Deeksha

ABHYAS KCET 2024

FREE
TEST SERIES

MOCK TEST 5
PDF
SOLUTION

Deeksha - CET

Subject	Topic	
C + M + P	Complete Syllabus	

Max. Marks: **180** **Duration:** **3 Hours**

1. This paper consists of 180 questions with 3 parts of Chemistry, Mathematics and Physics

- **Chemistry:** *(Q. No. 1 to 60) Multiple Choice Questions with one correct answer. A correct answer carries 1 Mark. No Negative marks.*
- **Mathematics:** *(Q. No. 61 to 120) Multiple Choice Questions with one correct answer. A correct answer carries 1 Mark. No Negative marks.*
- **Physics:** *(Q. No. 121 to 180) Multiple Choice Questions with one correct answer. A correct answer carries 1 Mark. No Negative marks.*

2. The OMR sheet for 200 questions is to be used

3. Use of calculators and log tables is prohibited

4. Darken the appropriate bubble using a pen in the OMR sheet provided to you. Once entered, the answer cannot be changed. Any corrections or modifications will automatically draw a penalty of 1 mark

5. No clarification will be entertained during the examination. Doubts in the paper can be reported to the coordinator after the exam

6. If the details in the OMR Sheet are not filled, If the OMR sheet is mutilated, torn, white Ink used, the circles filled and scratched, then the OMR sheet will not be graded

All the best!!

Useful Data

At. Wt.:

$N = 14;\ O = 16;\ H = 1;\ S = 32;\ Cl = 35.5;\ Mn = 55;\ Na = 23;\ C = 12;\ Ag = 108;\ K = 39;\ Fe = 56;\ Pb = 207$

Physical Constants:

$h = 6.626 \times 10^{-34}\,\mathrm{Js}$, $\mathrm{N_a} = 6.022 \times 10^{23}\,\mathrm{mol^{-1}}$, $\mathrm{c} = 2.998 \times 10^{8}\,\mathrm{m\,s^{-1}}$, $\mathrm{m_e} = 9.1 \times 10^{-31}\,\mathrm{kg}$, $R = 8.314\,\mathrm{J\,mol^{-1}\,K^{-1}}$

Chemistry

Multiple Choice Questions with one correct answer. A correct answer carries 1 mark. No negative mark. 60 x 1 = 60

1. Of the ions Zn^{2+}, Co^{3+} and Cr^{3+} (At. Nos. $Zn = 30, Ni = 28, Cr = 24$)

   Options:

   (a) Only Zn^{2+} is colourless and Co^{3+} and Cr^{3+} are coloured

   (b) All three are colourless

   (c) All three are coloured

   (d) Only Co^{3+} is coloured and Zn^{2+} and Cr^{3+} are colourless

   Sol:

Ion	Zn^{2+}	Co^{3+}	Cr^{2+}
Electronic configuration	$3d^{10}$	$3d^{6}$	$3d^{8}$
No. of unpaired electrons	0	4	2

   Co^{3+} and Cr^{3+} have partially filled d – orbital thus they are coloured but Zn^{2+} has completely filled d – orbital and is thus colourless.

   Ans: (a)

2. Mercury is liquid at room temperature. This is due to the

   Options:

   (a) High viscosity of mercury

   (b) Weak metallic bonding and weak van der Waals forces

   (c) Large surface tension of mercury

   (d) Strong metallic bonding and strong van der Waals forces

   Sol: Mercury is the only metal which is liquid at room temperature because of weak metallic bonding and weak van der Waals forces of attraction.

   Ans: (b)

3. Which of the following are d – block elements but not regarded as transition elements?

   Options:

   (a) Cu, Ag, Au (b) Ru, Rh, Pd (c) Fe, Co, Ni (d) Zn, Cd, Hg

   Sol: Zn, Cd and Hg are to be excluded from transition series as they have completely filled $(n-1)d$ – orbital i.e., the configuration is $(n-1)d^{10}$ in their elementary states as well as in the common oxidation state.

   Ans: (d)

4. The correct order of ionic radii of $Yb^{3+}, La^{3+}, Eu^{3+}$ and Lu^{3+} is

   Options:

   (a) $Yb^{3+} < La^{3+} < Eu^{3+} < Lu^{3+}$ (b) $Lu^{3+} < Eu^{3+} < La^{3+} < Yb^{3+}$

   (c) $Lu^{3+} < Yb^{3+} < Eu^{3+} < La^{3+}$ (d) $La^{3+} < Eu^{3+} < Yb^{3+} < Lu^{3+}$

Sol: Ionic radii decrease from La^{3+} to Lu^{3+} due to lanthanoid contraction.

Thus order of ionic radii is $Lu^{3+} < Yb^{3+} < Eu^{3+} < La^{3+}$

Ans: (c)

5. The hypothetical complex triamminediaquachloridocobalt(III) chloride can be represented as

Options:

(a) $\left[Co(NH_3)_3(H_2O)_2Cl\right]Cl_2$ (b) $\left[Co(NH_3)_3(H_2O)Cl_3\right]$

(c) $\left[Co(NH_3)_3(H_2O)_2Cl\right]$ (d) $\left[Co(NH_3)_3(H_2O)_3\right]Cl_3$

Sol: triamminediaquachloridocobalt(III) chloride $\left[Co(NH_3)_3(H_2O)_2Cl\right]Cl_2$

Ans: (a)

6. Which of the following speies represents the example of dsp^2 – hybridization?

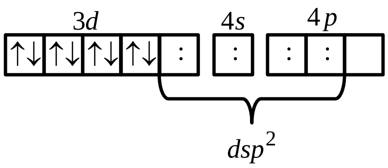
Options:

(a) $\left[Fe(CN)_6\right]^{3-}$ (b) $\left[Ni(CN)_4\right]^{2-}$ (c) $\left[Zn(NH_3)_4\right]^{2+}$ (d) $\left[FeF_6\right]^{3-}$

Sol: Oxidation state of Ni in $\left[Ni(CN)_4\right]^{2-} = +2$

$Ni^{2+}(Z = 28) \rightarrow 3d^8$ i.e.

CN^- being strong field ligand forces electrons to pair up.

$\left[Ni(CN)_4\right]^{2-}$ 

Ans: (b)

7. The compound which does not show paramagnetism is

Options:

(a) $\left[Cu(NH_3)_4\right]Cl_2$ (b) $\left[Ag(NH_3)_2\right]Cl$ (c) NO (d) NO_2

Sol: In $\left[Ag(NH_3)_2\right]Cl$, oxidation state of Ag =+1 $Ag^+ \rightarrow 4d^{10}$

Ans: (b)

8. Which of the following solutions will exhibit highest boiling point?

Options:

(a) 0.01 M $Na_2SO_4(aq)$ (b) 0.01 M $KNO_3(aq)$

(c) 0.015 M urea (aq) (d) 0.015 M glucose (aq)

Sol: 0.01 M $Na_2SO_4(aq)$ solution give maximum number of particles and has highest boiling point.

$Na_2SO_4 \xrightarrow{aq} 2Na^+ + SO_4^{2-}$

Ans: (a)

9. Osmotic pressure observed when benzoic acid is dissolved in benzene is less than that expected from theoretical considerations. This is because

   Options:

   (a) Benzoic acid is an organic solute

   (b) Benzoic acid has higher molar mass than benzene

   (c) Benzoic acid gets associated in benzene

   (d) Benzoic acid gets dissociated in benzene

   Sol: Benzoic acid gets associated in benzene to form lesser no. of particles. Osmotic pressure observed is less since it is a colligative property and depends on the number of particles.

   Ans: (c)

10. The standard reduction potential values of the elements A, B and C are $+0.34$ V, -3.05 V and $+2.86$ V respectively. The order of their oxidising power will be

    Options:

    (a) B > A > C   (b) A < B < C   (c) B < A < C   (d) C < B < A

    Sol: Higher the reduction potential values, stronger is the oxidising agent.

    Ans: (c)

11. For hydrogen-oxygen fuel cell at one atm and 298 K

    $$H_2(g)+\frac{1}{2}O_2(g)\rightarrow H_2O(l);$$

    $\Delta G^\circ = -240$ kJ

    E° for the cell is approximately,(Given $F = 96,500$ C)

    Options:

    (a) 1.24 V   (b) 1.26 V   (c) 2.48 V   (d) 2.5 V

    Sol: $\Delta G^\circ = -nFE^\circ_{cell}$

    $$E^\circ_{cell} = \frac{\Delta G^\circ}{-nF} = \frac{-240,000}{-2\times 96500} = 1.24 \text{ V}$$

    Ans: (a)

12. $RCOOR' + H_2O \xrightarrow{(HCl)} RCOOH + R'OH$ what type of reaction is this?

    Options:

    (a) Second order   (b) Unimolecular   (c) Pseudounimolecular   (d) Third order

    Sol: Pseudounimolecular

    Ans: (c)

13. Half life period of a reaction is found to be inversely proportional to the cube of the initial concentration. The order of reaction is

    Options:

    (a) 4   (b) 3   (c) 5   (d) 2

    Sol: Order of reaction 4 because

    $t_{1/2} \propto \frac{1}{a^{n-1}}$ or $t_{1/2} \propto \frac{1}{a^3}$ Ans: (a)

14. The incorrect relation for a first order reaction is

Options:

(a) $t_{99\%} = 2\times t_{90\%}$ (b) $k = \frac{2.303}{t}\log\frac{[R]_0}{[R]}$

(c) $k = \frac{[R]_0 - [R]}{t}$ (d) $[R] = [R]_0 e^{-kt}$

Sol: $k = \frac{[R]_0 - [R]}{t}$ It is an integrated rate equation for zero order reaction.

Ans: (c)

15. For reaction, $2N_2O_5 \longrightarrow 4NO_2 + O_2$, rate and rate constant are 1.02×10^{-4} mol L^{-1} sec^{-1} and 3.4×10^{-5} sec^{-1}

The concentration of N_2O_5 at that time will be

Options:

(a) 1.732 mol L^{-1} (b) 3 mol L^{-1} (c) 1.02×10^{-4} mol L^{-1} (d) 3.2×10^{5} mol L^{-1}

Sol: Rate = rate constant $\times$ $[\text{concentration}]^n$

$1.02\times10^{-4} = 3.4\times10^{-5}\times[N_2O_5]$

(Unit of rate constant shows that it's a first order reaction)

$[N_2O_5] = \frac{1.02\times10^{-4}}{3.4\times10^{-5}} = 3M$

Ans: (b)

16. A reaction is first order in A and second order in B. How is the rate affected when the concentrations of both A and B are doubled?

Options:

(a) 5 times (b) 8 times (c) 4 times (d) 9 times

Sol: Let rate $= kab^2$ $([A] = a, [B] = b)$

If both $[A]$ and $[B]$ are doubled, rate $= k(2a)(2b)^2 = 8kab^2$

i.e., Rate of reaction increases 8 times.

Ans: (b)

17. A reaction which is of first order w.r.t reactant A, has a rate constant 0.6 min^{-1}. If we start with $[A] = 0.5$ mol L^{-1}, when would $[A]$ reach the value of 0.05 mol L^{-1}

Options:

(a) 0.384 min (b) 0.15 min (c) 3 min (d) 3.84 min

Sol: $t = \frac{2.303}{k}\log\frac{a}{a-x} = \frac{2.303}{0.6}\log\frac{0.5}{0.05} = \frac{2.303}{0.6}\log 10 = 3.84\,\text{min}$

Ans: (d)

18. If the standard electrode potential of Cu^{2+}/Cu electrode is 0.34 V, what is the electrode potential of 0.01M concentration of Cu^{2+} ? $(T = 298K)$

Options:

(a) 0.399 V (b) 0.281 V (c) 0.222 V (d) 0.176 V

Sol: $E = E° - \frac{0.0591}{n}\log\frac{1}{\left[Cu^{2+}\right]} = 0.34 - \frac{0.0591}{2}\log\frac{1}{10^{-2}}$

$= 0.34 - 0.0591 = 0.281V$

Ans: (b)

19. Molar conductivities at infinite dilution at 293 K for aqueous HCl, CH_3COONa and $NaCl$ are 384, 78 and 102 $S\ cm^2\ mol^{-1}$ respectively. The molar conductivity of CH_3COOH at some other dilution is 108 $S\ cm^2\ mol^{-1}$ at 293 K. Calculate the degree of ionization of acetic acid at the given dilution.

Options:

(a) 0.150 (b) 0.6 (c) 0.3 (d) 0.48

Sol: The molar conductivity of acetic acid at infinite dilution is given by,

$\Lambda^0_{CH_3COOH} = \Lambda^0_{CH_3COONa} + \Lambda^0_{HCl} - \Lambda^0_{NaCl}$

$\Lambda^0_{CH_3COOH} = 78 + 384 - 102 = 360\,S\,cm^2 mol^{-1}$

The degree of dissociation of the acetic acid solution = $\frac{\Lambda^c}{\Lambda^0} = \frac{108}{360} = 0.3$

Ans: (c)

20. H_2S a toxic gas with rotten egg like smell, is used for qualitative analysis. If the mole fraction of H_2S in water at STP is 0.004 , Henry's law constant is

Options:

(a) 300 atm (b) 250 atm (c) 100 atm (d) 125 atm

Sol: Pressure at STP $= 1.0atm$

Applying Henry's law, $P_{H_2S} = K_H \times x_{H_2S}$

Or $K_H = \frac{P_{H_2S}}{x_{H_2S}} = \frac{1.0}{0.004} = 250\ atm$

Ans: (b)

21. A binary liquid solution is prepared by mixing $n-$heptane and ethanol. Which one of the following statements is correct regarding the behaviour of the solution?

Options:

(a) The solution formed is an ideal solution.

(b) The solution is non- ideal, showing +ve deviation from Raoult's law

(c) The solution is non- ideal, showing -ve deviation from Raoult's law

(d) $n-$Heptane shows +ve deviation while ethanol shows –ve deviation from Raoult's law

Sol: The solution containing $n-$heptane and ethanol shows non-ideal behaviour with positive deviation from Raoult's law. This is because the ethanol molecules are held together by strong H-bonds, however the force between $n-$heptane and ethanol are not very strong, as a result they easily vapourise showing higher vapour pressure than expected.

Ans: (b)

22. 45 g of ethylene glycol $\left(C_2H_6O_2\right)$ is mixed with 600g of water. The freezing point depression is

Options:

(a) 3.5 (b) 2.25 (c) 4.3 (d) 5.4

Sol: $\Delta T_s = \dfrac{K_f \times w_2 \times 1000}{M_2 \times w_1} = \dfrac{1.86 \times 45 \times 1000}{62 \times 600} = 2.25$

Ans: (b)

23. The decreasing order of osmotic pressure of 10 g glucose (P_1),$10g$ urea (P_2) and 10 g sucrose (P_3) at 273 K when dissolved in 250 mL of water separately is

Options:

(a) $P_1 > P_2 > P_3$ (b) $P_3 > P_3 > P_1$ (c) $P_2 > P_1 > P_3$ (d) $P_3 > P_2 > P_1$

Sol: $P = \dfrac{\omega RT}{M \times V}$ $P \propto \dfrac{1}{M}$

The decreasing order is urea> glucose >sucrose

$P_2 > P_1 > P_3$

Ans: (c)

24. On analysis a certain compound was found to contain 254g of iodine (at. mass 127) and 64g oxygen (at. mass 16). What is the formula of the compound?

Options:

(a) IO (b) I_2O_4 (c) I_2O_3 (d) I_2O_5

Sol: Moles of iodine = $\dfrac{254}{127} = 2$

Moles of oxygen = $64/16 = 4$

Formula = I_2O_4

Ans: (b)

25. Nitrogen laser produces a radiation at a wavelength of 337.1 nm. If the number of photons emitted is 5.6×10^{24}, the power of this laser is

Options:

(a) 2.3×10^6 J (b) 3.3×10^6 J (c) 4.3×10^{-7} J (d) 5.3×10^{-6} J

Sol: Wavelength of nitrogen $= 337.1 nm = 337.1 \times 10^{-9} m$

Number of photons $= 5.6 \times 10^{24}$

Energy of photon (E) $= \dfrac{Nhc}{\lambda} = \dfrac{5.6 \times 10^{24} \times 6.626 \times 10^{-34} \times 3 \times 10^8}{337.1 \times 10^{-9}}$

$= 3.30\times10^6$ J

Power of this nitrogen laser is 3.3×10^6 J

Ans: (b)

26. Which one of the following arrangements represents the correct order of electron gain enthalpy (with negative sign) of the given atomic species?

Options:

(a) $Cl < F < S < O$ (b) $O < S < F < Cl$ (c) $S < O < Cl < F$ (d) $F < Cl < O < S$

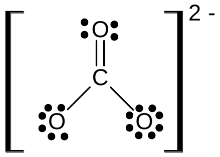
Sol: Electron affinity of given elements follows the order $O < S < F < Cl$

Thus, order of their electron gain enthalpy (with negative sign) would be same i.e.,

$$\Delta_{eg}H\left(\text{in kJ mol}^{-1}\right) \quad \begin{matrix} O < & S & < F & < Cl \\ -141 & -200 & -328 & -349 \end{matrix}$$

Ans: (b)

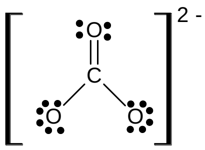
27. In the following structure of CO_3^{2-}, formal charges on carbon atom, double bonded oxygen atom and single bonded oxygen atom are respectively.



Options:

(a) $-1, 0, 0$ (b) $1, -2, 0$ (c) $0, 0, -1$ (d) $0, -1, 0$

Sol: Lewis structure of CO_3^{2-} ion is



Formula charge = [valence electrons – lone pair electrons $-\frac{1}{2}$ bonding electrons]

Formula charge on carbon atom = $4-\frac{1}{2}\times8=0$

Formula charge on double bonded O atom = $6-4-\frac{1}{2}\times4=0$

Formula charge on single bonded O atom = $6-6-\frac{1}{2}\times2=-1$

Ans: (c)

28. Which of the following pairs is isoelectronic?

Options:

(a) Ar and Cl (b) Na^+ and Ne (c) Na^+ and Mg (d) Mg and Ne

Sol: Na^+ and Ne are isoelectronic as each one of them contains 10 electrons

Ans: (b)

29. A system is provided with $50J$ of heat and work done on the system is $10J$. The change in internal energy during the process is:

Options:

(a) $40J$ (b) $60J$ (c) $80J$ (d) $50J$

Sol: $\Delta U = q + W$; W is work done on the system $\therefore$ $\Delta U = q + W = 50 + 10 = 60$

Ans: (b)

30. Values of ΔH and ΔS for four different reactions are given below:

Reaction	$\Delta H\left(\text{kJ mol}^{-1}\right)$	$\Delta S\left(\text{kJ mol}^{-1}\right)$
I	+98.0	+14.8
II	-55.5	-84.8
III	+28.3	-17.0
IV	-40.5	+24.6

On the basis of these values predict which one of these will be spontaneous at all temperatures?

Options:

(a) Reaction I (b) Reaction II (c) Reaction III (d) Reaction IV

Sol: For reaction IV $\Delta H = -ve$ and $\Delta S = +ve$,hence $\Delta G = -ve$ at all temperatures.

Ans: (d)

31. $NH_4COONH_{2(s)} \rightleftharpoons 2NH_{3(g)} + CO_{2(g)}$. If equilibrium pressure is 3 atm for the above reaction, K_p for the reaction is

Options:

(a) 4 (b) $\frac{4}{27}$ (c) $\frac{1}{27}$ (d) 27

Sol: $NH_4COONH_{2(s)} \rightleftharpoons 2NH_{3(g)} + CO_{2(g)}$

Pressure at Equilibrium $2P$ P

It is given that $2P + P = 3\text{atm}$ $\therefore p = 1\, atm$

$K_p = P_{NH_3}^2 \times P_{CO_2} = (2)^2 \times 1 = 4$.

Ans: (a)

32. pH of the solution at $25°C$ is 2. If the pH is to be doubled then the hydronium ion concentration of the solution should be

Options:

(a) Halved (b) Doubled

(c) Increased to 100 times (d) Decreased to 100 times

Sol: $\text{pH} = -\log\left[H^+\right] = 2$ $\therefore \left[H^+\right] = 10^{-2}$

On doubling the pH

$\text{pH} = -\log\left[H^+\right] = 4, \left[H^+\right] = 10^{-4}$ i.e., $\left[H^+\right]$ decreases 100 times.

Ans: (d)

33. In the reaction, $3I_2 + 6NaOH \rightarrow NaIO_3 + 5NaI + 3H_2O$ oxidising agent is

Options:

(a) $NaOH$ (b) $NaIO_3$ (c) I_2 (d) NaI

Sol: $3\overset{0}{I_2} + 6NaOH \rightarrow Na\overset{+5}{I}O_3 + 5I^{-1} + 3H_2O$

In the given reaction, I_2 is reduced thus, acts as oxidising agent.

Ans: (c)

34. Which of the following is the correct order of radius

Options:

(a) $H^- > H > H^+$ (b) $Na^+ > F^- > O^{2-}$ (c) $F^- > O^{2-} > Na^+$ (d) $Al^{3+} > Mg^{2+} > N^{3-}$

Sol: Anion has larger radius but cation has smaller radius than neutral atom. Thus, the answer is

$H^- > H > H^+$

Ans: (a)

35. The set representing the correct order of first ionization potential is

Options:

(a) K > Na > Li (b) Be > Mg > Ca (c) Ge > Si > C (d) B > C > N

Sol: I.E decreases down the group

Ans: (b)

36. The correct statement is

Options:

(a) The extent of actinoid contraction is almost the same as lanthanoid contraction.

(b) Ce^{+4} in aqueous solution is not known.

(c) The earlier members of lanthanoid series resemble calcium in their chemical properties.

(d) In general, lanthanoids and actinoids do not show variable oxidation states.

Sol: The earlier members of lanthanoid series resemble calcium in their chemical properties.

Ans: (c)

37. The correct order of reactivity towards electrophilic substitution is

Options:

(a) Phenol>benzene> chlorobenzene>benzoic acid

(b) Benzoic acid> chlorobenzene >benzene >phenol

(c) Phenol > chlorobenzene> benzene >benzoic acid

(d) Benzoic acid > Phenol> benzene >chlorobenzene

Sol:

Phenol>benzene> chlorobenzene>benzoic acid

Ans: (a)

38. Which of the following pairs of elements cannot form an alloy?

Options:

(a) Zn, Cu (b) Fe, Hg (c) Fe, C (d) Hg, Na

Sol: Fe and Hg do not form alloy (amalgam).

Ans: (b)

39. Which among the following is the strongest ligand?

Options:

(a) CN^- (b) CO (c) NH_3 (d) en

Sol: CO is the correct answer

Ans: (b)

40. Cationic complex is

Options:

(a) hexa amino platinum chloride (b) potassium ferrocyanide

(c) sodium argentocyanide (d) nickel carbonyl

Sol: hexa amino platinum chloride

Ans: (a)

41. The compound that exhibit geometrical isomerism are

(I) $\left[Pt(en)Cl_2\right]$ (ii) $\left[Pt(en)_2\right]Cl_2$ (iii) $\left[Pt(en)_2Cl_2\right]Cl_2$ (iv) $\left[Pt(NH_3)_2Cl_2\right]$

Options:

(a) 1, 2 (b) 1, 3 (c) 2, 4 (d) 3, 4

Sol: Octahedral complex of the type $\left[M(AA)_2B_2\right]$ i.e., $\left[Pt(en)_2Cl_2\right]^{2+}$ and square planar complex of the type MA_2B_2 i.e., $Pt(NH_3)_2Cl_2$ shows geometrical isomerism.

Ans: (d)

42. The product of reaction of alcoholic silver nitrite with ethyl bromide is

Options:

(a) Ethane (b) Ethene (c) Ethyl alcohol (d) Nitroethane

Sol: $C_2H_5Br + AgNO_2 \longrightarrow \underset{\text{Nitroethane}}{C_2H_5NO_2} + AgBr$

Ans: (d)

43. In which case formation of butane nitrile is possible?

Options:

(a) $C_3H_7Br + KCN$ (b) $C_4H_9Br + KCN$ (c) $C_3H_7OH + KCN$ (d) $C_4H_9OH + KCN$

Sol: $C_3H_7Br + KCN \longrightarrow \underset{\text{Butane nitrile}}{C_3H_7CN} + KBr$

Ans: (a)

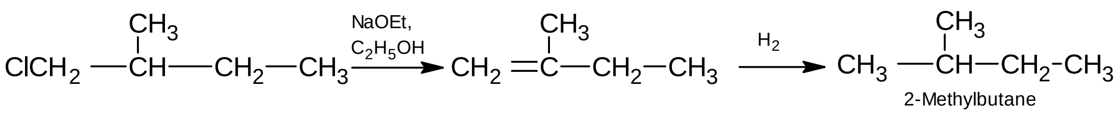
44. An alkyl chloride produces a single alkene on reaction with sodium ethoxide and ethanol. The alkene further undergoes hydrogenation to yield 2-methylbutane. Identify the alkyl chloride from the following

Options:

(a) $ClCH_2C(CH_3)_2CH_3$ (b) $ClCH_2CH_2CH_2CH_3$

(c) $ClCH_2CH(CH_3)CH_2CH_3$ (d) $CH_3C(Cl)(CH_3)CH_2CH_3$

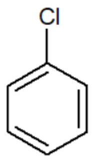
Sol:

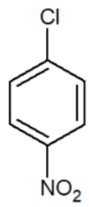


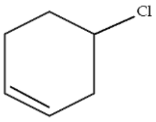
Ans: (c)

45. The compound having longest C-Cl bond is

Options:

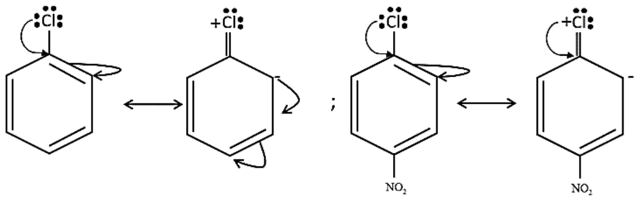
(a) 

(b) 

(c) 

(d) $CH_2=CH-Cl$

Sol: When Cl is attached to carbon having double and (1, 2, 4), formation of double bond takes place between C-Cl bond due to resonance but in '3', no such resonance takes place, hence, C-Cl bond length is longest in this compound



Chlorobenzene 1-Chloro-4-nitrobenzene

$$CH_2=CH-\ddot{Cl}: \longleftrightarrow \overset{-}{C}H_2-CH=\overset{+}{Cl}:$$

Vinyl chloride

Ans: (c)

46. An organic compound (A) reacts with sodium metal and forms (B). On heating with conc. H_2SO_4 (A) gives diethylether. (A) and (B) are respectively

Options:

(a) C_2H_5OH and C_2H_5ONa

(b) C_3H_7OH and CH_3ONa

(c) CH_3OH and CH_3ONa

(d) C_4H_9OH and C_4H_9ONa

Sol: $\underset{(A)}{C_2H_5OH} \xrightarrow{Na} \underset{(B)}{C_2H_5ONa}$

$$\underset{(A)}{2C_2H_5OH} \xrightarrow{H_2SO_4} \underset{\text{Diethyl ether}}{C_2H_5-O-C_2H_5}$$

Ans: (a)

47. Identify Z in the following series: $C_2H_5OH \xrightarrow{PBr_3} X \xrightarrow{alc.\, KOH} Y \xrightarrow[(ii)\, H_2O + \text{heat}]{(i)\, H_2SO_4} Z$

Options:

(a) $CH_2 = CH_2$

(b) $CH_3 - CH_2OH$

(c) $CH_3 - CH_2 - O - CH_2 - CH_3$

(d) $CH_3 - CHO$

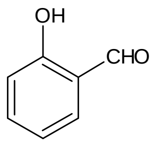
Sol:

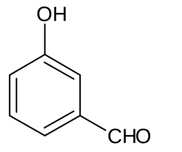
$$\underset{}{C_2H_5OH} \xrightarrow{PBr_3} \underset{(X)}{C_2H_5Br} \xrightarrow{alc\ KOH} CH_2 = CH_2 \xrightarrow[\Delta]{(i)\ H_2SO_4,\ (ii)\ H_2O} \underset{(Z)}{CH_3 - CH_2OH}$$

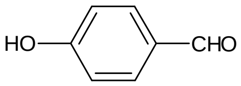
Ans: (b)

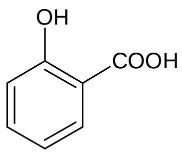
48. What is the major product obtained when phenol is treated with chloroform and aqueous alkali?

Options:

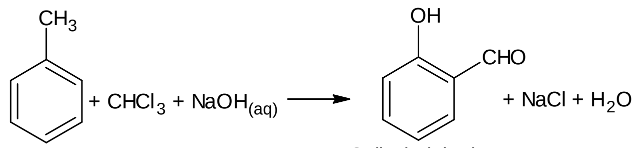
(a) 

(b) 

(c) 

(d) 

Sol:



Salicyladehyde

Ans: (a)

49. Which is not true about acetophenone $(C_6H_5COCH_3)$?

Options:

(a) Reacts to form 2, 4- dinitrophenylhydrazone

(b) Reacts with Tollens' reagent to form silver mirror

(c) Reacts with $I_2/NaOH$ to form iodoform

(d) On oxidation with alkaline $KMnO_4$ followed by hydrolysis gives benzoic acid

Sol: Acetophenone, $(C_6H_5COCH_3)$ being ketone does not react with Tollens' reagent to give silver mirror.

Ans: (b)

50. Propanal on treatment with dilute sodium hydroxide forms

Options:

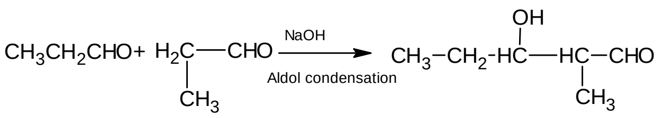
(a) $CH_3CH_2CH_2CH_2CH_2CHO$

(b) $CH_3CH_2CH(OH)CH_2CH_2CHO$

(c) $CH_3CH_2CH(OH)CH(CH_3)CHO$

(d) CH_3CH_2COONa

Sol:



Ans: (c)

51. Which of the following is the strongest acid?

Options:

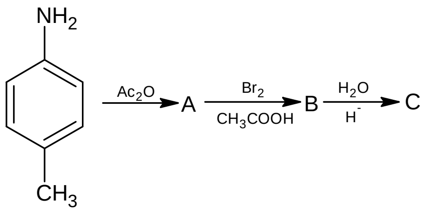
(a) CF_3COOH (b) CBr_3COOH (c) CH_3COOH (d) CCl_3COOH

Sol: Greater the $-I$ effect of substituent more is the acidic strength. Thus order of acidic strength is

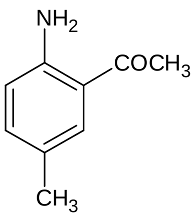
$CF_3COOH > CCl_3COOH > CBr_3COOH$

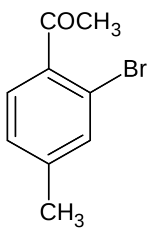
Ans: (a)

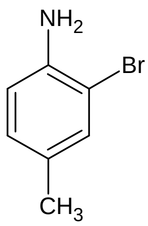
52. Identify C

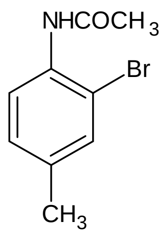


Options:

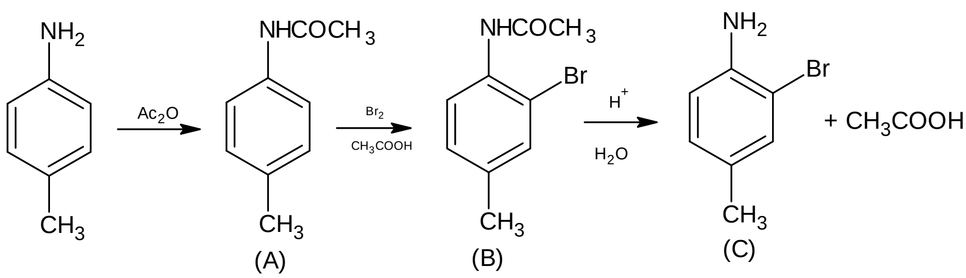
(a) 

(b) 

(c) 

(d) 

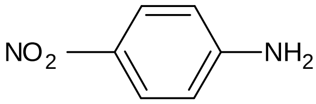
Sol:

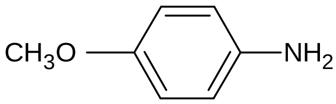


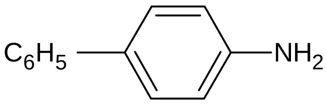
Ans: (c)

53. Which of the following is least basic?

Options:

(a) 

(b) 

(c) 

(d) All are equally basic

Sol: $-NO_2$ is a strong electron withdrawing group hence, decreases the basic strength to maximum extent.

Ans: (a)

54. Which amine amongst the following will positively answer the carbylamines test (i.e., heating with $CHCl_3$ and KOH)?

Options:

(a) $C_6H_5-NH-CH_3$ (b) $CH_3-C_6H_4-NH_2$

(c) $C_6H_5-NH-C_4H_9$ (d) $C_6H_5-N(C_2H_5)_2$

Sol: Only primary amines give carbylamines test

Ans: (b)

55. Which one of the following is an essential amino acid?

Options:

(a) Lysine (b) Tyrosine (c) Proline (d) Glycine

Sol: Lysine is an essential amino acid

Ans: (a)

56. Which of the following is a non-reducing sugar?

Options:

(a) Galactose (b) Glucose (c) Fructose (d) Sucrose

Sol: Sucrose is a non-reducing sugar

Ans: (d)

57. In DNA, the complementary bases are

Options:

(a) Uracil and adenine: cytosine and guanine

(b) Adenine and thymine: guanine and cytosine

(c) Adenine and thymine: Guanine and uracil

(d) Adenine and guanine: thymine and cytosine

Sol: In DNA complementary bases are adenine & thymine $(A=T)$, guanine and cytosine $(G\equiv C)$

Ans: (b)

58. Which of the following is least stable?

Options:

(a) $CH_3-CH_2-\overset{+}{C}H_2$ (b) $CH_3-\overset{+}{C}H-CH_2-CH_3$

(c) $CH_3-\overset{+}{C}(CH_3)-CH_3$ (d) $(CH_3)_3C-\overset{+}{C}H-C_6H_5$

Sol: $1°$ carbocations is least stable because of lower $+I$ effect.

Ans: (a)

59. Tetrabromoethane on treatment with alcoholic zinc gives

Options:

(a) Ethyl bromide (b) Ethane (c) Ethene (d) Ethyne

Sol:

$$H-\underset{Br}{\overset{Br}{C}}-\underset{Br}{\overset{Br}{C}}-H + 2\,Zn \xrightarrow{C_2H_5OH} \underset{\text{Ethyne}}{CH\equiv CH} + 2ZnBr_2$$

Ans: (d)

60. Identify the name of the reaction which is not correctly matched with the reaction

Options:

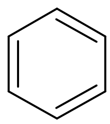
(a) $CH_3CH_2CH_2CH_3 \xrightarrow{Anhy.AlCl_3/HCl} CH_3CH(CH_3)CH_3$ Isomerization

(b) $CH_4+O_2 \xrightarrow{Mo_2O_3\ \Delta} HCHO+H_2O$ Controlled oxidation

(c) $CH_4+Cl_2 \longrightarrow CH_3Cl+HCl$ Chlorination

(d) $C_6H_{14} \xrightarrow{Cr_2O_3/V_2O_5\ ,773K} \underset{Benzene}{C_6H_6}$ Isomerization

Sol:

$C_6H_{14} \xrightarrow[773\ K]{Cr_2O_3/V_2O_5}$  Aromatization

Ans: (d)

Mathematics

Multiple Choice Questions with one correct answer. A correct answer carries 1 mark. No negative mark. 60 x 1 = 60

61. If R is a relation on the set N, defined by $\{(x, y): 2x - y = 10\}$, then R is

Options:

(a) Reflexive (b) Symmetric (c) Transitive (d) None of these

Sol: Reflexive: As $20 \in N$ but $(20, 20) \notin R$.

So, it is not reflexive.

Symmetric: As $(20, 30) \in R$ but $(30, 20) \notin R$.

So, it is not symmetric.

Transitive: As $(20, 30) \in R, (30, 50) \in R$ but $(20, 50) \notin R$.

So, it is not transitive.

Ans: (d)

62. If $A = \{1, 2, 3\}$ and $B = \{2, 3, 4\}$, then which of the following relations is a function from A to B?

Options:

(a) $\{(1, 2), (2, 3), (3, 4), (2, 2)\}$ (b) $\{(1, 2), (2, 3), (1, 3)\}$

(c) $\{(1, 3), (2, 3), (3, 3)\}$ (d) $\{(1, 1), (2, 3), (3, 4)\}$

Sol: In the given options, only option (c) satisfies the condition of a function.

Ans: (c)

63. The function $f : [0, \infty) \to [0, \infty)$ defined by $f(x) = \dfrac{2x}{1 + 2x}$

Options:

(a) one-one and onto (b) one-one but not onto

(c) not one-one but onto (d) neither one-one nor onto

Sol: f is one-one: $f(x_1) = f(x_2)$

$$\Rightarrow \frac{2x_1}{1 + 2x_1} = \frac{2x_2}{1 + 2x_2} \Rightarrow x_1 + 2x_1x_2 = x_2 + 2x_1x_2 \Rightarrow x_1 = x_2$$

Also, f is not onto as 1 does not have a pre-image.

Ans: (b)

64. The domain of the real function $f(x) = \dfrac{1}{\sqrt{4 - x^2}}$ is

Options:

(a) The set of all real numbers (b) The set of all positive real numbers

(c) $(-2, 2)$ (d) $[-2, 2]$

Sol: Given, $f(x) = \dfrac{1}{\sqrt{4 - x^2}}$

For domain of $f(x)$, $4-x^2>0 \Rightarrow x^2<4 \Rightarrow -2<x<2$

$\therefore$ Domain $=(-2, 2)$

Ans: (c)

65. The value of $\frac{\cot 54°}{\tan 36°}+\frac{\tan 20°}{\cot 70°}$ is

Options:

(a) 0 (b) 2 (c) 3 (d) 1

Sol: $\frac{\cot 54°}{\tan 36°}+\frac{\tan 20°}{\cot 70°}=\frac{\cot(90°-36°)}{\tan 36°}+\frac{\tan 20°}{\cot(90°-20°)}$

$=\frac{\tan 36°}{\tan 36°}+\frac{\tan 20°}{\tan 20°}=1+1=2$

Ans: (b)

66. If $\tan\theta=\frac{1}{\sqrt{7}}$, then $\frac{(\operatorname{cosec}^2\theta-\sec^2\theta)}{(\operatorname{cosec}^2\theta+\sec^2\theta)}$ is equal to

Options:

(a) $\frac{1}{2}$ (b) $\frac{3}{4}$ (c) $\frac{5}{4}$ (d) 2

Sol: Given, $\tan\theta=\frac{1}{\sqrt{7}} \Rightarrow \cot\theta=\sqrt{7}$

$\therefore \frac{(\operatorname{cosec}^2\theta-\sec^2\theta)}{(\operatorname{cosec}^2\theta+\sec^2\theta)}=\frac{(1+\cot^2\theta-1-\tan^2\theta)}{(1+\cot^2\theta+1+\tan^2\theta)}$

$=\frac{\cot^2\theta-\tan^2\theta}{2+\cot^2\theta+\tan^2\theta}=\frac{(\sqrt{7})^2-(1/\sqrt{7})^2}{2+(\sqrt{7})^2+(1/\sqrt{7})^2}$

$=\frac{49-1}{7}\times\frac{7}{63+1}=\frac{48}{64}=\frac{3}{4}$

Ans: (b)

67. If $A=35°, B=15°$ and $C=40°$, then $\tan A\tan B+\tan B\tan C+\tan C\tan A$ is equal to

Options:

(a) 0 (b) 1 (c) 2 (d) 3

Sol: $\because \tan(A+B+C)$

$=\frac{[\tan A+\tan B+\tan C-\tan A\tan B\tan C]}{[1-\tan A\tan B-\tan B\tan C-\tan C\tan A]}$

$\Rightarrow \tan(90°)=\frac{\tan A+\tan B+\tan C-\tan A\tan B\tan C}{1-\tan A\tan B-\tan B\tan C-\tan C\tan A}$

$\therefore \tan A\tan B+\tan B\tan C+\tan C\tan A=1$

OR

$A+B=90°-C$

$\tan(A+B)=\cot C$

$\Rightarrow \dfrac{\tan A+\tan B}{1-\tan A\tan B}=\dfrac{1}{\tan C}$

$\Rightarrow \tan A\tan B+\tan B\tan C+\tan C\tan A=1$

Ans: (b)

68. The value of $\sin^{-1}\{\cos(4095°)\}$ is

Options:

(a) $-\dfrac{\pi}{3}$ (b) $\dfrac{\pi}{6}$ (c) $-\dfrac{\pi}{4}$ (d) $\dfrac{\pi}{4}$

Sol: $\cos(4095°)=\cos(45\times 90°+45°)=-\sin 45° \ =-\sin\dfrac{\pi}{4}=\sin\left(-\dfrac{\pi}{4}\right)$

$\therefore \sin^{-1}\{\cos(4095°)\}=\sin^{-1}\left\{\sin\left(-\dfrac{\pi}{4}\right)\right\}=-\dfrac{\pi}{4}$

Ans: (c)

69. If $z=\dfrac{\left(\sqrt{3}+i\right)^3(3i+4)^2}{(8+6i)^2}$, then $|z|$ is equal to

Options:

(a) 8 (b) 2 (c) 5 (d) 4

Sol: Given, $z=\dfrac{\left(\sqrt{3}+i\right)^3(3i+4)^2}{(8+6i)^2}$

Now, $|z|=\left|\dfrac{\left(\sqrt{3}+i\right)^3(3i+4)^2}{(8+6i)^2}\right|=\dfrac{\left|\left(\sqrt{3}+i\right)^3\right|\left|(3i+4)^2\right|}{\left|(8+6i)^2\right|}$ $\left[\because \left|\dfrac{z_1}{z_2}\right|=\left|\dfrac{z_1}{z_2}\right|\right]$

$=\dfrac{\left|\sqrt{3}+i\right|^3|3i+4|^2}{|8+6i|^2}$ $\left[\because \left|z^n\right|=|z|^n\right]$

$=\dfrac{\left(\sqrt{3+1}\right)^3\left(\sqrt{9+16}\right)^2}{\left(\sqrt{64+36}\right)^2}=\dfrac{(2)^3(5)^2}{(10)^2}=\dfrac{10^2\cdot 2}{(10)^2}=2$

Ans: (b)

70. If gas is being pumped into a spherical balloon at the rate of $30\text{ ft}^3/\text{min}$. Then, the rate at which the radius increases, when it reaches the value 15 ft is

Options:

(a) $\dfrac{1}{15\pi}$ ft/min (b) $\dfrac{1}{30\pi}$ ft/min (c) $\dfrac{1}{20}$ ft/min (d) $\dfrac{1}{25}$ ft/min

Sol: Let $V=\dfrac{4}{3}\pi r^3 \Rightarrow \dfrac{dV}{dt}=4\pi r^2\dfrac{dr}{dt}$

$\therefore \frac{dr}{dt} = \frac{30}{4\times\pi\times15\times15} = \frac{1}{30\pi}\text{ft/min}$ $\left[\because \frac{dV}{dt} = 30, r = 15\right]$

Ans: (b)

71. The maximum value of $f(x) = \frac{x}{4+x+x^2}$ on $[-1, 1]$ is

Options:

(a) $-\frac{1}{3}$ (b) $-\frac{1}{4}$ (c) $\frac{1}{4}$ (d) $\frac{1}{6}$

Sol: Given, $f(x) = \frac{x}{4+x+x^2}$

Let $f(x) = \frac{1}{u}$, then $u = \frac{4+x+x^2}{x} = \frac{4}{x} + 1 + x$

$\therefore \frac{du}{dx} = -\frac{4}{x^2} + 1, \frac{d^2u}{dx^2} = \frac{8}{x^3}$

For maximum or minimum, put $\frac{du}{dx} = 0$

$\Rightarrow 1 - \frac{4}{x^2} = 0 \Rightarrow x \pm 2$

$\therefore$ At $x = -2, \frac{d^2u}{dx^2} = \frac{-8}{(2)^3} < 0$ maximum

At $x = 2, \frac{d^2u}{dx^2} = 1 > 0$ minima

$\therefore$ At $x = -2$, $f(x)$ is maxima

And at $x = -2$, $f(x)$ is maxima. It is increasing function in the given interval

$\therefore$ The maximum value at $x = 1$ is $f(1) = \frac{1}{4+1+1} = \frac{1}{6}$

Ans: (d)

72. If $f(x) = \begin{cases} 0, & x = 0 \\ x-3, & x > 0 \end{cases}$, then the function $f(x)$ is

Options:

(a) Increasing when $x \geq 0$

(b) Strictly increasing when $x > 0$

(c) Strictly increasing at $x = 0$

(d) Not continuous at $x = 0$ and so it is not increasing when $x > 0$

Sol: $f'(x) = 1 > 0$, when $x > 0$.

So, $f(x)$ is strictly increasing when $x > 0$.

Ans: (b)

73. The number of permutations of the letters of the word CONSEQUENCE in which all the three E's are together is

Options:

(a) $9!3!$ (b) $\frac{9!}{2!2!}$ (c) $\frac{9!}{2!2!3!}$ (d) $\frac{9!}{2!3!}$

Sol: The letters in the word 'CONSEQUENCE' are $2C, 3E, 2N, 1O, 1Q, 1S, 1U$.

$\therefore$ Required number of permutations $=\frac{9!}{2!2!}$

Ans: (b)

74. If 3 and 4 are intercepts of a line $L \equiv 0,$ then the distance of $L \equiv 0$ from the origin is

Options:

(a) 5 units (b) 12 units (c) $\frac{5}{12}$ units (d) $\frac{12}{5}$ units

Sol: Equation of line is $\frac{x}{3}+\frac{y}{4}=1$

$\Rightarrow 4x+3y-12=0$

Now, distance from origin $=\left|\frac{4\times 0+3\times 0-12}{\sqrt{3^2+4^2}}\right|=\frac{12}{5}$ units

Ans: (d)

75. Compute the shortest distance between the circle $x^2+y^2-10x-14y-151=0$ and the point $(-7,2)$.

Options:

(a) 0 (b) 1 (c) 2 (d) 4

Sol: We have an equation of circle $x^2+y^2-10x-14y-151=0$

Let us compare this equation with $x^2+y^2+2gx+2fy+c=0$

Clearly, $g=-5,\ f=-7$ and $c=-151$

$\therefore$ Centre of circle $=(-g,-f)=(5,7)$ and radius

$=\sqrt{g^2+f^2-c}=\sqrt{25+49+151}=\sqrt{225}=15$

Now, the distance between centre and the given point $(-7,2)$

$=\sqrt{(5+7)^2+(5)^2}=\sqrt{(12)^2+25}=\sqrt{169}=13$

Clearly, the point $(-7,2)$ lies inside the circle.

$\therefore$ Shortest distance $=$ Radius $-$ Distance between point and centre $=15-13=2$

Ans: (c)

76. If a line in the space makes angles α, β and γ with the coordinate axes, then

$\cos 2\alpha+\cos 2\beta+\cos 2\gamma+\sin^2\alpha+\sin^2\beta+\sin^2\gamma$ equals

Options:

(a) -1 (b) 0 (c) 1 (d) 2

Sol: Given, $\cos 2\alpha + \cos 2\beta + \cos 2\gamma + \sin^2 \alpha + \sin^2 \beta + \sin^2 \gamma$

$= \left(\cos^2 \alpha - \sin^2 \alpha\right) + \left(\cos^2 \beta - \sin^2 \beta\right) + \left(\cos^2 \gamma - \sin^2 \gamma + \sin^2 \alpha + \sin^2 \beta + \sin^2 \gamma\right)$

$= \cos^2 \alpha + \cos^2 \beta + \cos^2 \gamma = 1$

Ans: (c)

77. The foot of the perpendicular from $(2, 4, -1)$ to the line $x+5 = \frac{1}{4}(y+3) = -\frac{1}{9}(z-6)$ is

Options:

(a) $(-4, 1, -3)$ (b) $(4, -1, -3)$ (c) $(-4, -1, 3)$ (d) $(-4, -1, -3)$

Sol: In given options, only option (a) satisfies the given equation of line.

Ans: (a)

78. Given, $p = 3\hat{i} + 2\hat{j} + 4\hat{k}, a = \hat{i} + \hat{j}, b = \hat{j} + \hat{k}, c = \hat{i} + \hat{k}$ and $p = xa + yb + zc$, then x, y and z are respectively,

Options:

(a) $\frac{3}{2}, \frac{1}{2}, \frac{5}{2}$ (b) $\frac{1}{2}, \frac{3}{2}, \frac{5}{2}$ (c) $\frac{5}{2}, \frac{3}{2}, \frac{1}{2}$ (d) $\frac{1}{2}, \frac{5}{2}, \frac{3}{2}$

Sol: $p = xa + yb + zc$

$\Rightarrow 3\hat{i} + 2\hat{j} + 4\hat{k} = x\left(\hat{i} + \hat{j}\right) + y\left(\hat{j} + \hat{k}\right) + z\left(\hat{i} + \hat{k}\right)$

$\Rightarrow 3\hat{i} + 2\hat{j} + 4\hat{k} = (x+z)\hat{i} + (x+y)\hat{j} + (y+z)\hat{k}$

On comparing both sides the coefficients of $\hat{i}, \hat{j}, \hat{k}$, we get

$x + z = 3$ … (i)

$x + y = 2$ … (ii)

And $y + z = 4$ ... (iii)

On solving equation (i), (ii) and (iii), we get

$x = \frac{1}{2}, y = \frac{3}{2}$, and $z = \frac{5}{2}$

Ans: (b)

79. If $\hat{i} + \hat{j}, \hat{j} + \hat{k}$ and $\hat{i} + \hat{k}$ are the position vectors of the vertices of a ΔABC taken in order, then $\angle A$ is equal to

Options:

(a) $\frac{\pi}{2}$ (b) $\frac{\pi}{5}$ (c) $\frac{\pi}{6}$ (d) $\frac{\pi}{3}$

Sol: Let position vector of the vertices be $OA = \hat{i} + \hat{j}, OB = \hat{j} + \hat{k}$ and $OC = \hat{i} + \hat{k}$

Now, $AB = -\hat{i} + \hat{k}$ and $AC = \hat{k} - \hat{j}$

$\therefore \cos\theta = \frac{(AB)\cdot(AC)}{|AB||AC|} = \frac{\left(-\hat{i} + \hat{k}\right)\cdot\left(\hat{k} - \hat{j}\right)}{\sqrt{1^2 + 1^2}\sqrt{1^2 + 1^2}}$

$$=\frac{(1)}{\sqrt{2}\sqrt{2}}=\frac{1}{2}\Rightarrow\theta=\frac{\pi}{3}$$

Ans: (d)

80. $|a|=|b|=5$ and the angle between a and b is $\frac{\pi}{4}$. The area of the triangle constructed on the vectors $a-2b$ and $3a+2b$ is

Options:

(a) 50 (b) $50\sqrt{2}$ (c) $\frac{50}{\sqrt{2}}$ (d) 100

Sol: We have, $|a|=|b|=5$ and angle between a and b is $\frac{\pi}{4}$.

Now, area of the triangle constructed on the vectors is given by

$$=\frac{1}{2}|(a-2b)\times(3a+2b)|$$

$$=\frac{1}{2}|3(a\times a)+2(a\times b)-6(b\times a)-4(b\times b)|$$

$$=\frac{1}{2}|2(a\times b)+6(a\times b)| \qquad [\because a\times a=b\times b=0 \text{ and } a\times b=-b\times a]$$

$$=\frac{1}{2}|8(a\times b)|=\frac{8}{2}|a\times b|$$

$$=4|a||b|\left|\sin\frac{\pi}{4}\right|=4\cdot5\cdot5\cdot\frac{1}{\sqrt{2}}=2\sqrt{2}\times5\times5=50\sqrt{2} \text{ square units}$$

Ans: (b)

81. $\lim_{x\to\infty}\left(\frac{x^3}{3x^2-4}-\frac{x^2}{3x+2}\right)$ is equal to

Options:

(a) $-\frac{1}{4}$ (b) $-\frac{1}{2}$ (c) 0 (d) $\frac{2}{9}$

Sol:

$$\lim_{x\to\infty}\left(\frac{x^3}{3x^2-4}-\frac{x^2}{3x+2}\right)$$

$$=\lim_{x\to\infty}\frac{x^3(3x+2)-x^2(3x^2-4)}{(3x^2-4)(3x+2)}$$

$$=\lim_{x\to\infty}\frac{2x^3+4x^2}{9x^3+6x^2-12x-8}$$

$$=\lim_{x\to\infty}\frac{2+4/x}{9+6/x-12/x^2-8/x^3}=\frac{2}{9}$$

Ans: (d)

82. $\lim_{x\to 0}\frac{a^x+a^{-x}-2}{x^2}$ is equal to

Options:

(a) $(\log a)^2$ (b) $\log a$ (c) 0 (d) none of these

Sol: $\lim_{x\to 0}\frac{a^x+a^{-x}-2}{x^2}=\lim_{x\to 0}\frac{a^x\log a-a^{-x}\log a}{2x}$ [Using L' Hopital's rule]

$=\lim_{x\to 0}\frac{a^x(\log a)^2+a^{-x}(\log a)^2}{2}=(\log a)^2$

Ans: (a)

83. The value of $\lim_{x\to 0}\frac{\sin^2 x+\cos x-1}{x^2}$ is

Options:

(a) 1 (b) $\frac{1}{2}$ (c) $-\frac{1}{2}$ (d) 0

Sol: $\lim_{x\to 0}\frac{\sin^2 x+\cos x-1}{x^2}=\lim_{x\to 0}\frac{\cos x-\cos^2 x}{x^2}$

$=\lim_{x\to 0}\cos x.\frac{1-\cos x}{x^2}=1.\frac{1}{2}=\frac{1}{2}$

Ans: (b)

84. If $f(x)=\begin{cases}\frac{3\sin\pi x}{5x}, & x\neq 0\\ 2k, & x=0\end{cases}$ is continuous at $x=0$, then the value of k is

Options:

(a) $\frac{\pi}{10}$ (b) $\frac{3\pi}{10}$ (c) $\frac{3\pi}{2}$ (d) $\frac{3\pi}{5}$

Sol: Given, $f(x)=\begin{cases}\frac{3\sin\pi x}{5x}, & x\neq 0\\ 2k, & x=0\end{cases}$

Now, $\lim_{x\to 0}f(x)=\lim_{x\to 0}\left(\frac{3\sin\pi x}{5x}\right)=\frac{3}{5}\lim_{x\to 0}\left(\sin\frac{\pi x}{\pi x}\right)\times\pi=\frac{3}{5}\times 1\times\pi=\frac{3}{5}\pi$

Also, $f(0)=2k$ Since, $f(x)$ is continuous at $x=0$. $\therefore f(0)=\lim_{x\to 0}f(x)\Rightarrow 2k=\frac{3}{5}\pi\Rightarrow k=\frac{3\pi}{10}$

Ans: (b)

85. The number of points of $f(x)=|x-1|+|x-3|+\sin x,\ x\in[0,4)$, where $f(x)$ is not differentiable, is

Options:

(a) 0 (b) 1 (c) 2 (d) 3

Sol: Since, function $|x-1|$ is not differentiable at $x=1$ and function $|x-3|$ is not differentiable at $x=3$.

Hence, $f(x)$ is not differentiable at $x=3$ and $x=1$

Ans: (c)

86. If $y = f\left(x^2+2\right)$ and $f'(3)=5$, then $\frac{dy}{dx}$ at $x=1$ is

Options:

(a) 5 (b) 25 (c) 15 (d) 10

Sol: Given, $y = f\left(x^2+2\right)$

On differentiating both sides w.r.t. x, we get

$$\frac{dy}{dx} = f'\left(x^2+2\right)\times 2x$$

On putting $x=1$, we get

$$\frac{dy}{dx} = f'\left(1^2+2\right)\times 2 = f'(3)\times 2$$

$$=5\times 2 \qquad \left[\because f'(3)=5, \text{given}\right]$$

$$=10$$

Ans: (d)

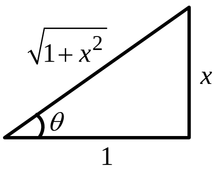
87. If $y=\sec\left(\tan^{-1}x\right)$, then $\frac{dy}{dx}$ at $x=1$ is equal to

Options:

(a) $\frac{1}{\sqrt{2}}$ (b) $\frac{1}{2}$ (c) 1 (d) $\sqrt{2}$

Sol: $y=\sec\left(\tan^{-1}x\right)$

Let $\tan^{-1}x=\theta \Rightarrow x=\tan\theta$



$\therefore y=\sec\theta=\sqrt{1+x^2}$

$$\frac{dy}{dx}=\frac{1}{2\sqrt{1+x^2}}\cdot 2x \Rightarrow \left(\frac{dy}{dx}\right)_{x=1}=\frac{1}{\sqrt{2}}$$

Ans: (a)

88. If $y=e^{ax}\sin bx$, then $\frac{d^2y}{dx^2}-2a\frac{dy}{dx}+a^2y$ is equal to

Options:

(a) 0 (b) 1 (c) $-b^2y$ (d) $-by$

Sol: Given, $y=e^{ax}\sin bx \qquad \ldots$ (i)

$$\Rightarrow \frac{dy}{dx}=ae^{ax}\sin bx+be^{ax}\cos bx$$

$$\Rightarrow \frac{dy}{dx}=ay+be^{ax}\cos bx \qquad \ldots \text{(ii)}$$

$$\Rightarrow \frac{d^2y}{dx^2}=a\frac{dy}{dx}+abe^{ax}\cos bx-e^{ax}b^2\sin bx$$

$$\Rightarrow \frac{a^2y}{dx^2} = a\frac{dy}{dx} + a\left(\frac{dy}{dx} - ay\right) - b^2y$$

[From Equation (i) and (ii)]

$$\Rightarrow \frac{d^2y}{dx^2} - 2a\frac{dy}{dx} + a^2y = -b^2y$$

Ans: (c)

89. $\frac{d}{dx}\left[\log_e e^{\sin\left(x^2\right)}\right]$ is equal to

Options:

(a) $2\cos\left(x^2\right)$ (b) $2\cos x$ (c) $2x\cdot\cos x$ (d) $2x\cos\left(x^2\right)$

Sol: $\frac{d}{dx}\left[\log_e e^{\sin\left(x^2\right)}\right] = \frac{d}{dx}\left[\sin\left(x^2\right)\right] = \cos\left(x^2\right)2x$

Ans: (d)

90. Five persons A, B, C, D and E are in queue of a shop. The probability that A and E are always together, is

Options:

(a) $\frac{1}{4}$ (b) $\frac{2}{3}$ (c) $\frac{2}{5}$ (d) $\frac{3}{5}$

Sol: Total number of ways $= 5!$

And favourable number of ways $= 2\cdot 4!$

$\therefore$ Required probability $= \frac{2\cdot 4!}{5!} = \frac{2}{5}$

Ans: (c)

91. The probability of choosing randomly a number c from the set $\{1, 2, 3, \ldots, 9\}$ such that the quadratic equation $x^2 + 4x + c = 0$ has real roots, is

Options:

(a) $\frac{1}{9}$ (b) $\frac{2}{9}$ (c) $\frac{3}{9}$ (d) $\frac{4}{9}$

Sol: Given, $x^2 + 4x + c = 0$

For real roots, $D = b^2 - 4ac \geq 0 = 16 - 4c \geq 0$

So, $c = 1, 2, 3, 4$ will satisfy the above inequality.

$\therefore$ Required probability $= \frac{4}{9}$

Ans: (d)

92. If four persons independently solve a certain problem correctly with probabilities $\frac{1}{2}, \frac{3}{4}, \frac{1}{4}$ and $\frac{1}{8}$. Then, the probability that the problem is solved correctly by atleast one of them, is

Options:

(a) $\frac{235}{256}$ (b) $\frac{21}{256}$ (c) $\frac{3}{256}$ (d) $\frac{253}{256}$

Sol: Required problem $= 1 - P(\text{none solves the problem})$

$= 1 - \left\{\frac{1}{2} \times \frac{1}{4} \times \frac{3}{4} \times \frac{7}{8}\right\} = 1 - \frac{21}{256} = \frac{235}{256}$

Ans: (a)

93. An urn contains 3 red and 5 blue balls. The probability that two balls are drawn in which 2^{nd} ball drawn is blue without replacement is

Options:

(a) $\frac{5}{16}$ (b) $\frac{5}{56}$ (c) $\frac{5}{8}$ (d) $\frac{20}{56}$

Sol: Required probability $= P$ (Ist is red and IInd is blue) $+ P$ (Ist is blue and IInd is also blue)

$= \frac{3}{8} \times \frac{5}{7} + \frac{5}{8} \times \frac{4}{7} = \frac{5}{8}$

Ans: (c)

94. The set of values of x satisfying $3(2-x) \geq 2(1-x)$

Options:

(a) $\{x : x \in R, x \leq 4\}$ (b) $\{x : x \in R, x < 4\}$ (c) $\{x : x \in R, x \geq 4\}$ (d) none of these

Sol: $3(2-x) \geq 2(1-x) \Rightarrow 6 - 3x \geq 2 - 2x \quad \Rightarrow -x \geq -4 \Rightarrow x \leq 4$

Ans: (a)

95. If given constraints are $5x + 4y \geq 2$, $x \leq 6$ and $y \leq 7$, then the maximum value of the function $z = x + 2y$ is

Options:

(a) 13 (b) 14 (c) 15 (d) 20

Sol: Feasible region is $ABCDEA$ and $z = x + 2y$.

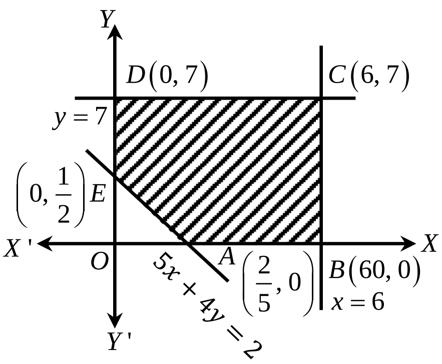
At point $A\left(\frac{2}{5}, 0\right)$, $z = \frac{2}{3} + 0 = \frac{2}{5}$

At point $B(6, 0)$, $z = 6 + 0 = 6$

At point $C(6, 7)$, $z = 6 + 14 = 20$

At point $D(0, 7)$, $z = 0 + 2(7) = 14$

At point $E\left(0, \frac{1}{2}\right)$, $x = 0 + 2\left(\frac{1}{2}\right) = 1$



Hence, maximum value of z is 20.

Ans: (d)

96. If $A=\begin{bmatrix} 3 & x-1 \\ 2x+3 & x+2 \end{bmatrix}$ is a symmetric matrix, then the value of x is

Options:

(a) 4 (b) 3 (c) -4 (d) -3

Sol: We have $A=\begin{bmatrix} 3 & x-1 \\ 2x+3 & x+2 \end{bmatrix}$ is a symmetric matrix,

i.e., $A^T = A$

$\Rightarrow \begin{bmatrix} 3 & 2x+3 \\ x-1 & x+2 \end{bmatrix} = \begin{bmatrix} 3 & x-1 \\ 2x+3 & x+2 \end{bmatrix} \Rightarrow 2x+3 = x-1$

$x=-4$

Ans: (c)

97. If $U=[2-3\ \ 4]$, $X=[0\ \ 2\ \ 3]$, $V=\begin{bmatrix} 3 \\ 2 \\ 1 \end{bmatrix}$ and $Y=\begin{bmatrix} 2 \\ 2 \\ 4 \end{bmatrix}$ then $UV+XY$ is equal to

Options:

(a) $[20]$ (b) 20 (c) $[-20]$ (d) -20

Sol: $UV+XY=[2\ \ -3\ \ 4]\begin{bmatrix} 3 \\ 2 \\ 1 \end{bmatrix}+[0\ \ 2\ \ 3]\begin{bmatrix} 2 \\ 2 \\ 4 \end{bmatrix}$

$=[6-6+4]+[0+4+12]=[4]+[16]=[20]$

Ans: (a)

98. $\int (x+1)(x+2)^7(x+3)\,dx$ is equal to

Options:

(a) $\frac{(x+2)^{10}}{10}-\frac{(x+2)^8}{8}+C$ (b) $\frac{(x+1)^2}{2}-\frac{(x+2)^8}{8}-\frac{(x+3)^2}{2}+C$

(c) $\frac{(x+2)^{10}}{10}+C$ (d) $\frac{(x+2)^9}{9}-\frac{(x+2)^7}{7}+C$

Sol: $\int (x+1)(x+2)^7(x+3)\,dx$

Let $(x+1)(x+3)=(x+2-1)(x+2+1)=(x+2)^2-1$

$\therefore \int (x+1)(x+2)^7(x+3)\,dx=\int\left\{(x+2)^9-(x+2)^7\right\}dx$

$=\frac{(x+2)^{10}}{10}-\frac{(x+2)^8}{8}+C$

Ans: (a)

99. $\int \frac{2dx}{\left(e^x+e^{-x}\right)^2}$ is equal to

Options:

(a) $\frac{-e^x}{e^{-x}+e^x}+C$ (b) $\frac{e^x}{x+1}+C$ (c) $\frac{xe^x}{x+1}+C$ (d) $e^x\left(\frac{x-1}{x+1}\right)+C$

Sol: Let $I=\int \frac{2dx}{\left(e^x+e^{-x}\right)^2}=\int \frac{2dx}{e^{2x}+e^{-2x}+2}=\int \frac{2e^{2x}dx}{\left(e^{2x}\right)^2+2e^{2x}+1}$

Put $e^{2x}=t \Rightarrow 2e^{2x}dx=dt$

$\therefore I=\int \frac{dt}{t^2+2t+1}=\int \frac{dt}{(t+1)^2}$

$=\frac{-1}{1+t}+C=\frac{-1}{1+e^{2x}}+C=\frac{-e^{-x}}{e^{-x}+e^x}+C$

Ans: (a)

100. $\int \frac{e^x}{\left(2+e^x\right)\left(e^x+1\right)}dx$ is equal to

Options:

(a) $\log\left(\frac{e^x+1}{e^x+2}\right)+C$ (b) $\log\left(\frac{e^x+2}{e^x+1}\right)+C$ (c) $\left(\frac{e^x+1}{e^x+2}\right)+C$ (d) $\left(\frac{e^x+2}{e^x+1}\right)+C$

Sol: Let $I=\int \frac{e^x}{\left(2+e^x\right)\left(e^x+1\right)}dx$

Putting $e^x=t \Rightarrow e^x dx=dt$

$\Rightarrow I=\int \frac{dt}{(2+t)(t+1)}=\int\left[\frac{1}{(1+t)}-\frac{1}{(2+t)}\right]dt$

$=\log(1+t)-\log(2+t)+C=\log\left(\frac{1+t}{2+t}\right)+C=\log\left(\frac{1+e^x}{2+e^x}\right)+C$

Ans: (a)

101. The value of $\int_0^1 \frac{x^4+1}{x^2+1}dx$ is

Options:

(a) $\frac{1}{6}(3-4\pi)$ (b) $\frac{1}{6}(3\pi+4)$ (c) $\frac{1}{6}(3+4\pi)$ (d) $\frac{1}{6}(3\pi-4)$

Sol: $\int_0^1 \frac{x^4+1}{x^2+1}dx=\int_0^1 \frac{x^4-1+2}{x^2+1}dx=\int_0^1\left[\frac{x^4-1}{x^2+1}+\frac{2}{x^2+1}\right]dx$

$=\int_0^1\left(x^2-1+\frac{2}{x^2+1}\right)dx=\left[\frac{x^3}{3}-x+2\tan^{-1}x\right]_0^1$

$$=\left[\frac{1}{3}-1+2\tan^{-1}(1)-0\right]=-\frac{2}{3}+2\cdot\frac{\pi}{4}=\frac{3\pi-4}{6}$$

Ans: (d)

102.If $f(x)=\begin{cases}2x^2+1, & x\le 1\\ 4x^3-1, & x>1\end{cases}$, then $\int_0^2 f(x)\,dx$ is equal to

Options:

(a) $\frac{47}{3}$ (b) $\frac{50}{3}$ (c) $\frac{1}{3}$ (d) $\frac{47}{2}$

Sol: Given, $f(x)=\begin{cases}2x^2+1, & x\le 1\\ 4x^3-1, & x>1\end{cases}$

$$\therefore \int_0^2 f(x)\,dx=\int_0^1 f(x)\,dx+\int_1^2 f(x)\,dx$$

$$=\int_0^1\left(2x^2+1\right)dx+\int_1^2\left(4x^3-1\right)dx$$

$$=\left[\frac{2x^3}{3}+x\right]_0^1+\left[\frac{4x^4}{4}-x\right]_1^2$$

$$=\frac{2}{3}(1)^3+1-(0+0)+\left[(2)^4-2-\left\{(1)^4-1\right\}\right]$$

$$=\frac{2}{3}+1+[16-2-0]=\frac{2}{3}+15=\frac{2+45}{3}=\frac{47}{3}$$

Ans: (a)

103.The solution of the differential equation $x\frac{dy}{dx}+y=x\cos x+\sin x,$ given that $y=1$ when $x=\frac{\pi}{2},$ is

Options:

(a) $y=\sin x-\cos x$ (b) $y=\cos x$ (c) $y=\sin x$ (d) $y=\sin x+\cos x$

Sol: Given differential equation can be rewritten as $\frac{dy}{dx}+\frac{y}{x}=\cos x+\frac{\sin x}{x}$

Here, $P=\frac{1}{x}$ and $Q=\cos x+\frac{\sin x}{x}$ $\therefore IF=e^{\int\frac{1}{x}dx}=e^{\log x}=x$

Hence, required solution is $xy=\int(x\cos x+\sin x)\,dx \Rightarrow xy=x\sin x+C$

At $y=1, x=\frac{\pi}{2}\Rightarrow C=0$ $\therefore y=\sin x$

Ans: (c)

104.The slope at any point of a curve $y=f(x)$ is given by $\frac{dy}{dx}=3x^2$ and it passes through $(-1,1)$. The equation of the curve is

Options:

(a) $y=x^3+2$ (b) $y=-x^3-2$ (c) $y=3x^3+4$ (d) $y=-x^3+2$

Sol: Given, $\frac{dy}{dx}=3x^2 \Rightarrow dy=3x^2dx$

On integrating both sides, we get $y=\frac{3x^3}{3}+C \Rightarrow y=x^3+C$

Since, it passes through the point $(-1,1)$.

$\therefore 1=(-1)^3+C \Rightarrow C=2$ Hence, $y=x^3+2$

Ans: (a)

105.The interesting factor of the differential equation $\cos x\frac{dy}{dx}+y\sin x=1$, is

(a) $\sin x$ (b) $\sec x$ (c) $\tan x$ (d) $\cos x$

Sol: The given differential equation is

$\frac{dy}{dx}+\tan x\, dx=\sec x$

$I.F=e^{\int \tan x dx}=e^{\log(\sec x)}=\sec x$

Ans: (b)

106.Consider an infinite geometric series with first term $'a'$ and common ratio $'r'$. If the sum 4 and the second term is $\frac{3}{4}$, then

(a) $a=2, r=\frac{3}{8}$ (b) $a=\frac{4}{7}, r=\frac{3}{7}$ (c) $a=\frac{3}{2}, r=\frac{1}{2}$ (d) $a=3, r=\frac{1}{4}$

Sol: By data, $ar=\frac{3}{4}$ and $S_\infty=4 \Rightarrow \frac{a}{1-r}=4$

$\Rightarrow a=4-4\left(\frac{3}{4a}\right) \quad \left(\because ar=\frac{3}{4}\right)$

$\Rightarrow a^2-4a+3=0$

$\Rightarrow (a-3)(a-1)=0$

$\Rightarrow a=3 \text{ or } a=1$

Now, $a=3 \Rightarrow r=\frac{1}{4}$ and $a=1 \Rightarrow r=\frac{3}{4}$.

Ans: (d)

107.The angle between the lines $2x=3y=-z$ and $6x=-y=-4z$ is

(a) $0°$ (b) $45°$ (c) $90°$ (d) $30°$

Sol:

Given lines are, $\frac{x}{(1/2)}=\frac{y}{(1/3)}=\frac{z}{-1}$ and $\frac{x}{(1/6)}=\frac{y}{-1}=\frac{z}{(-1/4)}$

Consider, $\left(\frac{1}{2}\right)\left(\frac{1}{6}\right)+\left(\frac{1}{3}\right)(-1)+(-1)\left(-\frac{1}{4}\right)=\frac{1}{12}-\frac{1}{3}+\frac{1}{4}=\frac{1-4+3}{1}=0$

This angle between the lines $=90°$.

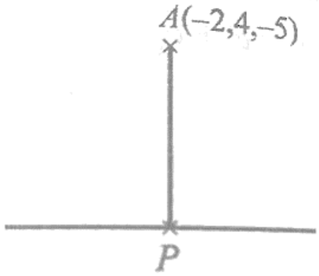
Ans: (c)

108. The distance of the point $(-2,4,-5)$ from the line $\frac{x+3}{3}=\frac{y-4}{5}=\frac{z+8}{6}$ is

(a) $\frac{\sqrt{37}}{10}$ (b) $\sqrt{\frac{37}{10}}$ (c) $\frac{37}{\sqrt{10}}$ (d) $\frac{37}{10}$

Sol: $A=(-2,4,-5); \frac{x+3}{3}=\frac{y-4}{5}=\frac{z+8}{6}=\lambda$

Let, $P=(3\lambda-3,\ 5\lambda+4,\ 6\lambda-8)$ be the foot of the perpendicular drawn from A onto the line.



D.r's of A.P: $3\lambda-1, 5\lambda, 6\lambda-3$. A.P is perpendicular to the lines

$\Rightarrow 3(3\lambda-1)+5(5\lambda)+6(6\lambda-3)=0 \Rightarrow \lambda=\frac{3}{10}$.

D.r's of AP are $-\frac{1}{10},\frac{3}{2},-\frac{6}{5} \quad \Rightarrow \quad \overrightarrow{AP}=\left(-\frac{1}{10},\frac{3}{2},-\frac{6}{5}\right)$

Required length $=\left|\overrightarrow{AP}\right|=\sqrt{\frac{1}{100}+\frac{9}{4}+\frac{36}{25}}=\sqrt{\frac{1+225+144}{100}}=\sqrt{\frac{370}{100}}=\sqrt{\frac{37}{10}}$.

Ans: (b)

109. A straight line passes through the points $(5,0)$ and $(0,3)$. The length of perpendicular to the point $(4,4)$ on the line is

(a) $\frac{15}{\sqrt{34}}$ (b) $\frac{\sqrt{17}}{2}$ (c) $\frac{17}{2}$ (d) $\sqrt{\frac{17}{2}}$

Sol: Equation of the line throught $(5,0)$ and $(0,3)$ is $\frac{y-0}{x-5}=\frac{3-0}{0-5} \quad \Rightarrow -5y=3x-15 \quad \Rightarrow 3x+5y-15=0$

Now, perpendicular distance from $(4,4)$ is given by $d=\left|\frac{12+20-15}{\sqrt{9+25}}\right|=\left|\frac{17}{\sqrt{34}}\right|=\sqrt{\frac{17}{2}}$

Ans: (d)

110. The eccentricity of the ellipse $\frac{x^2}{36}+\frac{y^2}{16}=1$

(a) $\frac{2\sqrt{5}}{6}$ (b) $\frac{2\sqrt{5}}{4}$ (c) $\frac{2\sqrt{13}}{6}$ (d) $\frac{2\sqrt{13}}{4}$

Sol: $l=\sqrt{\frac{a^2-b^2}{a^2}}=\sqrt{\frac{36-16}{36}}=\frac{2\sqrt{5}}{6}$.

Ans: (a)

111. The number of terms in the expansion of $\left(x^2+y^2\right)^{25}-\left(x^2-y^2\right)^{25}$ after simplification is

(a) 0 (b) 13 (c) 26 (d) 50

Sol: The number of terms in the expansion of $(x+a)^n-(x-a)^n$ is $\frac{n}{2}$ if n is even, and is $\frac{n+1}{2}$ if n is odd.

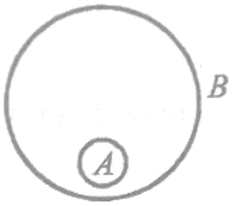
Here $n=25$. Thus the number of terms $=\frac{25+1}{2}=13$.

Ans: (b)

112.If A and B are finite sets and $A \subset B$, then

(a) $n(A \cup B) = n(A)$ (b) $n(A \cap B) = n(B)$ (c) $n(A \cup B) = n(B)$ (d) $n(A \cap B) = \phi$

Sol: Clearly $n(A \cup B) = n(B)$.



Ans: (c)

113.If $\vec{a}, \vec{b}, \vec{c}$ are unit vectors such that $\vec{a} + \vec{b} + \vec{c} = \vec{0}$, then the value of is equal to $\vec{a} \cdot \vec{b} + \vec{b} \cdot \vec{c} + + \vec{c} \cdot \vec{a}$

(a) 1 (b) 3 (c) $-\frac{3}{2}$ (d) $\frac{3}{2}$

Sol: Standard problem; $Ans \quad is \quad -\frac{3}{2}$.

OR $\left|\vec{a} + \vec{b} + \vec{c}\right| = \left|\vec{a}\right|^2 + \left|\vec{b}\right|^2 + \left|\vec{c}\right|^2 + 2\left(\vec{a} \cdot \vec{b} + \vec{b} \cdot \vec{c} + \vec{c} \cdot \vec{a}\right)$

$\Rightarrow \quad 0 = 3 + 2\left(\vec{a} \cdot \vec{b} + \vec{b} \cdot \vec{c} + \vec{c} \cdot \vec{a}\right) \quad \Rightarrow \vec{a} \cdot \vec{b} + \vec{b} \cdot \vec{c} + \vec{c} \cdot \vec{a} = -\frac{3}{2}.$

Ans: (c)

114.The value of integral $\int_{-\pi/4}^{\pi/4} \log(\sec\theta - \tan\theta)\, d\theta$ is

(a) 0 (b) $\frac{\pi}{4}$ (c) π (d) $\frac{\pi}{2}$

Sol: We have, $I = \int_{-\pi/4}^{\pi/4} \log(\sec\theta - \tan\theta)\, d\theta$

Use the result, $I = \int_{-\pi/4}^{\pi/4} \left[\log(\sec\theta - \tan\theta) + \log(\sec\theta + \tan\theta)\right] d\theta$

$= \int_{-\pi/4}^{\pi/4} \log\left(\sec^2\theta - \tan^2\theta\right) d\theta \qquad \int_{-\pi/4}^{\pi/4} 0\, d\theta = 0 \qquad \left(\because \sec^2\theta - \tan^2\theta = 1\right)$

Ans: (a)

115. $\int e^{\sin x} \cdot \left(\frac{\sin x + 1}{\sec x}\right) dx$ is equal to

(a) $\sin x \cdot e^{\sin x} + c$ (b) $\cos x \cdot e^{\sin x} + c$ (c) $e^{\sin x} + c$ (d) $e^{\sin x}(\sin x + 1) + c$

Sol:

$I = \int e^{\sin x} \cdot (1 + \sin x) \cos x dx$, put $\sin x = t \Rightarrow \cos x\, dx = dt$

$I = \int (1+t) e^t dt = (1+t)e^t - 1 \cdot e^t = t \cdot e^t = \sin x \cdot e^{\sin x} + c$

Ans: (a)

116.If $y=\left(\tan^{-1}x\right)^2$, then $\left(x^2+1\right)^2 y_2+2x\left(x^2+1\right)y_1$ is equal to

(a) 4 (b) 0 (c) 2 (d) 1

Sol: We have $y=\left(\tan^{-1}x\right)^2$ $\Rightarrow y_1=2\left(\tan^{-1}x\right)\cdot\frac{1}{1+x^2}$

$\Rightarrow$ $\left(1+x^2\right)y_1=2\tan^{-1}x \Rightarrow \left(1+x^2\right)y_2+2xy_1=2\frac{1}{1+x^2}$ $\Rightarrow \left(1+x^2\right)^2 y_2+2x\left(x^2+1\right)y_1=2$

Ans: (c)

117.The value of $\sin\left(2\sin^{-1}0.8\right)$ is equal to

(a) 0.48 (b) $\sin 1.2°$ (c) $\sin 1.6°$ (d) 0.96

Sol: Now, $0.8=\frac{4}{5}$, let $\sin^{-1}\frac{4}{5}=\theta$ $\Rightarrow \cos^{-1}\frac{3}{5}=\theta$; $\sin(2\theta)=2\sin\theta\cdot\cos\theta=2\times\frac{4}{5}\times\frac{3}{5}=0.96$

Ans: (d)

118.The symmetric part of the matrix $A=\begin{pmatrix}1&2&4\\6&8&2\\2&-2&7\end{pmatrix}$

(a) $\begin{pmatrix}0&-2&-1\\-2&0&-2\\-1&-2&0\end{pmatrix}$ (b) $\begin{pmatrix}1&4&3\\2&8&0\\3&0&7\end{pmatrix}$ (c) $\begin{pmatrix}0&-2&1\\2&0&2\\-1&2&0\end{pmatrix}$ (d) $\begin{pmatrix}1&4&3\\4&8&0\\3&0&7\end{pmatrix}$

Sol: Symmetric part of A is $\frac{A+A'}{2}=\begin{pmatrix}1&4&3\\4&8&0\\3&0&7\end{pmatrix}$

Ans: (d)

119.If A is a matrix of order 3, such that $A(adjA)=10I$, then $|adj\ A|=$

(a) 1 (b) 10 (c) 100 (d) 101

Sol: We have, $A\cdot(adj\ A)|A|\cdot I$. Thus, $|A|=10$.

Now, $|adj\ A|=|A|^{n-1}$. $\therefore$ $|adj\ A|=10^{3-1}=100$ $(\because\ n=3)$

Ans: (c)

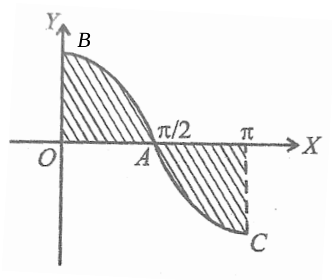
120.Area of region bounded by the curve $y=\cos x, x=0$ and $x=\pi$ is

(a) 2 sq.units (b) 4 sq.units (c) 3 sq.units (d) 1 sq.units

Sol:

Required area $=2$ Area $OAB=2\int_0^{\pi/2}\cos x\,dx$

$=2[\sin x]_0^{\pi/2}=2$ sq.units



Ans: (a)

Physics

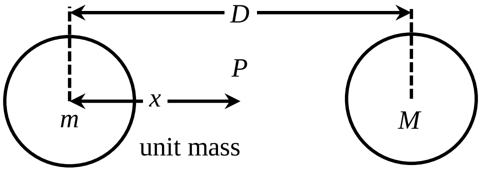
Multiple Choice Questions with one correct answer. A correct answer carries 1 mark. No negative mark. 60 x 1 = 60

121. The distance of the centres of moon and earth is D. The mass of earth is 81 times the mass of the moon. At what distance from the centre of the earth, the gravitational force will be zero?

(a) $\frac{D}{2}$ (b) $\frac{2D}{3}$ (c) $\frac{4D}{3}$ (d) $\frac{D}{10}$

Sol: Force will be zero at the point P, then $F_1 = F_2$ where,

$F_1 = \frac{Gm \cdot 1}{x^2}$ and $F_2 = \frac{GM \cdot 1}{(D-x)^2}$



and $F_1 = F_2$, so $\Rightarrow \frac{Gm}{x^2} = \frac{GM}{(D-x)^2}$

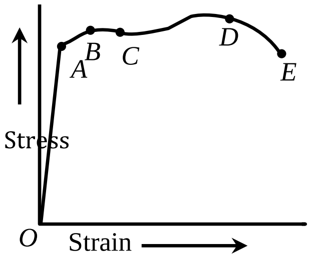
$\Rightarrow \frac{m}{x^2} = \frac{81m}{(D-x)^2}$ $[M = 81\text{ m}]$

$\Rightarrow \frac{(D-x)^2}{x^2} = 81$ $\Rightarrow D - x = 9x$

$\Rightarrow D = 10x$ $\Rightarrow \frac{D}{10} = x$

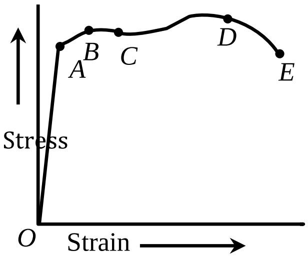
Ans: (d)

122. The stress-strain graph for a metal wire is as shown in the figure. In the graph, the region in which Hooke's law is obeyed, the ultimate strength and fracture points are represented by



(a) OA, C, D (b) OB, D, E (c) OA, D, E (d) OB, C, D

Sol: In the region OA, the graph is linear showing that stress is proportional to the strain. Thus, in this region Hooke's law is obeyed. The point D on the graph is known as ultimate tensile strength. The point E on the graph is known as fracture point.



Ans: (c)

123.During summersault, a swimmer bends his body to

(a) Increase moment of Inertia (b) Decrease moment of Inertia

(c) Decrease the angular momentum (d) Reduce the angular velocity

Sol: By bending his body, he decreases his moment of inertia. This would increase his angular velocity.

Ans: (b)

124.A large open tank has two holes in the wall. One is a square hole of side L at a depth y from the top and the other is a circular hole of radius R at a depth $4y$ from the top. When the tank is completely filled with water, the quantities of water flowing out per second from both holes are the same. Then, R is equal to

(a) $\frac{L}{\sqrt{2\pi}}$ (b) $2\pi L$ (c) L (d) $\frac{L}{2\pi}$

Sol: Equating the rate of flow, we have

$\sqrt{(2gy)} \times L^2 = \sqrt{(2g \times 4y)}\pi R^2$

[Flow $=(\text{area}) \times (\text{velocity})$, velocity $=\sqrt{2gx}$]

where $x =$ height from top

$\Rightarrow L^2 = 2\pi R^2 \Rightarrow R = \frac{L}{\sqrt{2\pi}}$

Ans: (a)

125.A clock with a metal pendulum beating seconds keeps correct time at $0°C$. If it loses $12.5s$ a day at $25°C$, the coefficient of linear expansion of metal pendulum is

(a) $\frac{1}{86400}/°C$ (b) $\frac{1}{43200}/°C$ (c) $\frac{1}{14400}/°C$ (d) $\frac{1}{28800}/°C$

Sol: Number of seconds lost in a day

$\Delta t = \frac{1}{2}\alpha \Delta\theta \times 86400$

The coefficient of linear expansion of metal pendulum

$\alpha = \frac{2\Delta t}{\Delta\theta \times 86400} = \frac{2 \times 12.5}{25 \times 86400} \quad \alpha = \frac{1}{86400}/°C$

Ans: (a)

126.The pressure is P, volume V and temperature T of a gas in jar A and the other gas in jar B is at pressure P, volume $V/4$ and temperature $2T$, then the ratio of the number of molecules in jar A and B will be

(a) $1:1$ (b) $1:2$ (c) $2:1$ (d) $8:1$

Sol: $PV = NkT \Rightarrow \frac{N_A}{N_B} = \frac{P_A V_A}{P_B V_B} \times \frac{T_B}{T_A}$

$\Rightarrow \frac{N_A}{N_B} = \frac{P \times V \times (2T)}{P \times \frac{V}{4} \times T} = \frac{8}{1}$

Ans: (d)

127.If ΔU and ΔW represent the increase in internal energy and work done by the system respectively in a thermodynamical process, which of the following is true?

(a) $\Delta U = -\Delta W$, in an adiabatic process
(b) $\Delta U = \Delta W$, in an isothermal process
(c) $\Delta U = \Delta W$, in adiabatic process
(d) $\Delta U = -\Delta W$, in an isothermal process

Sol: By first law of thermodynamics

$\Delta Q = \Delta U + \Delta W$

In adiabatic process, $\Delta Q = 0$

$\therefore \quad \Delta U = -\Delta W$

In isothermal process, $\Delta U = 0$

$\therefore \quad \Delta Q = \Delta W$

Ans: (a)

128.A particle is executing simple harmonic motion with frequency f. The frequency at which its kinetic energy change into potential energy is

(a) $\frac{f}{2}$
(b) f
(c) $2f$
(d) $4f$

Sol: In SHM frequency of KE and PE

$= 2\times$ (Frequency of oscillating particle)

Ans: (c)

129.The speed of longitudinal wave in a wire is 100 times the speed of transverse wave. If Young's modulus of the wire material is $1\times10^{11}\ \text{Nm}^{-2}$ then the stress in the wire is

(a) $1\times10^{7}\ \text{Nm}^{-2}$
(b) $1.5\times10^{7}\ \text{Nm}^{-2}$
(c) $1\times10^{11}\ \text{Nm}^{-2}$
(d) $1.5\times10^{11}\ \text{Nm}^{-2}$

Sol: $v_{\text{long}} = 100\, v_{\text{trans}}$

$\sqrt{\frac{Y}{d}} = 100\sqrt{\frac{\text{stress}}{d}}$

$\sqrt{1\times10^{11}} = 100\sqrt{\text{stress}}$

$\text{Stress} = \frac{10^{11}}{10^{4}} = 10^{7}\ \text{Nm}^{-2}$

Ans: (a)

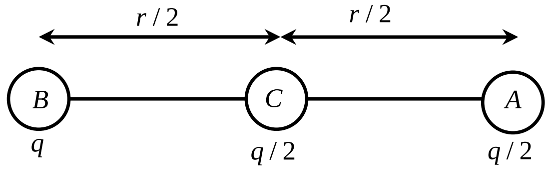
130.Two equally charged, identical metal spheres A and B repel each other with a force $'F'$. The spheres are kept fixed with a distance $'r'$ between them. A third identical, but uncharged sphere C is brought in contact with A and then placed at the mid-point of the line joining A and B. The magnitude of the net electric force on C is

(a) F
(b) $\frac{3F}{4}$
(c) $\frac{F}{2}$
(d) $\frac{F}{4}$

Sol: Initial force between the two spheres carrying charge (say q) is

$F = \frac{1}{4\pi\varepsilon_0}\frac{q^2}{r^2}$ (r is the distance between them)

Further when an uncharged sphere is kept in touch with the sphere of charge q, the net charge on both become $\frac{q+0}{2}=\frac{q}{2}$. Force on the 3rd charge, when placed in center of the 1st two



$$F_3=\frac{1}{4\pi\varepsilon_0}\frac{q\left(\frac{q}{2}\right)}{\left(\frac{r}{2}\right)^2}-\frac{1}{4\pi\varepsilon_0}\frac{\left(\frac{q}{2}\right)^2}{\left(\frac{r}{2}\right)^2}$$

$$=\frac{1}{4\pi\varepsilon_0}\frac{q^2}{r^2}[2-1]=F$$

Ans: (a)

131.If the electric flux entering and leaving an enclosed surface respectively ϕ_1 and ϕ_2 then the electric charge inside the surface will be

(a) $(\phi_1+\phi_2)\varepsilon_0$ (b) $(\phi_2-\phi_1)\varepsilon_0$ (c) $(\phi_1-\phi_2)/\varepsilon_0$ (d) $(\phi_2-\phi_1)/\varepsilon_0$

Sol: $\phi_{net}=\frac{1}{\varepsilon_0}\times Q_{net} \Rightarrow Q_{enc}=(\phi_2-\phi_1)\varepsilon_0$

Ans: (b)

132.The electrostatic force between the metal plates of an isolated parallel plate capacitor C having a charge Q and area A, is

(a) independent of the distance between the plates

(b) linearly proportional to the distance between the plates

(c) inversely proportional to the distance between the plates

(d) proportional to the square root of the distance between the plates

Sol: Electrostatic force between the metal plates

$$F_{plate}=\frac{Q^2}{2A_{\varepsilon_0}}$$

For isolated capacitor $Q=\text{constant}$

Clearly, F is independent of the distance between plates.

Ans: (a)

133.Electric lines of force about a negative point charge are

(a) Circular anticlockwise (b) Circular clockwise

(c) Radial, inwards (d) Radial, outwards

Sol: Radial, inwards

Ans: (c)

134.Equal charges are given to two spheres of different radii. The potential will be

(a) more on smaller sphere (b) more on bigger sphere

(c) equal on both sphere (d) none of these

Sol: $V=\frac{Kq}{R}$ i.e., $V\propto\frac{1}{R}$ $\Rightarrow$ Potential on smaller sphere will be more

Ans: (a)

135. Two points P and Q are maintained at the potentials of $10\,\text{V}$ and $-4\,\text{V}$, respectively. The work done in moving 100 electrons from P to Q is

(a) 9.6×10^{-17} J (b) -2.24×10^{-16} J (c) 2.24×10^{-16} J (d) -9.6×10^{-17} J

Sol: $\frac{W_{PQ}}{q} = (V_Q - V_P)$

$W_{PQ} = q(V_Q - V_P) = (-100\times1.6\times10^{-19})(-4-10)$

$= +2.24\times10^{-16}$ J

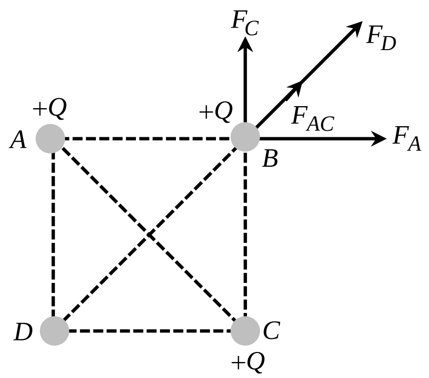
Ans: (c)

136. Equal charges q are placed at the four corners, A, B, C, D of a square of length a. The magnitude of the force on the charge at B will be

(a) $\frac{3q^2}{4\pi\varepsilon_0 a^2}$ (b) $\frac{4q^2}{4\pi\varepsilon_0 a^2}$ (c) $\left(\frac{1+2\sqrt{2}}{2}\right)\frac{q^2}{4\pi\varepsilon_0 a^2}$ (d) $\left(2+\frac{1}{\sqrt{2}}\right)\frac{q^2}{4\pi\varepsilon_0 a^2}$

Sol: $F_{\text{net}} = F_{AC} + F_D = \sqrt{F_A^2 + F_C^2} + F_D$

Since, $F_A = F_C = \frac{kq^2}{a^2}$ and $F_D = \frac{kq^2}{(a\sqrt{2})^2}$



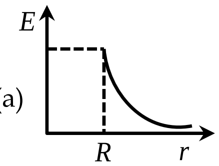
$F_{\text{net}} = \frac{\sqrt{2}kq^2}{a^2} + \frac{kq^2}{2a^2}$

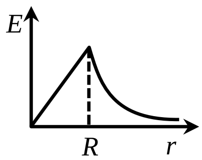
$= \frac{kq^2}{a^2}\left(\sqrt{2}+\frac{1}{2}\right)$

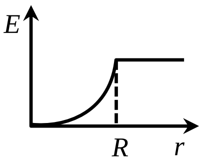
$= \frac{q^2}{4\pi\varepsilon_0 a^2}\left(\frac{1+2\sqrt{2}}{2}\right)$

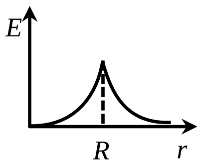
Ans: (c)

137. Which of the following graphs shows the variation of electric field E due to a hollow spherical conductor of radius R as a function of distance from the centre of the spherical conductor?

(a) 

(b) 

(c) 

(d) 

Sol: Electric field due to a hollow spherical conductor is governed by following equation,

$E = 0$, for $r < R$ … (i)

and $E = \frac{Q}{4\pi\varepsilon_0 r^2}$ for $r \geq R$

i.e. inside the conductor field will be zero and outside the conductor will vary according to $E \propto \frac{1}{r^2}$

Ans: (a)

138. Two wires have lengths, diameters and specific resistances all in the ratio of $1:2$. The resistance of the first wire is $10\,\text{ohm}$. Resistance of the second wire in ohm will be

(a) 5 (b) 10 (c) 20 (d) infinite

Sol: Given: $\frac{l_1}{l_2}=\frac{d_1}{d_2}=\frac{\rho_1}{\rho_2}=\frac{1}{2}$

Resistance of the wire,

$$R=\rho\frac{l}{A}=\rho\frac{l}{\pi(d/2)^2}=\frac{4\rho l}{\pi d^2} \qquad \left[\because\ A=\pi r^2=\pi\left(\frac{d}{2}\right)^2\right]$$

$$\therefore\ \frac{R_1}{R_2}=\frac{\rho_1 l_1}{d_1^2}\times\frac{d_2^2}{\rho_2\ell_2}=\left(\frac{\rho_1}{\rho_2}\right)\left(\frac{l_1}{l_2}\right)\left(\frac{d_2}{d_1}\right)^2,\ \text{i.e.}\ \frac{10}{R_2}=\left(\frac{1}{2}\right)\left(\frac{1}{2}\right)(2)^2$$

$$\frac{10}{R_2}=1\ \Rightarrow\ R_2=10\,\Omega$$

Ans: (b)

139. A primary cell has an e.m.f. of 1.5 volt, when short-circuited it gives a current of 3 ampere. The internal resistance of the cell is

(a) 4.5 ohm (b) 2 ohm (c) 0.5 ohm (d) 1/4.5 ohm

Sol: Short circuit current, $i_{SC}=\frac{E}{r}\ \Rightarrow\ 3=\frac{1.5}{r}\ \Rightarrow\ r=0.5\Omega$

Ans: (c)

140. How much heat is developed in 210 watt electric bulb in 5 minutes? (Chemical equivalent of heat $=4.2\ \text{JC}^{-1}$)

(a) 30000 cal (b) 22500 cal (c) 15000 cal (d) 7500 cal

Sol: $H=P\times t=\frac{210\times5\times60}{4.2}=15000\,\text{cal}$

Ans: (c)

141. Drift velocity of electrons is due to

(a) Motion of conduction electrons due to random collisions.

(b) Motion of conduction electrons due to electric field $\vec{E}$.

(c) Repulsion to the conduction electrons due to inner electrons of ions.

(d) Collision of conduction electrons with each other.

Sol:

Motion of conduction electrons due to random collisions has no preffered direction and average to zero.

Drift velocity is caused due to motion of conduction electron due to applied electric field $\vec{E}$.

Ans: (b)

142. To minimise the power loss in the transmission cables connecting the power stations to homes and factories, the transmission cables carry current

(a) At a very low voltage.

(b) At a very high voltage

(c) At 220 volt

(d) Neither at a very high voltage nor at a very low voltage.

Sol: The power dissipated in the transmission cable is inversely proportional to the square of voltage at which current is transmitted through the cables. Therefore to minimize the power loss the transmission cables carry current at a very high voltage.

Ans: (b)

143. The current through a bulb is increased by 1%. Assuming that the resistance of the filament remains unchanged the power of the bulb will

(a) increase by 1% (b) decrease by 1% (c) increase by 2% (d) decrease by 2%

Sol: $P = I^2R$. Hence $\frac{dP}{P} = \frac{2dI}{I}$.

Since $\frac{dI}{I} = 1\%$

Hence $\frac{dP}{P} = 2\%$

Ans: (c)

144. Two long parallel wires P and Q are held perpendicular to the plane of the paper at a separation of 5 m. If P and Q carry currents of 2.5 A and 5 A respectively in the same direction, then the magnetic field at a point midway between P and Q is

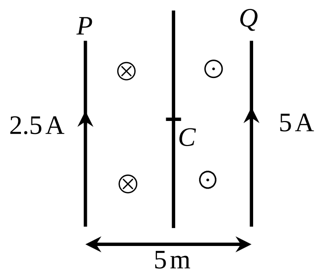
(a) $\frac{\mu_0}{\pi}$ (b) $\sqrt{3}\frac{\mu_0}{\pi}$ (c) $\frac{\mu_0}{2\pi}$ (d) $\frac{3\mu_0}{2\pi}$

Sol: When the current flows in both wires in the same direction then magnetic field at half way due to the wire P,

$\vec{B}_p = \frac{\mu_0 I_1}{2\pi \times 5/2} = \frac{\mu_0 I_1}{\pi \times 5} = \frac{\mu_0}{2\pi}$ (where $I_1 = 2.5\,\text{A}$)

The direction of $\vec{B}_p$ is downward ⊙. Magnetic field at half way due to wire Q

$\vec{B}_p = \frac{\mu_0 I_2}{2\pi \frac{5}{2}} = \frac{\mu_0}{\pi}$ [upward ⊙] [where $I_2 = 5\,\text{A}$]



Net magnetic field at half way,

$\vec{B} = \vec{B}_P + \vec{B}_Q = -\frac{\mu_0}{2\pi} + \frac{\mu_0}{\pi} = \frac{\mu_0}{2\pi}$ (upward)

Hence, net magnetic field at midpoint $= \frac{\mu_0}{2\pi}$

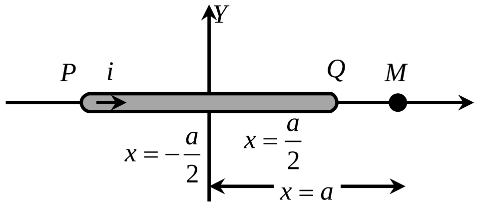
Ans: (c)

145. A straight section PQ of a circuit lies along the X – axis from $x = -\frac{a}{2}$ to $x = \frac{a}{2}$ and carries a steady current i. The magnetic field due to the section PQ at a point $X = +a$ will be

(a) proportional to a (b) proportional to a^2

(c) proportional to $1/a$ (d) zero

Sol: Magnetic field at a point on the axis of a current carrying wire is always zero.



Ans: (d)

146. A uniform magnetic field acts at right angles to the direction of motion of electron. As a result, the electron moves in a circular path of radius 2 cm. If the speed of electron is doubled, then the radius of the circular path will be

(a) 2.0 cm (b) 0.5 cm (c) 4.0 cm (d) 1.0 cm

Sol: $r=\frac{mv}{qB}$ or $r \propto v$ As v is doubled, the radius also becomes double. Hence radius $=2\times 2=4\text{ cm}$.

Ans: (c)

147. A charge moving with velocity v in $X-$direction is subjected to a magnetic field in negative $X-$direction. As a result, the charge will

(a) remain unaffected
(b) start moving in a circular path $Y-Z$ plane
(c) retard along $X-$axis
(d) move along a helical path around $X-$axis

Sol: The force acting on a charged particle in magnetic field is given by

$F=q\left(\vec{v}\times\vec{B}\right)$ or $F=qvB\sin\theta$ when angle between v and B is $180°$, $F=0$

Ans: (a)

148. Magnetic permeability is maximum for

(a) diamagnetic substance
(b) paramagnetic substance
(c) ferromagnetic substance
(d) all of these

Sol: ferromagnetic substance

Ans: (c)

149. A moving coil galvanometer has N number of turns in a coil of effective area A, it carries a current I. The magnetic field B is radial. The torque acting on the coil is

(a) NA^2B^2I (b) $NABI^2$ (c) N^2ABI (d) $NABI$

Sol: $\tau=MB\sin\theta \Rightarrow \tau_{max}=NIAB, \left(\theta=90°\right)$

Ans: (d)

150. Magnetic lines of force due to a bar magnet do not intersect because.

(a) a point always has a single net magnetic field
(b) the lines have similar charges and so repel each other
(c) the lines always diverge from a single force
(d) the lines need magnetic lenses to be made to interest

Sol: a point always has a single net magnetic field

Ans: (a)

151. A conducting circular loop is placed in a uniform magnetic field of $0.04\,\text{T}$ with its plane perpendicular to the magnetic field. The radius of the loop starts shrinking at $2\ \text{mm s}^{-1}$. The induced emf in the loop when the radius is $2\,\text{cm}$ is

(a) $4.8\ \pi\mu\text{V}$ (b) $0.8\ \pi\mu\text{V}$ (c) $1.6\ \pi\mu\text{V}$ (d) $3.2\ \pi\mu\text{V}$

Sol: Induced emf in the loop is given by $e = -B \cdot \frac{dA}{dt}$ where A is the area of the loop.

$$e = -B \cdot \frac{d}{dt}\left(\pi r^2\right) = -B\pi 2r \frac{dr}{dt}$$

$r = 2\,\text{cm} = 2\times10^{-2}\ \text{m}$

$dr = 2\,\text{mm} = 2\times10^{-3}\ \text{m}$

$dt = 1\text{s}$

$$e = -0.04\times3.14\times2\times2\times10^{-2}\times\frac{2\times10^{-3}}{1}\text{V}$$

$= 0.32\pi\times10^{-5}\,\text{V} = 3.2\pi\times10^{-6}\,\text{V} = 3.2\ \pi\mu\text{V}$

Ans: (d)

152. In an induction coil the current increases from 0 to $6\,\text{A}$ in 0.3s by which induced emf of 30 volts is produced in it. Then the value of coefficient of self-inductance of coil will be

(a) 3 henry (b) 2 henry (c) 1 henry (d) 1.5 henry

Sol: $\Delta I = 6\,\text{A},\ \Delta t = 0.3\text{s},\ E = 30\,\text{V}$

$$E = L\frac{dI}{dt}$$

$$\therefore\ \ L = \frac{30\times0.3}{6} = 1.5\ \text{H}$$

Ans: (d)

153. In LCR series a.c. circuit, the voltage across each of the components, L, C and R is $50\,\text{V}$. The voltage across the LC combination will be

(a) $100\,\text{V}$ (b) $50\sqrt{2}\ \text{V}$ (c) $50\ \text{V}$ (d) $0\ \text{V}$

Sol: Since the phase difference between L and C is π

$\therefore$ net voltage difference across $LC = 50 - 50 = 0$

Ans: (d)

154. In a series resonance LCR circuit, the voltage across R is 100 volt and $R = 1\text{k}\Omega$ with $C = 2\mu\text{F}$. The resonance frequency ω is $200\,\text{rad s}^{-1}$. At resonance the voltage across L is

(a) $2.5\times10^{-2}\ \text{V}$ (b) $40\,\text{V}$ (c) $250\,\text{V}$ (d) $4\times10^{-3}\,\text{V}$

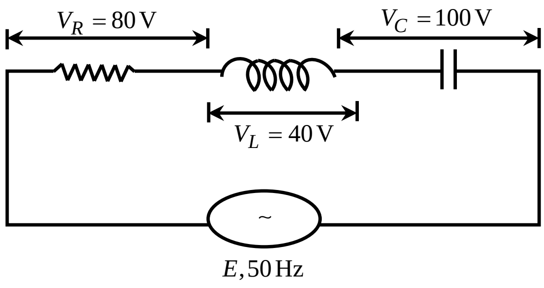
Sol: Across resistor, $I = \frac{V}{R} = \frac{100}{1000} = 0.1\text{A}$

At resonance, $X_L = X_C = \frac{1}{\omega C} = \frac{1}{200 \times 2 \times 10^{-6}} = 2500$

Voltage across L is $IX_L = 0.1 \times 2500 = 250$ V

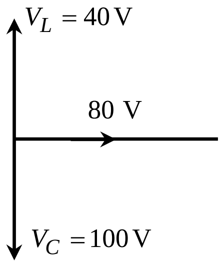
Ans: (c)

155.The value of alternating emf E in the given circuit will be



(a) 100 V (b) 20 V (c) 220 V (d) 140 V

Sol: $\therefore \; E = \sqrt{80^2 + (100-40)^2} = 100\,\text{V}$



Ans: (a)

156.Match List-I (Electromagnetic wave type) with List-II (its association/application) and select the correct option from the from the choices given below the lists

List I		List II	
(1)	Infrared waves	(i)	To treat muscular strain
(2)	Radio waves	(ii)	For broadcasting
(3)	X-rays	(iii)	To detect fracture of bones
(4)	Ultraviolet rays	(iv)	Absorbed by the ozone layer of the atmosphere

	1	2	3	4
(a)	(iv)	(iii)	(ii)	(i)
(b)	(i)	(ii)	(iv)	(iii)
(c)	(iii)	(ii)	(i)	(iv)
(d)	(i)	(ii)	(iii)	(iv)

Sol:

(1) Infrared rays are used to treat muscular strain because these are heat rays

(2) Radio waves are used for broadcasting because these waves have very long wavelength ranging from few centimeters to few hundred kilometres

(3) X-rays are used to detect fracture of bones because they have high penetrating power but they can't penetrate through denser medium like dones.

(4) Ultraviolet rays are absorbed by ozone of the atmosphere

Ans: (d)

157. When a plane face of planoconvex lens is silvered, it behaves as concave mirror of focal length $30\,\text{cm}$. But when its curved surface is silvered, it behaves as a concave mirror of focal length $10\,\text{cm}$. The refractive index of lens material is

(a) 1.25 (b) 1.33 (c) 1.732 (d) 1.5

Sol: $f_1 = \frac{R}{2(\mu - 1)} = 30\,\text{cm}$; $f_2 = \frac{R}{2\mu} = 10\,\text{cm}$

Solving, $\mu = 1.5$ $\left[\because \frac{1}{f_{eq}} = \frac{1}{f_1} + \frac{1}{f_2}\right]$

Ans: (d)

158. A ray of light travelling in a transparent medium of refractive index μ, falls on a surface separating the medium from air at an angle of incidence of $45°$. For which of the following value of μ the ray can undergo total internal reflection?

(a) $\mu = 1.33$ (b) $\mu = 1.40$ (c) $\mu = 1.50$ (d) $\mu = 1.25$

Sol: For total internal reflection,

$\mu \geq \frac{1}{\sin C} \geq \sqrt{2} \geq 1.414 \Rightarrow \mu = 1.50$

Ans: (c)

159. Minimum deviation is observed with a prism having angle of prism A, angle of deviation δ, angle of incidence i and angle of emergence e. We then have generally

(a) $i > e$ (b) $i < e$ (c) $i = e$ (d) $i = e = \delta$

Sol: In minimum deviation condition

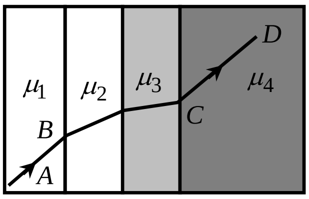
$\angle i = \angle e, \angle r_1 = \angle r_2$

Ans: (c)

160. A ray of light passes through four transparent media with refractive indices μ_1, μ_2, μ_3 and μ_4 as shown in the figure. The surfaces of all media are parallel. If the emergent ray CD is parallel to the incident ray AB, we must have

(a) $\mu_1 = \mu_2$ (b) $\mu_2 = \mu_3$

(c) $\mu_3 = \mu_4$ (d) $\mu_4 = \mu_1$



Sol:

For successive refraction through different media $\mu \sin\theta =$ constant. Here as θ is same in the two extreme media, $\mu_1 = \mu_4$.

Ans: (d)

161. Huygens's concept of secondary wave

(a) Allows us to find the focal length of a thick lens

(b) Is a geometrical method to find a wave front

(c) Is used to determine the velocity of light

(d) Is used to explain polarisation

Sol: Huyghen's principle gives us a geometrical method of tracing a wavefront.

Ans: (b)

162. The condition for observing Fraunhoffer diffraction from a single slit is that the light wavefront incident on the slit should be

(a) Spherical (b) cylindrical (c) plane (d) elliptical

Sol: Because both source and screen are effectively at infinite distance from the diffractive device

Ans: (c)

163. The momentum of a photon of wavelength λ is

(a) $h\lambda$ (b) h/λ (c) λ/h (d) $h/c\lambda$

Sol: The momentum of a photon is $p = \frac{h}{\lambda}$

Ans: (b)

164. In a photoelectric emission process from a metal of work function $1.8\,\text{eV}$, the kinetic energy of most energetic electrons is $0.5\,\text{eV}$. The corresponding stopping potential is

(a) 1.8 V (b) 1.2 V (c) 0.5 V (d) 2.3 V

Sol: The stopping potential is equal to maximum kinetic energy.

Ans: (c)

165. In a Rutherford scattering experiment when a projectile of charge Z_1 and mass M_1 approaches a target nucleus of charge Z_2 and mass M_2, the distance of closest approach is r_0. The energy of the projectile is

(a) Directly proportional to Z_1Z_2 (b) Inversely proportional to Z_1

(c) Directly proportional to mass M_1 (d) Directly proportional to $M_1 \times M_2$

Sol: The kinetic energy of the projectile is given by $\frac{1}{2}mv^2 = \frac{Ze(2e)}{4\pi\varepsilon_0 r_0} = \frac{Z_1Z_2}{4\pi\varepsilon_0 r_0}$ Thus energy of the projectile is directly proportional to Z_1Z_2

Ans: (a)

166. In Bohr model of hydrogen atom, let $P.E.$ represents potential energy and $T.E.$ represents the total energy. In going to a higher level.

(a) $P.E.$ decreases, $T.E.$ increases (b) $P.E.$ increases, $T.E.$ decreases

(c) $P.E.$ decreases, $T.E.$ decreases (d) $P.E.$ increases, $T.E.$ increases

Sol: $P.E.$ increases, $T.E.$ increases

Ans: (d)

167. The ratio of the energies of the hydrogen atom in its first to second excited states is

(a) $1/4$ (b) $4/9$ (c) $9/4$ (d) 4

Sol: Ist excited state corresponds to $n=2$

2nd excited state corresponds to $n=3$

$$\therefore \frac{E_1}{E_2}=\frac{n_2^2}{n_1^2}=\frac{3^2}{2^2}=\frac{9}{4}$$

Ans: (c)

168.Fusion reaction takes place at high temperature because

(a) nuclei break up at high temperature

(b) atoms get ionised at high temperature

(c) kinetic energy is high enough to overcome the coulomb repulsion between nuclei

(d) molecules break up at high temperature

Sol: When the coulomb repulsion between the nuclei is overcome then nuclear fusion reaction takes place. This is possible when temperature is too high.

Ans: (c)

169.Neutron decay in free space is given as follows ${}_0n^1 \rightarrow {}_1H^1 + {}_{-1}e^0 + [\ ]$. Then the parenthesis [ ] represents as

(a) Neutrino (b) Photon (c) antineutrino (d) Graviton

Sol: An electron is accompanied by an antineutrino.

Ans: (c)

170.The binding energy per nucleon of deuteron $\left({}_1^2H\right)$ and helium nucleus $\left({}_2^4He\right)$ is 1.1 MeV and 7 MeV respectively. If two deuteron nuclei react to from a single helium nucleus, then then energy released is

(a) 23.6 MeV (b) 26.9 MeV (c) 13.9 MeV (d) 19.2 MeV

Sol: The chemical reaction of process is $2{}_1^2H \rightarrow {}_2^4He$

$=4\times(7)-4(1.1)=23.6$ MeV

Ans: (a)

171. The barrier potential of a $p-n$ junction depends on

(A) type of semiconductor material (B) amount of doping

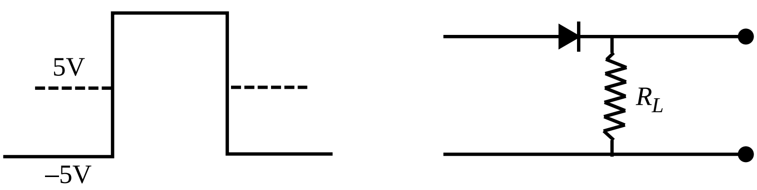
(C) temperature (D) Only (A) and (C)

(a) (A) and (B) only (b) (B) & (D) only (c) (B) and (C) only (d) (A), (B) and (C)

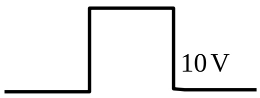
Sol: The barrier potential of $p-n$ junction depends on amount of doping, type of semiconductor material and temperature.

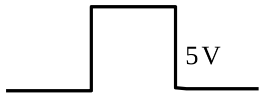
Ans: (d)

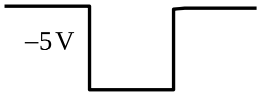
172.In a $p-n$ junction diode, a square input signal of 10 V is applied as shown in fig.

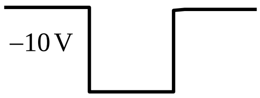


The output signal across R_L will be

(a) 

(b) 

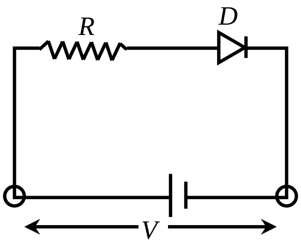
(c) 

(d) 

Sol: The $p-n$ junction diode is a half wave rectifier which produces output in forward biased mode only. Thus, there will be no output corresponding to $-5\,\text{V}$ input. Hence, output will be obtained corresponding to $+5\,\text{V}$ only.

Ans: (b)

173. A d.c. battery of V volt is connected to a series combination of a resistor R and an ideal diode D as shown in the figure below. The potential difference across R will be



(a) $2\,\text{V}$ when diode is forward biased

(b) Zero when diode is forward biased

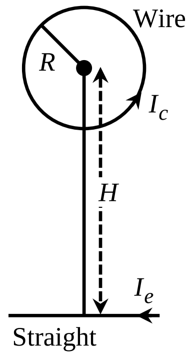
(c) V when diode is reverse biased

(d) V when diode is forward biased

Sol: In forward biasing, the diode conducts. For ideal junction diode, the forward resistance is zero; therefore, entire applied voltage occurs across external resistance R i.e., there occurs no potential drop, so potential across R is V in forward biased.

Ans: (b)

174. Circular loop of a wire and a long straight wire carry currents I_c and I_e, respectively as shown in figure. Assuming that these are placed in the same plane. The magnetic fields will be zero at the centre of the loop when the separation H is



(a) $\dfrac{I_e R}{I_c \pi}$

(b) $\dfrac{I_c R}{I_e \pi}$

(c) $\dfrac{\pi I_c}{I_e R}$

(d) $\dfrac{I_e \pi}{I_c R}$

Sol: $\dfrac{\mu_0 I_c}{2R} = \dfrac{\mu_0 I_e}{2\pi H} \Rightarrow H = \dfrac{I_e R}{\pi I_c}$

Ans: (a)

175. Which of the following set have different dimensions?

(a) pressure, Young's modulus, stress

(b) EMF, potential difference, electric potential

(c) heat, work done, energy

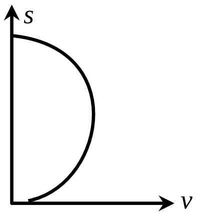
(d) dipole moment, electric flux, electric field

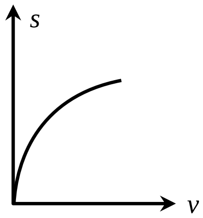
Sol: Electric flux $\phi_E = \vec{E} \cdot \vec{S}$

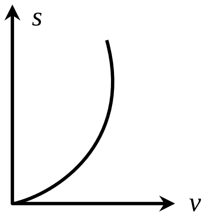
$\therefore$ Dimensionally $\phi_E \neq E$

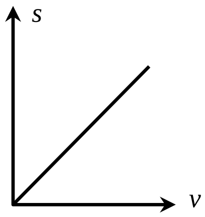
Ans: (d)

176. An object is moving with a uniform acceleration which is parallel to its instantaneous direction of motion. The displacements (s) – velocity (v) graph of this object is

(a) 

(b) 

(c) 

(d) 

Sol: $v^2 = u^2 + 2aS$. If $u = 0$ then $v^2 \propto S$

i.e., graph should be parabola symmetric to displacement axis.

Ans: (b)

177. The speed of a projectile at its maximum height is $\frac{\sqrt{3}}{2}$ times its initial speed. If the range of the projectile is 'P' times the maximum height attained by it. P is –

(a) $\frac{4}{3}$ (b) $2\sqrt{3}$ (c) $4\sqrt{3}$ (d) $\frac{3}{4}$

Sol:

Given, $u\cos\theta = \frac{\sqrt{3}u}{2}$

$\Rightarrow \cos\theta = \frac{\sqrt{3}}{2} \Rightarrow \theta = 30°$

Range $(R) = \frac{u^2 \sin 2\theta}{g} = \frac{u^2 \sin 60°}{g} = \frac{\sqrt{3}u^2}{2g}$

Maximum height $= \frac{u^2 \sin^2\theta}{2g} = \frac{u^2 \sin^2 30°}{2g} = \frac{u^2}{8g}$

Now, range $= P \times H$

$\Rightarrow \frac{\sqrt{3}u^2}{2g} = P \times \frac{u^2}{8g} \Rightarrow P = 4\sqrt{3}$

Ans: (c)

178. A man weighing $80\,\text{kg}$, stands on a weighing scale in a lift which is moving upwards with a uniform acceleration of $5\ \text{ms}^{-2}$. What would be the reading on the scale? $\left(g = 10\ \text{ms}^{-2}\right)$

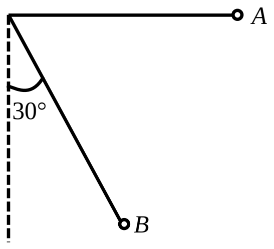
(a) 1200 N (b) zero (c) 400 N (d) 800 N

Sol: Reading of the scale $=$ Apparent weight of the mass $= m(g+a)$

$= 80(10+5) = 1200\,\text{N}$

Ans: (a)

179. A simple pendulum is released from A as shown. If m and l represent the mass of the bob and length of the pendulum, the gain in kinetic energy at B is



(a) $\frac{mgl}{2}$ (b) $\frac{mgl}{\sqrt{2}}$

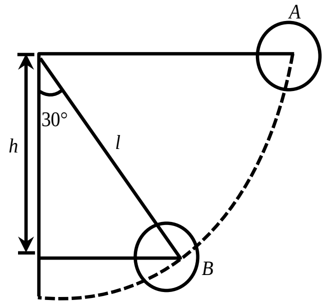
(c) $\frac{\sqrt{3}}{2}mgl$ (d) $\frac{2}{\sqrt{3}}mgl$

Sol:

Vertical height $= h = l\cos 30°$

Loss of potential energy $= mgh$

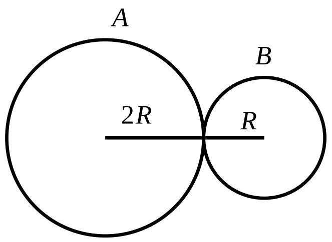
$= mgl\cos 30° = \frac{\sqrt{3}}{2}mgl$



$\therefore$ Kinetic energy gained $= \frac{\sqrt{3}}{2}mgl$

Ans: (c)

180. Two spheres A and B of masses m and $2m$, and radii $2R$ and R respectively are placed in contact as shown. The COM of the system lies



(a) inside A

(b) inside B

(c) at the point of contact

(d) none of these

Sol: Let centre of sphere A as origin then,

$$\text{COM} = \frac{m\times 0 + 2m\times 3R}{m+2m} = 2R$$

$=$ At the point of contact.

Ans: (c)

Key Answers:

1. a	2. b	3. d	4. c	5. a	6. b	7. b	8. a	9. c	10. c
11. a	12. c	13. a	14. c	15. b	16. b	17. d	18. b	19. c	20. b
21. b	22. b	23. c	24. b	25. b	26. b	27. c	28. b	29. b	30. d
31. a	32. d	33. c	34. a	35. b	36. c	37. a	38. b	39. b	40. a
41. d	42. d	43. a	44. c	45. c	46. a	47. b	48. a	49. b	50. c
51. a	52. c	53. a	54. b	55. a	56. d	57. b	58. a	59. d	60. d
61. d	62. c	63. b	64. c	65. b	66. b	67. b	68. c	69. b	70. b
71. d	72. b	73. b	74. d	75. c	76. c	77. a	78. b	79. d	80. b
81. d	82. a	83. b	84. b	85. c	86. d	87. a	88. c	89. d	90. c
91. d	92. a	93. c	94. a	95. d	96. c	97. a	98. a	99. a	100.a
101.d	102.a	103.c	104.a	105.b	106.d	107.c	108.b	109.d	110.a
111.b	112.c	113.c	114.a	115.a	116.c	117.d	118.d	119.c	120.a
121.d	122.c	123.b	124.a	125.a	126.d	127.a	128.c	129.a	130.a
131.b	132.a	133.c	134.a	135.c	136.c	137.a	138.b	139.c	140.c
141.b	142.b	143.c	144.c	145.d	146.c	147.a	148.c	149.d	150.a
151.d	152.d	153.d	154.c	155.a	156.d	157.d	158.c	159.c	160.d
161.b	162.c	163.b	164.c	165.a	166.d	167.c	168.c	169.c	170.a
171.d	172.b	173.b	174.a	175.d	176.b	177.c	178.a	179.c	180.c