TEST CODE : 113010

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IIT-JEE

Batch – Growth (June) | Minor Test-10

Time: 3 Hours | **Test Date: 05th January 2025** | **Maximum Marks: 300**

Name of the Candidate: ____ Roll No.____________

Centre of Examination (in Capitals):____

Candidate's Signature:________________________ Invigilator's Signature:________________________

READ THE INSTRUCTIONS CAREFULLY

1. The candidates should not write their Roll Number anywhere else (except in the specified space) on the Test Booklet/Answer Sheet.

2. This Test Booklet consists of 75 questions.

3. This question paper is divided into three parts **PART A - MATHEMATICS, PART B - PHYSICS** and **PART C - CHEMISTRY** having 25 questions each and every **PART** has two sections.

(i) **Section-I** contains 20 multiple choice questions with only one correct option. Marking scheme: +4 for correct answer, 0 if not attempted and –1 in all other cases.

(ii) **Section-II** contains 5 questions, is an INTEGERAL VALUE.

Marking scheme: +4 for correct answer, 0 if not attempted and –1 in all other cases.

4. No candidate is allowed to carry any textual material, printed or written, bits of papers, mobile phone any electronic device etc., except the Identity Card inside the examination hall/room.

5. Rough work is to be done on the space provided for this purpose in the Test Booklet only.

6. On completion of the test, the candidate must hand over the Answer Sheet to the invigilator on duty in the Room/Hall. However, the candidate is allowed to take away this Test Booklet with them.

7. For integer-based questions, the answer should be in decimals only not in fraction.

8. If learners fill the OMR with incorrect syntax (say 24.5. instead of 24.5), their answer will be marked wrong.

TEST SYLLABUS

Batch – Growth (June) | Minor Test-10

05^{th} January 2025

Mathematics:	Permutation & Combination, (Probability-NCERT)
Physics:	Elasticity, Thermal Expansion, Calorimetry and Heat Transfer
Chemistry:	Redox Reaction,Nomenclature

Useful Data Chemistry:

Gas Constant	R	$= 8.314\,JK^{-1}mol^{-1}$
		$= 0.0821$ Lit atm $K^{-1}mol^{-1}$
		$= 1.987 \approx 2$ Cal $K^{-1}mol^{-1}$
Avogadro's Number	N_a	$= 6.023 \times 10^{23}$
Planck's Constant	h	$= 6.626 \times 10^{-34}$ Js
		$= 6.25 \times 10^{-27}$ erg.s
1 Faraday		$= 96500$ Coulomb
1 calorie		$= 4.2$ Joule
1 amu		$= 1.66 \times 10^{-27}$ kg
1 eV		$= 1.6 \times 10^{-19}$ J

Atomic No:
H = 1, D = 1, Li = 3, Na = 11, K = 19, Rb = 37, Cs = 55, F = 9, Ca = 20, He = 2, O = 8, Au = 79.

Atomic Masses:
He = 4, Mg = 24, C = 12, O = 16, N = 14, P = 31, Br = 80, Cu = 63.5, Fe = 56, Mn = 55, Pb = 207, Au = 197, Ag = 108, F = 19, H = 2, Cl = 35.5, Sn = 118.6

Useful Data Physics:
Acceleration due to gravity $g = 10\ m/s^2$

PART-A: MATHEMATICS

SECTION-I

1. If in a regular polygon the number of diagonals is 54, then the number of sides of this polygon is:

(A) 12
(B) 10
(C) 6
(D) 9

Ans. (A)

Sol. Number of diagonals of an 'n' sided polygon is

$^nC_2 - n = 54$

$\frac{n(n-1)}{1.2} - n = 54$

$\frac{n^2 - n}{2} - n = 54$

$n^2 - 3n = 108$

$n^2 - n - 108 = 0$

$(n-12)(n+9) = 0$

$n = 12$

2. The number of integers greater than 6000 that can be formed, using the digits 3, 5, 6, 7 and 8, without repetition is

(A) 72
(B) 216
(C)192
(D) 120

Ans. (C)

Sol. 4 digit and 5 digit numbers are possible.

4 digit numbers:

6/7/8

$\bar{\uparrow}$ $\bar{\uparrow}$ $\bar{\uparrow}$ $\bar{\uparrow}$ Total numbers possible

3 4 3 2

5 digit numbers

$\bar{\uparrow}$ $\bar{\uparrow}$ $\bar{\uparrow}$ $\bar{\uparrow}$ $\bar{\uparrow}$ Total numbers possible

5 4 3 2 1

$\therefore$Total numbers = 72 + 120 = 192

3. All possible numbers are formed using the digits 1, 1, 2, 2, 2, 2, 3, 4, 4 taken all at a time. The number of such numbers in which the odd digits occupy even places is

(A) 175
(B) 162
(C) 180
(D) 160

Ans. (C)

Sol. _ _ _ _ _ _

$\uparrow$ $\uparrow$ $\uparrow$

Odd digits 1, 1, 3

Even digits: 2, 2, 2, 2, 4, 4

The number of ways of placing odd digits at even position

$= {}^4C_3 \times \frac{3!}{2!} = 4 \times 3 = 12$

The number of ways of placing even digits = $\frac{6!}{4!\,2!}$ = 15

$\therefore$ Total number of ways = 12 X 15 = 180

4. Consider a class of 5 girls and 7 boys. The number of different teams consisting of 2 girls and 3 boys that can be formed from this class, if there are two specific boys A and B, who refuse to be the members of the same team, is:

(A) 300

(B) 200

(C) 500

(D) 350

Ans. (A)

Sol. $\left.\begin{matrix}7B\\5G\end{matrix}\right\}\rightarrow\begin{pmatrix}3B\\2G\end{pmatrix}$

Total number of ways of forming a team of 3 boys and 2 girls

= $^7C_3$ X $^5C_2$ = $\frac{7.6.5}{1.2.3}\times\frac{5.4}{1.2}$ = 350

Total number of ways of forming a team if two specific boys B_1 , B_2 always join the team

= $^5C_1$ X $^5C_2$ = 50

So, the total number of ways of forming a team so that two specific boys never come together

= 350 — 50 = 300

5. A group of students comprises of 5 boys and n girls. If the number of ways, in which a team ot 3 students can randomly be selected from this group such that there is at least one boy and at least one girl in each team, is 1750, then n is equal to

(A) 24

(B) 27

(C) 25

(D)28

Ans. (C)

Sol.

(5)	(n)
Boys	Girls
2	1
1	2

Here total number of ways

= $^5C_1$ X $^nC_1$ + $^5C_1$ X $^nC_2$ = 1750

$\Rightarrow$ 10n + 5$\frac{n(n-1)}{2}$ = 1750

$\Rightarrow$ $n^2 + 3n - 700 = 0$

$\Rightarrow$ n = -28, 25

n cannot be negative Hence n = 25

6. Suppose that 20 pillars of the same height have been erected along the boundary of circular stadium. If the top of each pillar has been connected by beams with the top of all its non-adjacent pillars, then the total number of beams is•.

(A) 170

(B) 180

(C) 210

(D) 190

Ans. (A)

Sol. Each of the beams connects the top or two non-adjacent pillars. hence we have to find in how many ways we can select the required two pillars which are non- adjacent out of the given 20 pillars.

As, $^{20}C_2$ is the number of beams connecting any two pillars whereas 20 is the number of adjacent beams.

Thus, the total number of beams

= $^{20}C_2$ – 20

Using $^nC_2 = \frac{n!}{r!(n-r)!}$,

$= \frac{20!}{2! \times 18!} - 20$

$= \frac{20 \times 19 \times 18}{2! \times 18!} - 20$

= 190 – 20

= 170.

7. The number of triplets (x, y, z) where x, y, z are distinct non negative integers satisfying x + y + z = 15, is

(A) 80

(B) 136

(C) 114

(D) 92

Ans. (C)

Sol. Given, x + y + z = 15

Now we know that,

Non-negative integral solution of equation a + b + c = n is given by

$^{n+3-1}C_{3-1}$ where

a = b = c & a b ≠ c are also possibilities

So by above formula we get,

Total number of non-negative solution will be, $^{15+3-1}C_{3-1} = {}^{17}C_2$

Now solving If any of these 2 are equal So, the equation will become

X + 2y = 15

Now finding possible cases we get,

Y = 0 x = 15

Y = 1 x = 13

Y = 2 x = 11

Y = 3 x = 9

Y = 4 x = 7

Y = 5 x = 5 ⟶ x = y = z = 5

Y = 6 x = 3

Y = 7 x = 1

So, total possibilities where x, y & z are distinct will be,

$^{17}C_2 - {}^3C_2$ X 8 + 2

{Note adding 2 because the cases x=y=z is subtracted three times}

= 136 – 24 + 2 = 114

8. Let n > 2 be an integer. Suppose that there are n Metro stations in a city located around a circular path. Each pair of the nearest stations is connected by a straight track only. Further, each pair of the nearest station is connected by blue line, whereas all remaining pairs of stations are connected by red line. If number of red lines is 99 times the number of blue lines, then the value of n is

(A) 201

(B) 200

(C) 101

(D) 199

Ans. (A)

Sol. Two consecutive stations = n

Two non-consecutive stations = $^nC_2$ – n = 99n

$\Rightarrow \frac{n(n-1)}{2} - n = 99n$

$\Rightarrow \frac{n^2-n}{2} = 99n$

n = 0 is not possible.
n = 201

9. Eight persons are to be transported from city A to city B in three cars of different makes. If each car can accommodate at most three persons. then the number of ways, in which they can be transported, is

(A) 1120
(B) 3360
(C) 1680
(D) 560

Ans. (C)

Sol. Let us find the different ways so that 8 persons can travel in 3 cars.

C_1	C_2	C_3
3	3	3
2	3	3
3	2	3

Hence we have 3 ways.
Now the number of ways to distribute 8 persons such that they can travel in 3 cars with any car carrying maximum of
3 persons is $\left(\frac{8!}{3!3!2!}\right) \times 3$
= 1680
Therefore. the required answer is 1680

10. If the number of five digit numbers with distinct digits and 2 at the 10th place is 336k , then k is equal to:

(A) 4
(B) 6
(C) 7
(D) 8

Ans. (D)

Sol. Total Number of numbers
= 8 x 8 x 7 x 6 = 2688 = 336k $\Rightarrow$k = 8

11. The maximum number of points of intersections of 8 straight lines, is

(A) 56
(B) 28
(C) 16
(D) 8

Ans. (B)

Sol. ${}^8C_2$ = 28

12. The number of three-digit numbers whose middle digit is bigger than the extreme digits, is

(A) 180
(B) 240
(C) 300

(D) None of these

Ans. (B)

Sol. Let's take cases of middle digit numbers.

8 <u>9</u> 9 = 8 x 9

7 <u>8</u> 8 = 7 x 8

6 <u>7</u> 7 = 6 x 7

:

:

1 <u>2</u> 2 = 1 x 2

Sum = 1 x 2 + 2 x 3 + ... + 8 x 9.

= (8 x 9 x 10)/3

= 240

13. There are n concurrent lines and another line parallel to one of them. The number at different triangles that will be formed by the (n+1) lines, Is

(A) 120

(B) $\frac{(n-1)(n-2)}{2}$

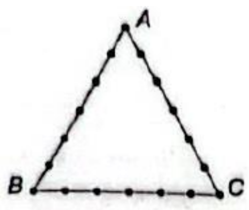
(C) $\frac{n(n+1)}{a}$

(D) $\frac{(n+1)(n+2)}{2}$

Ans. (B)

Sol. ${}^{n-1}C_2 = \frac{(n-1)(n-2)}{2}$

14. 18 points are indicated on the perimeter of a ΔABC (see figure). How many triangles are there with vertices at these points



(A) 331

(B) 408

(C) 710

(D) 711

Ans. (D)

Sol. Number of triangles = ${}^{18}C_3 - 3 \cdot ({}^{7}C_3)$

$= \frac{18.17.16}{3.2.1} - 3 \cdot \frac{76.5}{3.2.1} = 816 - 105 = 711$

15. The number of ways in which 200 different things can be divided into groups of 100 pairs, is

(A) $\frac{(200)!}{2^{100}}$

(B) $\frac{(200)!}{(100)!2^{100}}$

(C) $(101) \cdot (102) \cdots (200)$

(D) None of these

Ans. (B)

Sol. $\frac{(200)!}{(100)!2^{100}}$

16. The number of numbers, strictly between 5000 and 10000 can be formed using digits 1,3,5,7,9 without repetition is

(A) 6

(B) 12

(C) 120

(D) 72

Ans. (D)

Sol. Numbers between 5000 and 10000 using digits 1,3,5,7,9 without repetition is
3 x 4 x 3 x 2 = 72.

17. The number of different words that can be formed out of the letters of the word MORADABAD taken four at a time, Is

(A) 1500

(B) 600

(C) 620

(D) 626

Ans. (D)

Sol. MORADABAD, namely AAA, DD, M, R, B and O.
The four-letter word may consist of
(i) 3 alike letters and 1 distinct letter
(ii) 2 alike letters of one kind and 2 alike letters of the other kind
(iii) 2 alike letters and 2 distinct letters
(iv) all different letters
(i) 3 alike letters and 1 distinct letter:
There is one set of three alike letters, AAA which can be selected in one way. Out of the 5 different letters D, M, R, B and O, one can be selected in ${}^5C_1$ways.

18. The number of integers, greater than 7000 that can be formed, using the digits 3, 5, 6, 7, 8 without repetition, is

(A) 120

(B) 168

(C) 220

(D) 48

Ans. (B)

Sol. Four-digit numbers greater than 7000 = 2 x 4 x 3 x 2 = 48
Five-digit number = 5! = 120
Total number greater than 7000 = 120 + 48 = 168

19. The number of 3-digit numbers that are divisible by either 3 or 4 but not divisible by 48, is

(A) 472

(B) 432

(C) 507

(D) 400

Ans. (B)

Sol. Total 3-digit number = 900

Divisible by 3 = 300

Divisible by 4 = 225
Divisible by 3 & 4= 75
Number divisible by either 3 or 4 = 300 + 2250 – 75 = 450
We have to remove divisible by 48, 144, 192 …., 18 terms.
Required number of numbers = 450 – 18 = 432

20. The letters of the word OUGHT are written in all possible ways and these words are arranged as in a dictionary, in a series. Then the serial number of the word TOUGH is:

(A) 89

(B) 84

(C) 86

(D) 79

Ans. (A)

Sol. Let's arrange the letters of OUGHT in alphabetical order: G,H,O,T,U.
words starting with
G ---> 4!
H ---> 4!
O ---> 4!
TG ---> 3!
TH ---> 3!
TOG ---> 2!
TOH ---> 2!
TOUGH ---> 1!
Total = 89

SECTION-II

21. An urn contains 5 red marbles, 4 black marbles and 3 white marbles. Then, the number of ways in which 4 marbles can be drawn so that at the most three of them are red is .

Ans. (490)

Sol. We have,5 red,4 black, 3 white marbles
Required number of ways
= ${}^5C_0$ X ${}^7C_4$ X ${}^5C_1$ X ${}^7C_3$ X ${}^5C_2$ X ${}^7C_2$
= 35 + 175 + 210 + 70
= 490

22. The number of words, with or without meaning, that can be formed by taking 4 letters at a time from the letters of the word 'SYLLABUS' such that two letters are distinct and two letters are alike, is

Ans. (240)

Sol. From the given word,
S – 2, L – 2, A,B,Y,U.
Number of alike letter pairs = 2
Number of ways to select one pair = ${}^2C_1$
Number of distinct letters = 5
Number of ways to select two distinct letters= ${}^5C_2$
Number of ways to arrange four letters if two are alike = $\frac{4!}{2!}$
Required number of ways

$= {}^2C_1\, {}^5C_2 \,.\, \frac{4!}{2!} = 2 \,.\, 10 \,.\, \frac{24}{2} = 240$

23. If the number of ways in which 5 boys and 5 girls can be arranged around a circle such that the boys and girls alternate is N, then $[\frac{N}{100}]$, where [.] denotes G.I.F is ______

Ans. **(28)**

Sol. 4! X 5! = 2880.

24. If the sum of the digits in the unit's place of all numbers formed with the help of 3,4,5,6 taken all at a time (without repetition) is 'K' then $[\frac{K}{100}]$, where [.] denotes G.I.F is ______

Ans. **(1)**

Sol. Sum of the digits in the units place = $(4-1)!\,(3+4+5+6) = 108$

25. All the numbers that can be formed using the digits 1,2,3,4 (without repetition) are arranged in the increasing order of magnitude then the rank of the number '3241' is ______

Ans. **(16)**

Sol. $4 + 4p_1 + 4p_2 + 4p_3 + 16$

PART-B: PHYSICS
SECTION-I

26. A wire can support a load 'W' without breaking. It is cut into two equal parts. The maximum load that each part can support is

(A) $\frac{W}{4}$
(B) $\frac{W}{2}$
(C) W
(D) 2W

Ans. (C)

Sol. Since the area of cross-section is same, the stress developed will be same.

27. A metal ring of initial radius 'r' and cross sectional area ' A' is fitted onto a wooden disc of radius R(>r). If Young's modulus of the metal is 'Y' then the tension in the ring is

(A) $\frac{AYR}{r}$
(B) $\frac{AY(R-r)}{r}$
(C) $\frac{Y}{A}\left[\frac{R-r}{r}\right]$
(D) $\frac{Yr}{Ar}$

Ans. (B)

Sol. $Y = \frac{T(2\pi r)}{A(2\pi)(R-r)}$

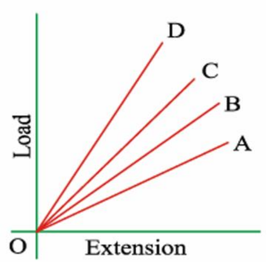
28. Two steel wires of lengths 1 m and 2 m have diameters 1 mm and 2 mm respectively. If they are stretched by forces of 40 N and 80 N respectively, the ratio of their elongations is

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

Ans. (D)

Sol. $\frac{e_1}{e_2}=\frac{F_1}{F_2}\times\frac{L_1}{L_2}\times\frac{r_2^2}{r_1^2}$

29. The load versus extension graph for four wires of same material is shown. The thinnest wire is represented by the line



(A) OA
(B) OB
(C) OC
(D) OD

Ans. (A)

Sol. For given load, extension in wire OA is maximum. Therefore, stress in OA is maximum. Stress is inversely proportional to the area of cross section.

30. One end of a horizontal thick copper wire of length 2L and radius 2R is welded to an end of another horizontal thin copper wire of length L and radius R. When the arrangement is stretched by applying forces at two ends, the ratio of the elongation in the thin wire to that in the thick wire is.

(A) 0.25
(B) 0.50
(C) 2.00
(D) 4.00

Ans. (C)

Sol. $\Delta l=\frac{FL}{AY}=\frac{FL}{(\pi r^2)Y}\Rightarrow\Delta l\propto\frac{L}{r^2}$

$\therefore\ \frac{\Delta l_1}{\Delta l_2}=\frac{L/R^2}{2L/(2R)^2}=2$

31. 1 gram ice at $0^\circ C$ and 1gram vapour at $100^\circ C$ are mixed together. Assuming no heat loss, the final temperature of the mixture will be

(A) $50^\circ C$
(B) $10^\circ C$
(C) $20^\circ C$
(D) $100^\circ C$

Ans. (D)

Sol. Heat of vaporization $(Q_1)=mL_v$

Heat of fusion $(Q_2)=mL_f$

$Q_3=mc\Delta T$

As $Q_1>Q_2+Q_3$

$\therefore$ Equilibrium temperature $(T)=100^\circ C$

32. Water of volume 2 litre in a container is heated with a coil of 1 kW at 27°C. The lid of the container is open and energy dissipates at rate of 160 J/s. In how much time temperature will rise from 27°C to 77°C? [Given specific heat of water is 4.2 kJ/kg]

(A) 8 min 20 s
(B) 6 min 2 s
(C) 7 min
(D) 14 min

Ans. (A)

Sol. Heat gained by the water = (Heat supplied by the coil) – (Heat dissipated to environment)

$2 \times 4.2 \times 10^3 \times (77 - 27) = 1000\ t - 160\ t$

t = 8 min 20 s

33. What force should be applied to the ends of steel rod of a cross sectional area 10 cm^2 to prevent it from elongation when heated form 273K to 303k? (α of steel $10^{-5}\ {}^{o}C^{-1}$, Y = 2 X 10^{11} Nm^{-2})

(A) 2 x 10^4N
(B) 3 x 10^4N
(C) 6 x 10^4N
(D) 12 x 10^4N

Ans. (C)

Sol. $\Delta l = \frac{F\ell}{AY}$ ....(1)

Increase in length, $\Delta l = l\alpha\ \Delta T$ ....(2)

from (1) and (2), $\frac{Fl}{AY} = l\alpha\Delta T \Rightarrow F = YA\alpha\Delta T$

34. Thermal capacity of 40 g of aluminum $(s = 0.2 cal/gK)$ is

(A) 168 joule $/^\circ C$
(B) 672 joule $/^\circ C$
(C) 840 joule $/^\circ C$
(D) 33.6 joule $/^\circ C$

Ans. (D)

Sol. Thermal capacity $= ms = 40 \times 0.2 = 8 cal/^\circ C\ = 4.2 \times 8\ J = 33.6$ joules $/^\circ C$

35. Equal masses of three liquids A, B and C have temperatures 10°C, 25°C and 40°C respectively. If A and B are mixed, the mixture has a temperature of 15°C. If B and C are mixed, the mixture has a temperature of 30°C. If A and C are mixed, the mixture will have a temperature of

(A) 16°C
(B) 20°C
(C) 25°C
(D) 29°C

Ans. (A)

Sol. $mC_A(15-10) = mC_B(25-15)$

$\frac{C_A}{C_B} = 2$

$\Rightarrow m \cdot C_B \cdot (30-25) = mC_{C^*}(40-30)$

$\Rightarrow \frac{C_B}{C_C} = 2 \Rightarrow \frac{C_A}{C_C} = 4$

$C_A\left(t-10\right)=C_c\left(40-t\right)$

$\Rightarrow 5t=80 \Rightarrow t=16^{\circ}C$

36. Power radiated by a perfectly black body is P_0 and wavelength corresponding to maximum energy is λ_0. On changing temperature the wavelength corresponding to maximum energy is increased by $\frac{2\lambda_0}{3}$. Now the power radiated by the body will be

(A) $\frac{2P_0}{3}$

(B) $\frac{4P_0}{9}$

(C) $\frac{16P_0}{81}$

(D) $\frac{256P_0}{729}$

Ans. (C)

Sol.

$$\frac{P_0}{P}=\left(\frac{T_0}{T}\right)^4, \lambda_0 T_0=\lambda T$$

37. An object cools in 5 minutes from 50°C to 40°C. Temperature of the surrounding is 30°C. Assuming Newtons' law of cooling to be valid, calculate approximate temperature of the object after next 5 minutes.

(A) 37°C

(B) 32°C

(C) 33°C

(D) 35°C

Ans. (D)

Sol.

$$\frac{-10}{5}=-b[45-30]$$

Let final temperature be θ

So; $\frac{\theta-40}{5}=-b\left[\frac{40+\theta}{2}-30\right]$

$$\Rightarrow \frac{10}{40-\theta}=\frac{15}{\frac{40+\theta}{2}-30}$$

$$\Rightarrow 40+\theta-60=120-3\theta$$

$$\Rightarrow \theta=35^{\circ}C$$

38. Two bodies A and B having equal surface areas are maintained at temperatures 10°C and 20°C. The thermal radiation emitted in a given time by A and B are in the ratio.

(A) 1:1.15

(B) 1:2

(C) 1:4

(D) 1:1.6

Ans. (A)

Sol. Temperature of body A, $T_A=10^{\circ}C=273+10=283$ K

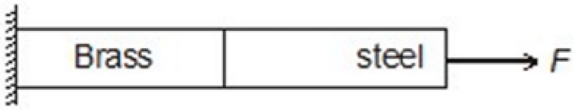
Temperature of body B, $T_B = 20^\circ C = 273 + 20 = 293K$

we know from Stefan's law,

$$\frac{U_A}{U_B} = \frac{\sigma\ A\ T_A^4}{\sigma\ A\ T_B^4} = \frac{T_A^4}{T_B^4} = \left(\frac{283}{293}\right)^4$$

$$\Rightarrow \frac{u_A}{u_B} = \frac{1}{1.15}$$

39. In an experiment, brass and steel wires of length 1 m each with areas of cross section 1 mm^2 each are used. The wires are connected in series and one end of the combined wire is connected to a rigid support and other end is subjected to elongation. The stress required to produce a net elongation of 0.2 mm is, [Given, the Young's Modulus for steel and brass are, respectively, 120 x 10^9 N/m^2 and 60 $\times$ 10^9N/m^2]



(A) $1.8 \times 10^6\ N/m^2$

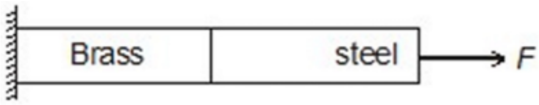
(B) $1.2 \times 10^6\ N/m^2$

(C) $8.0 \times 10^6\ N/m^2$

(D) $0.2 \times 10^6\ N/m^2$

Ans. (C)

Sol.



Corresponding to the stress (σ)

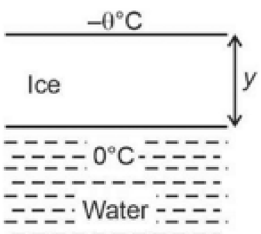
Total elongation $\Delta l_{net} = \frac{\sigma L_1}{Y_1} + \frac{\sigma L_2}{Y_2}$

$$\sigma = \Delta l\left(\frac{Y_1 Y_2}{Y_1 + Y_2}\right)$$

$$= 0.2 \times 10^{-3} \times \left(\frac{120 \times 60}{180}\right) \times 10^9$$

$$= 8 \times 10^6 \frac{N}{m^2}$$

40. A lake is freezing from the top with thickness of ice being y at time t. Assume the water below ice to be at 0°C while temperature of atmosphere above the ice surface is - θ°C. Ignore the difference in densities of ice and water. Let t_1 is the time taken for ice thickness to increase from 10 cm to 20 cm and t_2 is the time taken for ice thickness to increase from 20 cm to 30 cm. Calculate $\frac{t_1}{t_2}$



(A) 1/1

(B) 2/5

(C) 3/5

(D) 5/7

Ans. (C)

Sol. $t \alpha y_f^2 - y_i^2$

$$\Rightarrow \frac{t_1}{t_2} = \frac{(20)^2 - (10)^2}{(30)^2 - (20)^2} = \frac{3}{5}$$

41. A metal piece of 100 gm, initially at temperature 180°C is dropped in a copper calorimeter (of water equivalent 50 gm) containing 100 cc of water at 20°C. The final temperature is 30°C. Calculate the specific heat capacity of the metal. [Given that specific heat capacity of water=1 cal/gm°C]

(A) 0.6 cal/gm°C

(B) 0.4 cal/gm°C

(C) 0.2 cal/gm°C

(D) 0.1 cal/gm°C

Ans. (D)

Sol.

$$150 \times 1 \times [30 - 20] + 100 \times s \times (30 - 180) = 0$$

$$\Rightarrow s = \frac{0.1\text{cal}}{\text{gm}^\circ\text{C}}$$

42. Two rods A and B of identical dimensions are at temperature 30°C. If A is heated upto 180°C and B upto T° C, then the new lengths are the same. If the ratio of the coefficients of linear expansion of A and B is 4:3, then the value of T is

(A) 270°C

(B) 230°C

(C) 250°C

(D) 200°C

Ans. (B)

Sol. $\Delta\ell = \ell_0 \alpha\ (\Delta T)$

$$\alpha_A(180 - 30) = \alpha_B\ (T - 30)$$

$$4(180 - 30) = 3(T - 30)$$

43. A boy's catapult is made of rubber cord which is 42 cm long, with 6 mm diameter of cross-section and of negligible mass. The boy keeps a stone weighing 0.02 kg on it and stretches the cord by 20 cm by applying a constant force. When released, the stone flies off with a velocity of 20 ms^{-1}. Neglect the change in the area of cross-section of the cord while stretched. The Young's modulus of rubber is of the order of

(A) 10^4 Nm^{-2}

(B) 10^3 Nm^{-2}

(C) 10^8 Nm^{-2}

(D) 10^6 Nm^{-2}

Ans. (D)

Sol.

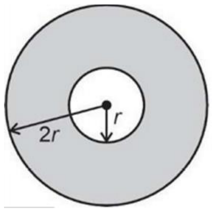
$$\frac{1}{2}\cdot\left(\frac{YA}{L}\right)(\Delta l)^2 = \frac{1}{2}mv^2$$

$$\Rightarrow \quad Y = \frac{mv^2 L}{A(\Delta l)^2}$$

$$= \frac{0.02\times 400\times 0.42\times 4}{\pi\times 36\times 10^{-6}\times 0.04}$$

$$= 2.9\times 10^6 N/m^2$$

44. Figure shows a thick spherical shell of inner radius r and outer radius 2r.A point source of heat producing power P is placed at the centre of the shell. Calculate the difference in temperature between the inner and outer surfaces of the shell if thermal conductivity of the material of shell is k



(A) $\frac{P}{8\pi kr}$

(B) $\frac{P}{4\pi kr}$

(C) $\frac{P}{2\pi kr}$

(D) $\frac{P}{\pi kr}$

Ans. (A)

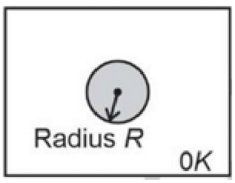
Sol. $P = -k\times 4\pi x^2\frac{dT}{dx}$

$$\Rightarrow \quad \Delta T = T_{\text{inner}} - T_{\text{outer}} = \frac{P}{4\pi k}\int_r^{2r}\frac{dx}{x^2}$$

$$\Rightarrow \Delta T = \frac{P}{8\pi kr}$$

45. A solid iron sphere of density ρ, specific heat capacity C and radius R is suspended in a chamber whose walls are maintained at 0K.

Assuming that the sphere behaves like an ideal black body, calculate the time taken by it to cool from initial temperature T_0 to final temperature $\frac{T_0}{2}$



(A) $\frac{5\rho RC}{9\sigma T_0^3}$

(B) $\frac{8\rho RC}{9\sigma T_0^3}$

(C) $\frac{7\rho RC}{9\sigma T_0^3}$

(D) $\frac{4\rho RC}{9\sigma T_0^3}$

Ans. (C)

Sol. $-mC\frac{dT}{dt} = \sigma AT^4$

$$\Rightarrow \quad dt = -\frac{mC}{\sigma A}\int_{T_0}^{\frac{T_0}{2}}\frac{dT}{T^4}$$

$$\Rightarrow \quad t = -\frac{\rho \times \frac{4}{3}\pi R^3 C}{\sigma \times 4\pi R^2}\left[\frac{T^{-3}}{-3}\right]_{T_0}^{T_0/2}$$

$$\Rightarrow \quad t = +\frac{\rho RC}{9\sigma}\left(\frac{7}{T_0^3}\right)$$

$$\Rightarrow \quad t = +\frac{\rho RC}{9\sigma}\left(\frac{7}{T_0^3}\right)$$

Or $t = \frac{7\rho RC}{9\sigma T_0^3}$

SECTION-II

46. Two liquids A and B are at temperatures of 75°C and 150°C respectively. Their masses are in the ratio of 2 : 3 and specific heats are in the ratio 3 : 4. The resultant temperature of the mixture, when the above liquids, are mixed (Neglect the water equivalent of container) is

(Answer in degree celsius)

Ans. (125)

Sol. $m_A S_A$ (q - 75) = $m_B S_B$ (150 - q)

47. 2 kg of ice at -20°C is mixed with 5 kg of water at 20°C in an insulating vessel having a negligible heat capacity. The final mass of water in the vessel. (The specific heat of water and ice are 1k cal/kg°C and 0.5 k cal/kg°C respectively and the latent heat of fusion of ice is 80 k cal/kg) is. (Answer in kg)

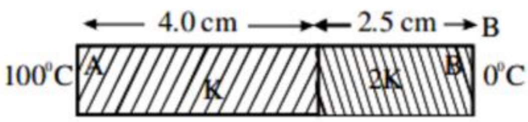
Ans. (6)

Sol. Let 'm' be mass of ice melted into water

M_{ice} X S_{ice} X 20 + m X L_{ice} = m_{water} X S_w X 20

final mass of water in vessel = m + 5kg.

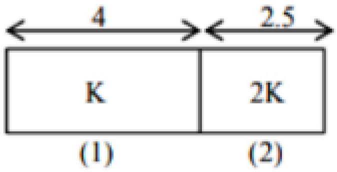
48. As per the given figure, two plates A and B of thermal conductivity K and 2 K are joined together to form a compound plate. The lengths of plates are 4.0 cm and 2.5 cm respectively and the area of cross-section is 120 cm^2 for each plate. The equivalent thermal conductivity of the compound plate is $(1 + 5/a)K$, then the value of a will be _______.



Ans. (21)

Sol.

$$\frac{\Delta Q}{\Delta t} = \left(\frac{1}{R}\right)\Delta T$$



R: Thermal resistivity

$$\therefore R_1 = \frac{L_1}{K_1 A} = \frac{L_1}{K(120)}$$

L_1 = 4cm

A= 120 cm^2

$$R_2 = \frac{2.5}{(2K)(120)}$$

Now, R_{cq} of this series combination

$$R_{cq} = R_1 + R_2$$

where $L_{eq} = 4 + 2.5 = 6.5$

$I_{eq} = 4 + 2.5 = 6.5$

e_s

$$\frac{L_{eq}}{K_{eq}(A)} = \frac{4}{K(120)} + \frac{2.5}{2K(120)}$$

$$\frac{6.5}{K_{eq}(120)} = \frac{4}{K(120)} + \frac{5}{4K(120)}$$

$$\frac{6.5}{K_{eq}} = \frac{21}{4K}$$

$$K_{cq} = \frac{26}{21}K = \left(1 + \frac{5}{21}\right)K$$

$\therefore a = 21$

49. The area of cross-section of a railway track is 0.01m^2. The temperature of track increases by 10°C but track is not allowed to expand linearly. Coefficient of linear expansion of material of track is 10^{-5}/°C. Then find energy stored per meter in the track in J/m. (Young's modulus of material of track is 10^{11} Nm^{-2}).

Ans. (5)

Sol. As the tracks won' t be allowed to expand linearly, the rise in temperature would lead to developing thermal stress in track.

$\frac{\text{Stress}(\sigma)}{\gamma} = \alpha \Delta T$ or $\sigma = Y\alpha\Delta T$

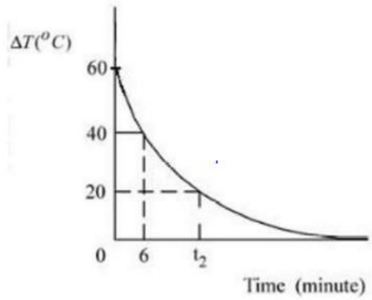
Energy stored per unit volume $= \frac{1}{2}\frac{\sigma^2}{\gamma}$

$\Rightarrow$ Energy stored per unit length= $\frac{A\sigma^2}{2\gamma}$

$= \frac{A}{2} \times Y\alpha^2 \Delta T^2$

$= \frac{10^{-2}\times10^{11}\times10^{-10}\times100}{2} = 5$ J/m

50. In an experiment to verify Newton's law of cooling, a "graph is plotted between, the temperature difference (ΔT) of the water and surroundings and time as shown in figure. The initial temperature of water is "taken as 80°C.The value of t_2 as mentioned in the graph will be



Ans. (16)

Sol. Temperature of surrounding = 20°C

For $0 \rightarrow 6$ minutes, average temp. = 20°C

$\rightarrow$Rate of cooling ∝ 70° - 20°C = 50°C

For $6 \rightarrow t_2$ minutes, average temp.= 50°C

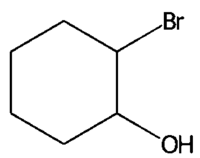
$\rightarrow$Rate of cooling ∝ 30°C

$t_2 - 6 = \frac{5}{3}$(6minutes)

$\Rightarrow t_2 = 16$ minutes

PART-C: CHEMISTRY
SECTION-I

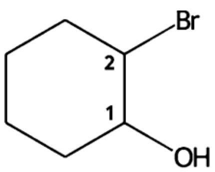
51. Write the IUPAC Name of following compound



(A) 2-Bromo cyclohexanol
(B) 1-Bromo 2-Hydroxy Cyclohexane
(C) 2-Hydroxy cyclohexanol
(D) Bromo cyclohexanol

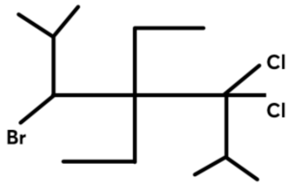
Ans. (A)

Sol.



2-Bromo cyclohexanol

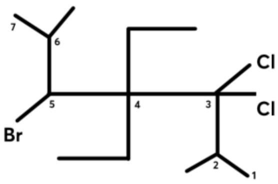
52. Write the IUPAC Name of following compound



(A) 3, 3-dichloro-5-Bromo-4, 4-diethyl-2, 6-dimethyl heptane
(B) 4, 4-diethyl-2, 6-dimethyl-3, 3-dichloro-5-bromo heptane
(C) 4, 4-diethyl-2, 6-dimethyl-5-Bromo-3, 3-dichloro heptane
(D) 5-Bromo-3, 3-dichloro-4, 4-diethyl-2, 6-dimethyl heptane

Ans. (D)

Sol.



5-Bromo-3, 3-dichloro-4, 4-diethyl-2, 6-dimethyl Heptane

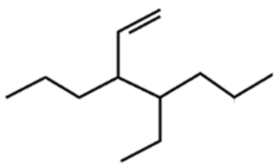
53. Write IUPAC Name of following compound

(A) 5-sec butyl, 3-sec-propyl nonane
(B) 3 sec-propyl, 5-sec-butyl nonane
(C) 5-sec-Butyl-3-ethyl–2-methyl nonane
(D) 5-Isobutyl,-3-sec-propyl nonane

Ans. (C)

Sol. 5-sec-Butyl-3-ethyl–2-methyl nonane

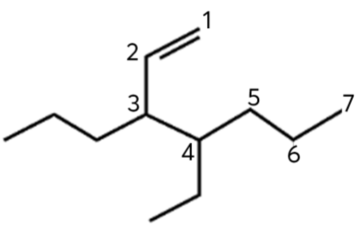
54. Write IUPAC Name of following compound



(A) 4-ethenyl-5-Ethyl Octane
(B) 5-ethyl-4- ethenyl octane
(C) 4-ethyl-5- ethenyl octane
(D) 4-ethyl-3-propyl hept-1-ene

Ans. (D)

Sol.



4-ethyl-3-propyl hept–1–ene

55. Write IUPAC Name of compound (i) and Compound (ii)

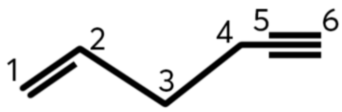
(i)

(ii)

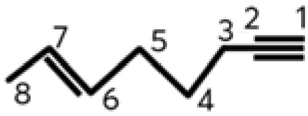
(A) Hex-5-en-1-yne, oct-6-en-1-yne
(B) Hex-1-en-5-yne, Oct-2-en-7-yne
(C) Hex-5-yne-1-en, Oct-1-yne-6-ene
(D) Hex-1-en-5-yne, Oct-6-en-1-yne

Ans. (D)

Sol.

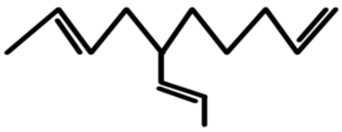


(i) Hex-1-en-5-yne



(ii) Oct-6-en-1-yne

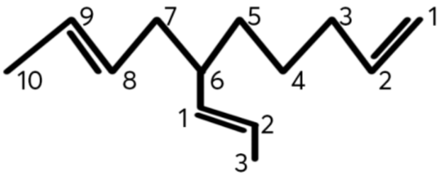
56. IUPAC Name of compound is



(A) 6-(Prop-1-enyl) deca- 1,8-diene
(B) 6-(Prop-1-en) deca–1, 8-diene
(C) 5-(Prop-1-en) deca-2, 9-diene
(D) 5-(Prop-1-enyl) deca-2, 9-diene

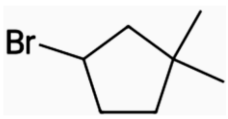
Ans. (A)

Sol.



6-(Prop-1-enyl)deca-1, 8-diene

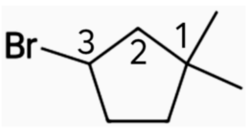
57. IUPAC Name of compound is



(A) 3-Bromo-1, 1-dimethyl cyclopentane
(B) 1-Bromo-3, 3-dimethyl cyclopentane
(C) 1-Bromo-4, 4-dimethyl cyclopentane
(D) 4-Bromo-1, 1-dimethyl cyclopentane

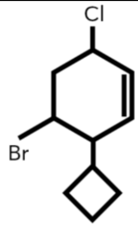
Ans. (A)

Sol.



3-Bromo-1, 1-dimethyl cyclopentane

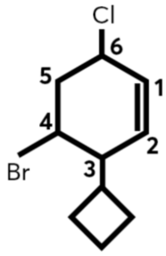
58. IUPAC Name of following compound is



(A) 5-Bromo-3-chloro-6- cyclobutyl cyclohexene
(B) 5-Bromo-6-cyclobutyl-3-chloro cyclohexene
(C) 4-Bromo-3-cyclobutyl-6-chloro cyclohexene
(D) 4-Bromo-6-chloro-3-cyclobutyl cyclohexene

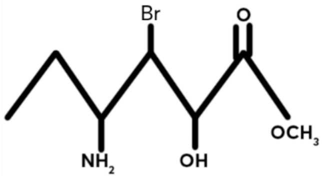
Ans. (D)

Sol.



4-Bromo-6-chloro-3-cyclobutyl Cyclohexene

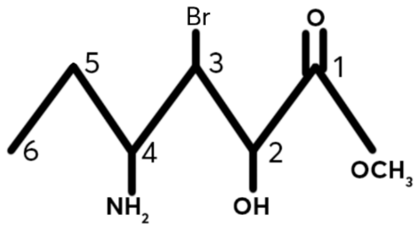
59. IUPAC Name of Following compound



(A) Methyl 4-amino-3-bromo-2-hydroxy hexanoate
(B) Methyl 3-bromo-4-hydroxy-4-amino hexanoate
(C) Methyl 2-hydroxy-4-amino-3-bromo hexanoate
(D) Methyl 3-bromo-2-hydroxy-4 amino hexanoate

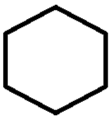
Ans. (A)

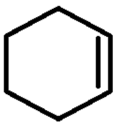
Sol.

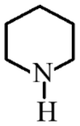


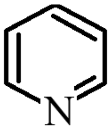
Methyl-4-Amino-3-Bromo-2 Hydroxy Hexanoate

60. Which of the following is a heterocyclic aliphatic compound?

(A) 

(B) 

(C) 

(D) 

Ans. (C)

Sol. Concept based

61. One gram of the acid $C_6H_{10}O_4$ requires 0.768 g of KOH for complete neutralization. How many neutralizable hydrogen atoms are in this molecule?

(A) 4

(B) 3

(C) 2

(D) 1

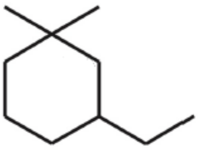
Ans. (C)

Sol. $n_{eq}C_6H_{10}O_4 = n_{eq}KOH$

or $\frac{1}{146} \times \text{Basicity} = \frac{0.768}{56} \times 1$

$\Rightarrow$ Basicity of $C_6H_{10}O_4 = 2$

62. The IUPAC name of given organic compound is:



(A) 3-Ethyl-1, 1-dimethylcyclohexane

(B) 1-ethyl-3, 3-dimethylcyclohexane

(C) Both (A) and (B)

(D) None of these

Ans. (A)

Sol. IUPAC Rules

63. A 0.1 M - $KMnO_4$ solution is used for the following titration. What volume of the solution will be required to react with 0.158 g of $Na_2S_2O_3$?

$S_2O_3^{2-} + MnO_4^- + H_2O \longrightarrow MnO_2(s) + SO_4^{2-} + OH^-$

(A) 80 ml

(B) 26.67 ml

(C) 13.33 ml

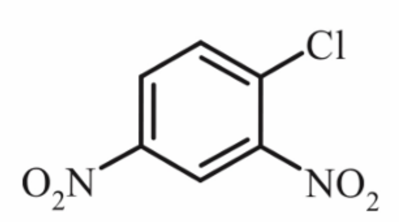
(D) 16 ml

Ans. (B)

Sol. $n_{eq}KMnO_4 = n_{eq}Na_2S_2O_3$

$\frac{V \times 0.1}{1000} \times 3 = \frac{0.158}{158} \times 8 \Rightarrow V = 26.67\text{ml}$

64. IUPAC name of given compound is:



(A) 4-chloro,1,3-dinitrobenzene

(B) 1-Chloro-2,4-dinitrobenzene

(C) Both (A) and (B)

(D) None of these

Ans. (B)

Sol. Substituent of the base compound is assigned number 1 and then the direction of numbering is chosen such that the next substituent gets the lowest number. The substituents appear in the name in alphabetical order

65. For the redox reaction,

$Zn + NO_3^- \rightarrow Zn^{2+} + NH_4^+$

on basic medium, the coefficients of Zn, NO_3^- and OH^- in the balanced equation, respectively, are

(A) 4,1,7

(B) 7,4,1

(C) 4,1,10

(D) 1,4,10

Ans. (C)

Sol. $4Zn + NO_3^- + 7H_2O \rightarrow 4Zn^{2+} + NH_4^+ + 10OH^-$

66. The oxidation number of phosphorus in $Mg_2P_2O_7$ is

(A) +5

(B) −5

(C) +6

(D) −7

Ans. (A)

Sol. 2(+2) + 2x + 7 (−2) = 0 => x = +5.

67. Purple of Cassius is prepared by reducing $AuCl_3$ to colloidal gold by $SnCl_2$. A 1 L solution containing 1.97 mg of gold per ml is prepared from 0.05 M solution of AuCl, by reduction with appropriate amount of 0.05 M-SnCl, solution, the resulting solution being diluted tó 1 L with water. The volume of stannous chloride solution required, if its oxidation product is $SnCl_4$(aq), is (Au=197)

(A) 300 ml

(B) 500 ml

(C) 800 ml

(D) 100 ml

Ans. (A)

Sol.

$n_{eq}\mathrm{Au} = n_{eq}\mathrm{SnCl_2}$

$$\text{or} \frac{1.97}{197} \times 3 = \frac{V \times 0.05}{1000} \times 2 \Rightarrow V = 300\text{ml}$$

68. IUPAC name of the given compound is

```
CH3-CH2-CH-CH2-CH2-CH-CH2-CH3
        |           |
        OH          CH3
```

(A) 6-Methyloctan-3-ol

(B) 3-Methyloctan-6-ol

(C) 6-Methyloctane-3-ol

(D) none of these

Ans. (A)

Sol. IUPAC Rules

69. What volume of 0.2 M-$KMnO_4$ solution is needed for complete reaction with 26.56 gm $Fe_{0.9}O_{1.0}$ in acidic medium? (Fe= 56)

(A) 280 ml

(B) $\frac{280}{9}$ ml

(C) $\frac{2800}{9}$ ml

(D) 560 ml

Ans. (A)

Sol. $n_{eq}\mathrm{Fe_{0.9}O} = n_{eq}\mathrm{KMnO_4}$

$$\text{or} \frac{26.56}{66.4} \times 0.7 = \frac{V \times 0.2}{1000} \times 5 \Rightarrow V = 280\text{ml}$$

70. A solution of $Na_2S_2O_3$ is standardized iodometrically against $\tilde{0}.167$ g of $KBrO_3$. This process required 50 ml of the $Na_2S_2O_3$ solution. What is the normality of the $Na_2S_2O_3$? (K = 39, Br=80)

$Na_2S_2O_3 + KBrO_3 \longrightarrow Na_2S_4O_6 + Br^-$

(A) 0.2 N

(B) 0.12 N

(C) 0.72 N

(D) 0.02 N

Ans. (B)

Sol. $n_{eq}\mathrm{Na_2S_2O_3} = n_{eq}\mathrm{KBrO_3}$

$\frac{50}{1000}$ x N = $\frac{0.167}{167}$ x 6

N = 0.12

SECTION-II

71. See the following chemical reaction

$C_2O_7^{-2} + XH^+ + 6Fe^{+2} \longrightarrow YCr^{+3} + 6Fe^{+3} + ZH_2O$

The sum of X, Y is

Ans. (16)

Sol. $Cr_2O_7^{-2} + 14H^+ + 6Fe^{+2} \rightarrow 2Cr^{+3} + 6\ Fe^{+3} + 7H_2O$

72. What is the n – factor of $Na_2S_2O_3$ in the following reaction:

$$I_2 + Na_2S_2O_3 \rightarrow NaI + Na_2S_4O_6$$

Ans. (1)

Sol. Concept based

73. The saponification number of fat or oil is defined as the number of mg of KOH required to saponify 1 g oil or fat. A sample of peanut oil weighing 1.5 g is added to 25.0 ml of 0.4 M-KOH. After saponification is complete, 8.0 ml of 0.25 MH_2SO_4 is needed to neutralize excess of KOH. What is the saponification number of peanut oil?

Ans. (224)

Sol. Moles of KOH used in saponification

$$= \frac{25\times0.4}{1000} - \frac{8.0\times0.25}{1000}\times 2 = 6\times10^{-3}$$

$\therefore$ Mass of KOH used$= 6\times10^{-3}\times 56 = 0.336$ g

$\therefore$ Saponification number$= \frac{0.336\times10^3}{1.5} = 224$

74. The value of n in the following processes: $AO_4^{n-} + 2e \rightarrow HAO_n^{2-}$ is

Ans. (3)

Sol.

$$AO_4^{n-} + (9-2n)H^+ + 2e^- \rightarrow HAO_n^{2-} + (4-n)H_2O$$

From charge conservation,

$$(-n) + (9-2n) + (-2) = -2 \Rightarrow n = 3.$$

75. Calculate the amount (in mg) of SeO_3^{2-} in solution, where 20 ml of M/40 solution of $KBrO_3$ was added to a definite volume of SeO_3^{2-} solution. The bromine evolved was removed by boiling and excess of $KBrO_3$ was back titrated with 7.5 ml of M/25 solution of $NaAsO_2$. The reactions are (Se=79)

$$SeO_3^{2-} + BrO_3^- + H^+ \rightarrow SeO_4^{2-} + Br_2 + H_2O$$

$$BrO_3^- + AsO_2^- + H_2O \rightarrow Br^- + AsO_4^{3-} + H^+$$

Ans. (127)

Sol. $n_{eq}SeO_3^{2-} = n_{eq}BrO_3^- \Rightarrow n\times 2 = \frac{V_1\times1/40}{1000}\times 5$ (1)

$n_{eq}AsO_2^- = n_{eq}BrO_3^-$

$\Rightarrow \frac{7.5\times\frac{1}{25}}{1000}\times 2 = \frac{V_2\times\frac{1}{40}}{1000}\times 6$ (2)

And $V_1 + V_2 = 20$ (3)

From (1),(2) and (3),we get:

$n = 10^{-3}$

∴Mass of $SeO_3^{2-} = 10^{-3} \times 127$ g = 127 mg

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