2\mu} + \frac{v_0^2}{2\mu g}$
2. A radioactive nuclei with decay constant $0.5/s$ is being produced at a constant rate of 100 nuclei/s. If at $t = 0$ there were no nuclei, the time when there are 50 nuclei is:
- (1) $\ln\left(\frac{4}{3}\right)s$ (2) $1s$ (3) $\ln 2s$ (4*) $2\ln\left(\frac{4}{3}\right)s$
3. An object is located in a fixed position in front of a screen. Sharp image is obtained on the screen for two positions of a thin lens separated by 10 cm. The size of the images in two situations are in the ratio $3:2$. What is distance between the screen and the object?
- (1) 144.5 cm (2*) 99.0 cm (3) 124.5 cm (4) 65.0 cm
4. An air bubble of radius 0.1 cm is in a liquid having surface tension 0.06 N/m and density 10^3 kg/m³. The pressure inside the bubble is 1100 Nm⁻² greater than the atmospheric pressure. At what depth is the bubble below the surface of the liquid? ($g = 9.8$ ms⁻²)
- (1) 0.25 m (2) 0.15 m (3*) 0.1 m (3) 0.20 m
5. A Zener diode is connected to a battery and a load as shown below:



The current I , I_Z and I_L are respectively

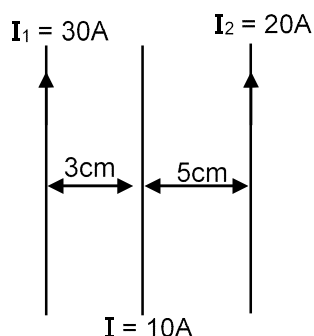
- (1) 15 mA, 7.5 mA, 7.5 mA (2*) 12.5 mA, 5 mA, 7.5 mA
 (3) 15 mA, 5 mA, 10 mA (4) 12 mA, 7.5 mA, 5 mA

6. The average mass of rain drops is 3.0×10^{-5} kg and their average terminal velocity is 9 m/s. Calculate the energy transferred by rain to each square meter of the surface at a place which receives 100 cm of rain in a year.
- (1) 3.0×10^5 J (2) 9.0×10^4 J
(3) 3.5×10^5 J (4*) 4.05×10^4 J
7. The initial speed of a bullet fired from a rifle is 630 m/s. The rifle is fired at the centre of a target 700 m away at the same level as the target. How far above the centre of the target the rifle must be aimed in order to hit the target?
- (1) 4.2 m (2) 9.8 m
(3*) 6.1 m (4) 1.0 m
8. Two monochromatic light beams of intensity 16 and 9 units are interfering. The ratio of intensities of bright and dark parts of the resultant pattern is:
- (1) $\frac{16}{9}$ (2) $\frac{4}{3}$ (3*) $\frac{49}{1}$ (4) $\frac{7}{1}$
9. A parallel plate capacitor is made of two plates of length l , width w and separated by distance d . A dielectric slab (dielectric constant K) that fits exactly between the plates is held near the edge of the plates. It is pulled into the capacitor by a force $F = \frac{\partial U}{\partial x}$ —Where U is the energy of the capacitor when dielectric is inside the capacitor up to distance x (see figure). If the charge on the capacitor is Q then the force on the dielectric when it is near the edge is:



- (1) $\frac{Q^2 w}{2d l^2 \epsilon_0} (K - 1)$ (2*) $\frac{Q^2 d}{2w l^2 \epsilon_0} (K - 1)$
(3) $\frac{Q^2 d}{2w l^2 \epsilon_0} K$ (4) $\frac{Q^2 w}{2d l^2 \epsilon_0} K$

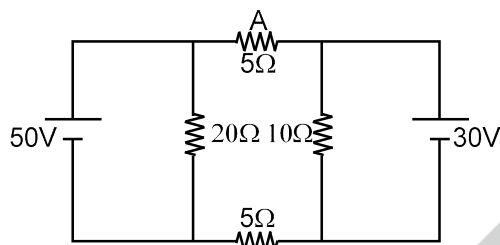
10. Three straight parallel current carrying conductors are shown in the figure. The force experienced by the middle conductor of length 25 cm is:



- (1) Zero (2) 9×10^{-4} N toward left
(3) 6×10^{-4} N toward left (4*) 3×10^{-4} N toward right
11. In compound microscope the focal length of objective lens is 1.2 cm and focal length of eye piece is 3.0 cm. When object is kept at 1.25 cm in front of objective, final image is formed at infinity. Magnifying power of the compound microscope should be:
(1*) 200 (2) 150 (3) 400 (4) 100
12. A photon of wavelength λ is scattered from an electron, which was at rest. The wavelength shift $\Delta\lambda$ is three times of λ and the angle of scattering θ is 60° . The angle at which the electron recoiled is ϕ . The value of $\tan \phi$ is: (electron speed is much smaller than the speed of light)
(1) 0.16 (2) 0.22 (3*) 0.25 (4) 0.28
13. The Bulk moduli of Ethanol Mercury and water are given as 0.9, 25 and 2.2 respectively in units of 10^9 Nm^{-2} . For a given value of pressure, the fractional compression in volume is $\frac{\Delta V}{V}$. Which of the following statements about $\frac{\Delta V}{V}$ for these three liquids is correct?
(1*) Ethanol > Water > Mercury (2) Mercury > Ethanol > Water
(3) Water > Ethanol > Mercury (4) Ethanol > Mercury > Water
14. A cone of base radius R and height h is located in uniform electric field $\vec{E}$ parallel to its base. The electric flux entering the cone is:
(1) $\frac{1}{2}EhR$ (2*) $E h R$ (3) $2 E h R$ (4) $4 E h R$
15. An electromagnetic wave of frequency 1×10^{14} hertz is propagating along z - axis. The amplitude of electric field is 4V/m. If $\epsilon_0 = 8.8 \times 10^{-12} \text{ C}^2/\text{N}\cdot\text{m}^2$, then average energy density of electric field will be
(1*) $35.2 \times 10^{-12} \text{ J/m}^3$ (2) $35.2 \times 10^{-10} \text{ J/m}^3$
(3) $35.2 \times 10^{-13} \text{ J/m}^3$ (4) $35.2 \times 10^{-11} \text{ J/m}^3$

16. A coil of circular cross-section having 1000 turns and 4 cm^2 face area is placed with its axis parallel to magnetic field which decreases by $10^{-2} \text{ Wb m}^{-2}$ in 0.01 s. The e.m.f. induced in the coil is:
 (1) 4 mV (2*) 400 mV (3) 200 mV (4) 0.4 mV

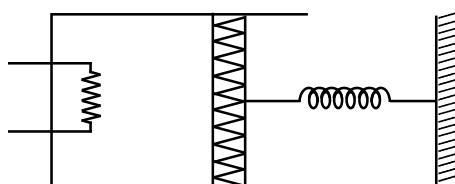
17. In the circuit shown, current (in A) through the 50 V and 30 V batteries are, respectively:



- (1*) 4.5 and 1 (2) 2.5 and 3 (3) 3 and 2.5 (4) 3.5 and 2
18. Two factories are sounding their sirens at 800Hz. A man goes from one factory to other at a speed of 2 m/s. The velocity of sound is 320 m/s. The number of beats heard by the person in one second will be:
 (1) 4 (2) 2 (3*) 10 (4) 8

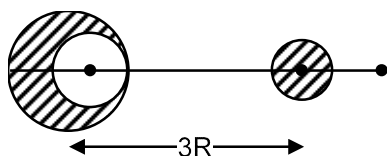
19. The angular frequency of the damped oscillator is given by, $\omega = \sqrt{\frac{k}{m} - \frac{r^2}{4m^2}}$ where k is the spring constant, m is the mass of the oscillator and r is the damping constant. If the ratio is 8%, the change in time period compared to the undamped oscillator is approximately as follows:
 (1) decreases by 8% (2) decreases by 1% (3*) increases by 1% (4) increases by 8%

20. An ideal monoatomic gas is confined in a cylinder by a spring loaded piston of cross section $8.0 \times 10^{-3} \text{ m}^2$. Initially the gas is at 300 K and occupies a volume of $2.4 \times 10^{-3} \text{ m}^3$ and the spring is in its relaxed state as shown in figure. The gas is heated by a small heater until the piston moves out slowly by 0.1 m. The force constant of the spring is 8000 N/m and the atmospheric pressure is $1.0 \times 10^5 \text{ N/m}^2$. The cylinder and the piston are thermally insulated. The piston and the spring are massless and there is no friction between the piston and the cylinder. The final temperature of the gas will be:
 (Neglect the heat loss through the lead wires of the heater. The heat capacity of the heater coil is also negligible)



- (1) 500 K (2*) 800 K (3) 1000 K (4) 300 K

21. From a sphere of mass M and radius R , a smaller sphere of radius $R/2$ is carved out such that the cavity made in the original sphere is between its centre and the periphery. (see figure). For the configuration in the figure where the distance between the centre of the original sphere and the removed sphere is $3R$, the gravitational force between the two spheres is:



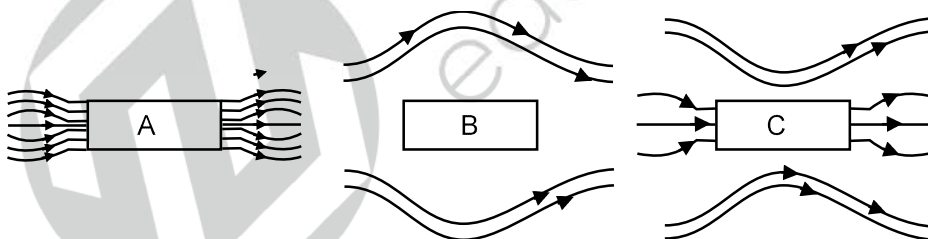
- (1) $\frac{59GM^2}{450R^2}$ (2) $\frac{GM^2}{225R^2}$ (3*) $\frac{41GM^2}{3600R^2}$ (4) $\frac{41GM^2}{450R^2}$
22. A thin bar of length L has a mass per unit length λ , that increases linearly with distance from one end. If its total mass is M and its mass per unit length at the lighter end is λ_0 , then the distance of the centre of mass from the lighter end is:

- (1*) $\frac{2L}{3} - \frac{\lambda_0 L^2}{6M}$ (2) $\frac{L}{3} + \frac{\lambda_0 L^2}{8M}$ (3) $\frac{L}{2} - \frac{\lambda_0 L^2}{4M}$ (4) $\frac{L}{3} + \frac{\lambda_0 L^2}{4M}$

23. A body of mass 5 kg under the action of constant force $\vec{F} = F_x \hat{i} + F_y \hat{j}$ has velocity at $t = 0$ s as $\vec{v} = (6\hat{i} - 2\hat{j})$ m/s and at $t = 10$ s as $\vec{v} = (8\hat{i} + 4\hat{j})$ m/s. The force $\vec{F}$ is:

- (1) $\left(-\frac{3}{5}\hat{i} + \frac{4}{5}\hat{j}\right)$ N (2) $\left(\frac{3}{5}\hat{i} - \frac{4}{5}\hat{j}\right)$ N (3) $(3\hat{i} - 4\hat{j})$ N (4*) $(-3\hat{i} + 4\hat{j})$ N

24. Three identical bars A, B and C are made of different magnetic materials. When kept in a uniform magnetic field, the field lines around them look as follows:



Make the correspondence of these bars with their material being diamagnetic (D), ferromagnetic (F) and paramagnetic (P):

- (1) $A \leftrightarrow D, B \leftrightarrow P, C \leftrightarrow F$ (2) $A \leftrightarrow F, B \leftrightarrow P, C \leftrightarrow D$
 (3*) $A \leftrightarrow F, B \leftrightarrow D, C \leftrightarrow P$ (4) $A \leftrightarrow P, B \leftrightarrow F, C \leftrightarrow D$
25. A hot body, obeying Newton's law of cooling is cooling down from its peak value 80°C to an ambient temperature of 30°C . It takes 5 minutes in cooling down from 80°C to 40°C . How much time will it take to cool down from 62°C to 32°C ?

(Given $\ln 2 = 0.693, \ln 5 = 1.609$)

- (1) 6.5 minutes (2*) 8.6 minutes (3) 9.6 minutes (4) 3.75 minutes

- 26 Match the List - I (Phenomenon associated with electromagnetic radiation) with List - II (Part of electromagnetic spectrum) and select the correct code from the choices given below the list:

List - I

- I Doublet of sodium
 II Wavelength corresponding to temperature associated with the isotropic radiation filling all space
 III Wavelength emitted by atomic hydrogen in interstellar space
 IV Wavelength of radiation arising from two close energy levels in hydrogen

List - II

- A Visible radiation
 B Microwave
 C Short radiowaves
 D X-rays

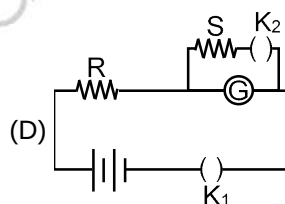
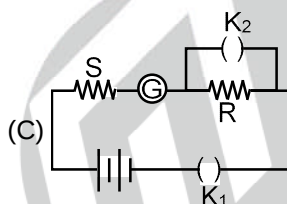
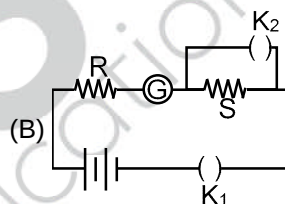
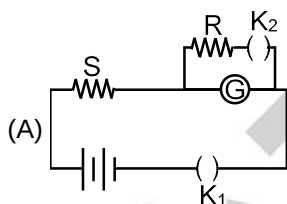
(1) I - B ; II - A ; III - D ; IV - A

(2*) I - A ; II - B ; III - C ; IV - C

(3) I - D ; II - C ; III - A ; IV - B

(4) I - A ; II - B ; III - B ; IV - C

27. In the circuit diagrams (A, B, C and D) shown below, R is a high resistance and S is a resistance of the order of galvanometer resistance G. The correct circuit, corresponding to the half deflection method for finding the resistance and figure of merit of the galvanometer, is the circuit labelled as :



(1) Circuit A with $G = \frac{RS}{(R-S)}$

(2) Circuit B with $G = S$

(3) Circuit C with $G = S$

(4*) Circuit D with $G = \frac{RS}{R-S}$

28. During an adiabatic compression 830 J of work is done on 2 moles of a diatomic ideal gas to reduce its volume by 50%. The change in its temperature is nearly:

($R = 8.3 \text{ JK}^{-1} \text{ mol}^{-1}$)

(1*) 20 K

(2) 40 K

(3) 33 K

(4) 14 K

29. A tank with a small hole at the bottom has been filled with water and kerosene (specific gravity 0.8). The height of water is 3 m and that of kerosene 2 m. When the hole is opened the velocity of fluid coming out from it is nearly: (take $g = 10 \text{ ms}^{-2}$ and density of water = 10^3 kg m^{-3})
- (1) 8.5 ms^{-1} (2) 7.6 ms^{-1} (3*) 9.6 ms^{-1} (4) 10.7 ms^{-1}
30. In terms of resistance R and time T, the dimensions of ratio $\frac{\mu}{\epsilon}$ of the permeability μ and permittivity ϵ is:
- (1) $[R^2 T^{-1}]$ (2) $[R^2 T^2]$ (3*) $[R^2]$ (4) $[RT^{-2}]$



PART-B-CHEMISTRY

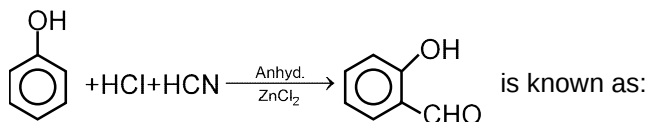
31. Consider the coordination compound, $[\text{Co}(\text{NH}_3)_6]\text{Cl}_3$. In the formation of this complex, the species which acts as the Lewis acid is:

(1) Cl^- (2) NH_3 (3) $[\text{Co}(\text{NH}_3)_6]^{3+}$ (4*) Co^{3+}

32. Which one of the following does not have a pyramidal shape

(1) $\text{P}(\text{CH}_3)_3$ (2*) $(\text{SiH}_3)_3\text{N}$ (3) $\text{P}(\text{SiH}_3)_3$ (4) $(\text{CH}_3)_3\text{N}$

33. The following reaction



(1) Gattermann-Koch formylation (2*) Gatterman reaction
(3) Kolbe's reaction (4) Perkin reaction

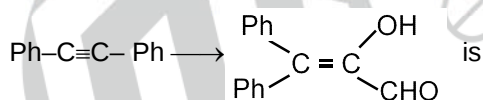
34. In some solutions, the concentration of H_3O^+ remains constant even when small amounts of strong acid or strong base are added to them. these solutions are known as:

(1*) Buffer solutions (2) True solution
(3) Colloidal solutions (4) Ideal solutions

35. Which one of the following is used as Antihistamine?

(1) Omeprazole (2) Chloranphenicol
(3*) Diphenhydramine (4) Norethindrone

36. The reagent needed for converting



(1) LiAlH_4 (2) $\text{H}_2/\text{Lindlar Cat.}$ (3*) Li / NH_3 (4) Cat. Hydrogenation

37. Which of the following statements about Na_2O_2 is not correct?

(1) Na_2O_2 oxidises Cr^{3+} to CrO_4^{2-} in acid medium.
(2) It is diamagnetic in nature.
(3) It is a derivative of H_2O_2
(4*) It is the super oxide of sodium.

38. The appearance of colour in solid alkali metal halides is generally due to:

(1) Schottky defect (2*) F-centres (3) Frenkel defect (4) Interstitial position

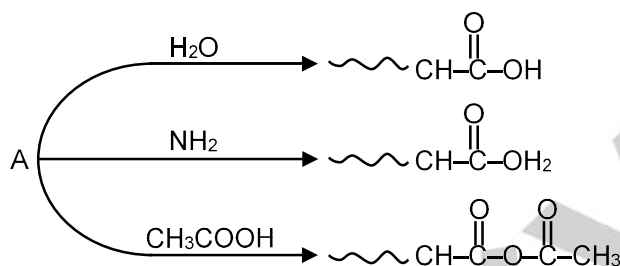
39. Complete reduction of benzene-diazonium chloride with Zn/HCl gives:

- (1) Phenylhydrazine (2*) Aniline
(3) Hydrazobenzene (4) Azobenzene

40. In the reaction of formation of sulphur trioxide by contact process $2\text{SO}_2 + \text{O}_2 \rightarrow 2\text{SO}_3$ the rate of reaction was measured as $\frac{2[\text{O}_2]}{dt} = -2.5 \times 10^{-4} \text{ mol L}^{-1} \text{ s}^{-1}$. The rate of reaction in terms of $[\text{SO}_2]$ in $\text{mol L}^{-1} \text{ s}^{-1}$ will be:

- (1) -3.75×10^{-4} (2*) -5.00×10^{-4} (3) -1.25×10^{-4} (4) -2.50×10^{-4}

41. An organic compound A, $\text{C}_5\text{H}_8\text{O}$; reacts with H_2O , NH_3 and CH_3COOH as described below :



A is:

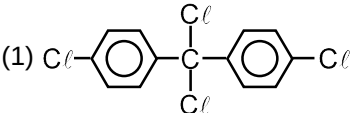
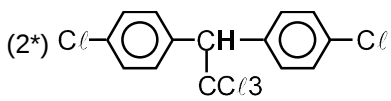
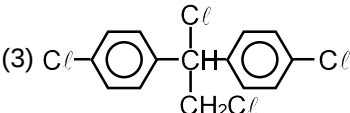
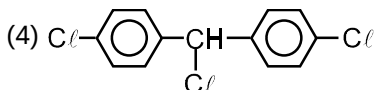
- (1) $\text{CH}_3 - \text{CH}_2 - \underset{\text{CH}_2\text{H}}{\underset{|}{\text{C}}} - \underset{|}{\text{C}} = \text{O}$ (2) $\text{CH}_3\text{CH} = \underset{\text{CH}_3}{\underset{|}{\text{C}}} - \text{CHO}$
(3) $\text{CH}_2 = \underset{\text{CH}_3}{\underset{|}{\text{CH}}} - \text{CH} - \text{CHO}$ (4*) $\text{CH}_3 - \text{CH}_2 - \underset{\text{CH}_3}{\underset{|}{\text{C}}} = \text{C} = \text{O}$

42. If λ_0 and λ be the threshold wavelength and wavelength of incident light, the velocity of photoelectron ejected from the metal surface is:

- (1) $\sqrt{\frac{2h}{m} \left(\frac{1}{\lambda_0} - \frac{1}{\lambda} \right)}$ (2) $\sqrt{\frac{2h}{m} (\lambda_0 - \lambda)}$ (3*) $\sqrt{\frac{2hc}{m} \left(\frac{\lambda_0 - \lambda}{\lambda \lambda_0} \right)}$ (4) $\sqrt{\frac{2hc}{m} (\lambda_0 - \lambda)}$

43. Which of the following statements about the depletion of ozone layer is correct? :

- (1*) The problem of ozone depletion is more serious at poles because ice crystals in the clouds over poles act as catalyst for photochemical reactions involving the decomposition of ozone by $\text{Cl}^\bullet$ and $\text{ClO}^\bullet$ radicals.
(2) Freons, chlorofluorocarbons, are inert chemically, they do not react with ozone in stratosphere.
(3) The problem of ozone depletion is less serious at poles because NO_2 solidifies and is not available for consuming $\text{ClO}^\bullet$ radicals.
(4) Oxides of nitrogen also do not react with ozone in stratosphere.

44. In allene (C_3H_4), the type(s) of hybridization of the carbon atoms is (are):
 (1) sp^2 and sp^3 (2) only sp^2 (3*) sp^2 and sp (4) sp and sp^3
45. For the reaction $2N_2O_5 \rightarrow 4NO_2 + O_2$, the rate equation can be expressed in two ways – $\frac{d[N_2O_5]}{dt} = k$
 $[N_2O_5]$ and $+\frac{d[N_2O_5]}{dt} = k'[N_2O_5]$ k and k' are related as :
 (1) $k = 2k'$ (2*) $2k = k'$ (3) $k = 4k'$ (4) $k = k'$
46. The molar heat capacity (C_p) of CD_2O is 10 cal at 1000 K. The change in entropy associated with cooling of 32 g of CD_2O vapour from 1000 K to 100 K at constant pressure will be:
 (D = deuterium, at. mass = 2u)
 (1) 2.303 cal deg^{-1} (2) -2.303 cal deg^{-1} (3) 23.03 cal deg^{-1} (4*) -23.03 cal deg^{-1}
47. The gas liberated by the electrolysis of Dipotassium succinate solution is:
 (1) Ethene (2) Propene (3) Ethyne (4*) Ethane
48. Which of the following series correctly represents relations between the elements from X to Y?
 $X \rightarrow Y$
 (1) ${}_3Li \rightarrow {}_{19}K$ Ionization enthalpy increases
 (2) ${}_{18}Ar \rightarrow {}_{54}Xe$ Noble character increases
 (3) ${}_9F \rightarrow {}_{35}Br$ Electron gain enthalpy with negative sign increases
 (4*) ${}_6C \rightarrow {}_{32}Ge$ Atomic radii increases
49. Chlorobenzene reacts with trichloro acetaldehyde in the presence of H_2SO_4
 $2 \text{C}_6\text{H}_5\text{Cl} + \text{H}-\text{C}(=\text{O})-\text{CCl}_3 \xrightarrow{H_2SO_4}$
 The major product formed is :
 (1)  (2*) 
 (3)  (4) 
50. The correct order of bond dissociation energy among N_2 , O_2 , O_2^- is shown in which of the following arrangements?
 (1) $O_2^- > O_2 > N_2$ (2*) $N_2 > O_2 > O_2^-$ (3) $N_2 > O_2^- > O_2$ (4) $O_2 > O_2^- > N_2$

51. Which one of the following statements is not correct ?
- (1) Acid strength of alcohols decreases in the following order
 $RCH_2OH > R_2CHOH > R_3COH$
- (2) The bond angle  in methanol is 108.9°
- (3*) Carbon-oxygen bond length in methanol, CH_3OH is shorter than that of C–O bond length in phenol.
- (4) Alcohols are weaker acids than water
52. Tischenko reaction is a modification of :
- (1) Aldol condensation (2) Pinacol-pinacolone reaction
 (3) Claisen condensation (4*) Cannizzaro reaction
53. Assuming that the degree of hydrolysis is small, the pH of 0.1 M solution of sodium acetate ($K_a = 1.0 \times 10^{-5}$) will be:
- (1) 6.0 (2) 5.0 (3) 8.0 (4*) 9.0
54. Consider the following equilibrium
 $AgCl \downarrow + 2NH_3 \rightleftharpoons [Ag(NH_3)_2]^+ + Cl^-$
 White precipitate of AgCl appears on adding which of the following?
- (1) aqueous NaCl (2*) aqueous HNO_3 (3) aqueous NH_4Cl (4) NH_3
55. A gaseous compound of nitrogen and hydrogen contains 12.5% (by mass) of hydrogen. The density of the compound relative to hydrogen is 16. The molecular formula of the compound is:
- (1) NH_2 (2*) N_2H_4 (3) N_3H (4) NH_3
56. Which of the following name formula combinations is not correct?
- | Formula | Name |
|-------------------------------|---|
| (1) $[Co(NH_3)_4(H_2O)I]SO_4$ | Tetraammine
aquaiodo cobalt(III)
sulphate |
| (2) $K_2[Pt(CN)_4]$ | Potassium
tetracyanoplatinate (II) |
| (3*) $[Mn(CN)_5]^{2-}$ | Pentacyanomagnate(II)
Ion |
| (4) $K[Cr(CN)_2Cl_4]$ | Potassium diammine
tetrachlorochromate(III) |

57. The initial volume of a gas cylinder is 750.0 mL. If the pressure of gas inside the cylinder changes from 840.0 mm Hg to 360.0 mm Hg, the final volume the gas will be :
 (1) 3.60 L (2*) 1.750 L (3) 7.50 (4) 4.032 L
58. Based on the equation:

$$\Delta E = -2.0 \times 10^{-18} \text{ J} \left(\frac{1}{n_2^2} - \frac{1}{n_1^2} \right)$$
 the wavelength of the light that must be absorbed to excite hydrogen electron from level $n = 1$ to level $n = 2$ will be ($h = 6.625 \times 10^{-34} \text{ Js}$, $c = 3 \times 10^8 \text{ ms}^{-1}$)
 (1*) $1.325 \times 10^{-7} \text{ m}$ (2) $5.300 \times 10^{-10} \text{ m}$ (3) $1.325 \times 10^{-10} \text{ m}$ (4) $2.650 \times 10^{-7} \text{ m}$
59. Shapes of certain interhalogen compounds are stated below. Which one of them is not correctly stated?
 (1) ICl_3 : planar dimeric (2) IF_7 : pentagonal bipyramid
 (3) BrF_3 Planar T-shaped (4*) BrF_5 : trigonal bipyramid
60. Given
 $\text{Fe}^{3+}(\text{aq}) + \text{e}^- \rightarrow \text{Fe}^{2+}(\text{aq}) ; E^\circ = +0.77$
 $\text{Al}^{3+}(\text{aq}) + 3\text{e}^- \rightarrow \text{Al}(\text{s}) ; E^\circ = -1.66 \text{ V}$
 $\text{Br}_2(\text{aq}) + 2\text{e}^- \rightarrow 2\text{Br}^- ; E^\circ = 1.09 \text{ V}$
 Considering the electrode potentials, which of the following represents the correct order of reducing power?
 (1*) $\text{Br}^- < \text{Fe}^{2+} < \text{Al}$ (2) $\text{Al} < \text{Fe}^{2+} < \text{Br}^-$ (3) $\text{Fe}^{2+} < \text{Al} < \text{Br}^-$ (4) $\text{Al} < \text{Br}^- < \text{Fe}^{2+}$

PART-C-MATHEMATICS

61. A set S contains 7 elements. A non-empty subset A of S and an element x of S are chosen at random. Then the probability that $x \in A$, is
- (1) $\frac{1}{2}$ (2) $\frac{31}{128}$ (3) $\frac{63}{128}$ (4) $\frac{64}{127}$
62. If z_1, z_2 and z_3, z_4 are 2 pairs of complex conjugate numbers, then $\arg\left(\frac{z_1}{z_4}\right) + \arg\left(\frac{z_2}{z_3}\right)$ equals
- (1) $\frac{\pi}{2}$ (2) 0 (3) $\frac{3\pi}{2}$ (4) π
63. If $|\vec{c}|^2 = 60$ and $\vec{c} \times (\hat{i} + 2\hat{j} + 5\hat{k}) = \vec{0}$, then a value of $\vec{c} \cdot (-7\hat{i} + 2\hat{j} + 3\hat{k})$ is
- (1) 12 (2) $12\sqrt{2}$ (3) $4\sqrt{2}$ (4) 24
64. The sum of the first 20 terms common between the series $3 + 7 + 11 + 15 + \dots$ and $1 + 6 + 11 + 16 + \dots$, is
- (1) 4200 (2) 4000 (3*) 4020 (4) 4220
65. The set of all real values of λ for which exactly two common tangents can be drawn to the circles $x^2 + y^2 - 4x - 4y + 6 = 0$ and $x^2 + y^2 - 10x - 10y + \lambda = 0$ is the interval
- (1) (18, 48) (2) (12, 32) (3*) (18, 42) (4) (12, 24)
66. Let for $i = 1, 2, 3$, $p_i(x)$ be a polynomial of degree 2 in x , $p'_i(x)$ and $p''_i(x)$ be the first and second order derivatives of $p_i(x)$ respectively. Let, $A(x) = \begin{bmatrix} p_1(x) & p'_1(x) & p''_1(x) \\ p_2(x) & p'_2(x) & p''_2(x) \\ p_3(x) & p'_3(x) & p''_3(x) \end{bmatrix}$ and $B(x) = [A(x)]^T A(x)$. Then determinant of $B(x)$
- (1) is a polynomial of degree 2 in x . (2) does not depend on x .
 (3) is a polynomial of degree 6 in x . (4) is a polynomial of degree 3 in x .
67. If $\lim_{x \rightarrow 2} \frac{\tan(x-2)(x^2 + (k-2)x - 2k)}{x^2 - 4x + 4} = 5$, then k is equal to
- (1) 2 (2) 1 (3*) 3 (4) 0
68. Let $f(x) = x |x|$, $g(x) = \sin x$ and $h(x) = (g \circ f)(x)$. Then
- (1) $h'(x)$ is differentiable at $x = 0$
 (2) $h(x)$ is not differentiable at $x = 0$
 (3) $h'(x)$ is continuous at $x = 0$ but it is not differentiable at $x = 0$
 (4) $h(x)$ is differentiable at $x = 0$ but $h'(x)$ is not continuous at $x = 0$

69. If $2\cos \theta + \sin \theta = 1$ $\left(\theta \neq \frac{\pi}{2}\right)$, then $7\cos \theta + 6\sin \theta$ is equal to
- (1) $\frac{46}{5}$ (2*) 2 (3) $\frac{1}{2}$ (4) $\frac{11}{2}$
70. The angle of elevation of the top of a vertical tower from a point P on the horizontal ground was observed to be α . After moving a distance 2 metres from P towards the foot of the tower, the angle of elevation changes to β . Then the height (in metres) of the tower is
- (1) $\frac{\sin \alpha \sin \beta}{\cos(\beta - \alpha)}$ (2) $\frac{2 \sin(\beta - \alpha)}{\sin \alpha \sin \beta}$ (3) $\frac{\cos(\beta - \alpha)}{\sin \alpha \sin \beta}$ (4) $\frac{2 \sin \alpha \sin \beta}{\sin(\beta - \alpha)}$
71. Let A be a 3×3 matrix such that
- $$A \begin{bmatrix} 1 & 2 & 3 \\ 0 & 2 & 3 \\ 0 & 1 & 1 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix}$$
- Then A^{-1} is
- (1) $\begin{bmatrix} 3 & 1 & 2 \\ 3 & 0 & 2 \\ 1 & 0 & 1 \end{bmatrix}$ (2) $\begin{bmatrix} 3 & 2 & 1 \\ 3 & 2 & 0 \\ 1 & 1 & 0 \end{bmatrix}$ (3) $\begin{bmatrix} 1 & 2 & 3 \\ 0 & 1 & 1 \\ 0 & 2 & 3 \end{bmatrix}$ (4) $\begin{bmatrix} 0 & 1 & 3 \\ 0 & 2 & 3 \\ 1 & 1 & 1 \end{bmatrix}$
72. If the general solution of the differential equation $y' = \frac{y}{x} + \phi\left(\frac{x}{y}\right)$, for some function ϕ , is given by $y \ln |cx| = x$, where c is an arbitrary constant, then $\phi(2)$ is equal to
- (1) -4 (2) $\frac{1}{4}$ (3) 4 (4) $-\frac{1}{4}$
73. The base of an equilateral triangle is along the line given by $3x + 4y = 9$. If a vertex of the triangle is (1, 2), then the length of a side of the triangle is
- (1) $\frac{2\sqrt{3}}{5}$ (2) $\frac{4\sqrt{3}}{5}$ (3) $\frac{2\sqrt{3}}{15}$ (4*) $\frac{4\sqrt{3}}{15}$
74. A stair-case of length l rests against a vertical wall and a floor of a room. Let P be a point on the stair-case, nearer to its end on the wall, that divides its length in the ratio 1: 2. If the stair-case begins to slide on the floor, then the locus of P is
- (1) a circle of radius $\frac{l}{2}$ (2) a circle of radius $\frac{\sqrt{3}l}{2}$
- (3) an ellipse of eccentricity $\frac{\sqrt{3}}{2}$ (4) an ellipse of eccentricity $\frac{1}{2}$

75. Let P (3 sec θ , 2tan θ) and Q (3sec ϕ , 2tan ϕ) where $\theta + \phi = \frac{\pi}{2}$, be two distinct points on the hyperbola $\frac{x^2}{9} - \frac{y^2}{4} = 1$. Then the ordinate of the point of intersection of the normals at P and Q is
- (1) $\frac{11}{3}$ (2) $\frac{-11}{3}$ (3) $\frac{13}{2}$ (4) $\frac{-13}{2}$
76. The integral $\int x \cos^{-1} \left(\frac{1-x^2}{1+x^2} \right) dx$ ($x > 0$) is equal to
- (1) $-x + (1+x^2) \cot^{-1}x + C$ (2) $x - (1+x^2) \tan^{-1}x + C$
 (3) $x - (1+x^2) \cot^{-1}x + C$ (4) $-x + (1+x^2) \tan^{-1}x + C$
77. For the curve $y = 3 \sin \theta \cos \theta$, $x = e^\theta \sin \theta$, $0 \leq \theta \leq \pi$, the tangent is parallel to x-axis when θ is
- (1) $\frac{3\pi}{4}$ (2) $\frac{\pi}{4}$ (3) $\frac{\pi}{2}$ (4) $\frac{\pi}{6}$
78. Let f be an odd function defined on the set of real numbers such that for $x \geq 0$, $f(x) = 3\sin x + 4\cos x$. Then $f(x)$ at $x = \frac{-11\pi}{6}$ is equal to
- (1*) $\frac{3}{2} + 2\sqrt{3}$ (2) $\frac{-3}{2} - 2\sqrt{3}$ (3) $\frac{3}{2} - 2\sqrt{3}$ (4) $\frac{-3}{2} + 2\sqrt{3}$
79. The coefficient of x^{50} in the binomial expansion of $(1+x)^{1000} + x(1+x)^{999} + x^2(1+x)^{998} + \dots + x^{1000}$ is
- (1*) $\frac{(1001)!}{(50)!(951)!}$ (2) $\frac{(1000)!}{(50)!(950)!}$ (3) $\frac{(1001)!}{(51)!(950)!}$ (4) $\frac{(1000)!}{(49)!(951)!}$
80. The proposition $\sim (p \vee \sim q) \vee \sim (p \vee q)$ is logically equivalent to
- (1) p (2) q (3) $\sim p$ (4) $\sim q$
81. The volume of the largest possible right circular cylinder that can be inscribed in a sphere of radius = $\sqrt{2}$ is
- (1) $\frac{4\sqrt{3}\pi}{3}$ (2) 2π (3) $\frac{8\sqrt{3}\pi}{3}$ (4) 4π
82. If X has a binomial distribution, B(n, p) with parameters n and p such that $P(X=2) = P(X=3)$, then E(X), the mean of variable X, is
- (1) $\frac{p}{3}$ (2) $2-p$ (3) $\frac{p}{2}$ (4) $3-p$

83. The plane containing the line $\frac{x-1}{1} = \frac{y-2}{2} = \frac{z-3}{3}$ and parallel to the line $\frac{x}{1} = \frac{y}{1} = \frac{z}{4}$ passes through the point
 (1) (1, 0, 5) (2) (-1, -3, 0) (3) (1, -2, 5) (4) (0, 3, -5)
84. Let L_1 be the length of the common chord of the curves $x^2 + y^2 = 9$ and $y^2 = 8x$, and L_2 be the length of the latus rectum of $y^2 = 8x$, then
 (1) $\frac{L_1}{L_2} = \sqrt{2}$ (2) $L_1 > L_2$ (3) $L_1 < L_2$ (4) $L_1 = L_2$
85. If α and β are roots of the equation $x^2 - 4\sqrt{2}kx + 2e^{4\ln k} - 1 = 0$ for some k and $\alpha^2 + \beta^2 = 66$, then $\alpha^3 + \beta^3$ is equal to
 (1*) $280\sqrt{2}$ (2) $248\sqrt{2}$ (3) $-32\sqrt{2}$ (4) $-280\sqrt{2}$
86. If for $n \geq 1$, $P_n = \int_1^e (\log x)^n dx$, then $P_{10} - 90P_8$ is equal to
 (1) $10e$ (2) $-9e$ (3) -9 (4) 10
87. Let A (2, 3, 5), B (-1, 3, 2) and C (λ , 5, μ) be the vertices of a $\triangle ABC$. If the median through A is equally inclined to the coordinate axes, then
 (1) $8\lambda - 5\mu = 0$ (2) $10\lambda - 7\mu = 0$ (3) $7\lambda - 10\mu = 0$ (4) $5\lambda - 8\mu = 0$
88. An eight digit number divisible by 19 is to be formed using digits from 0 to 9 without repeating the digits. The number of ways in which this can be done is
 (1) $40 (7!)$ (2) $36 (7!)$ (3) $72 (7!)$ (4) $18 (7!)$
89. In a geometric progression, if the ratio of the sum of first 5 terms to the sum of their reciprocals is 49, and the sum of the first and the third term is 35. Then the first term of this geometric progression is
 (1) 42 (2) 21 (3) 7 (4*) 28
90. Two ships A and B are sailing straight away from a fixed point O along routes such that $\angle AOB$ is always 120° . At a certain instance, $OA = 8$ km, $OB = 6$ km and the ship A is sailing at the rate of 20 km/hr while the ship B sailing at the rate of 30 km/hr. Then the distance between A and B is changing at the rate(in km/hr)
 (1) $\frac{80}{\sqrt{37}}$ (2) $\frac{260}{37}$ (3) $\frac{80}{37}$ (4) $\frac{260}{\sqrt{37}}$