

Date: 30/11/2025

Question Paper Code: H04

Max. Marks: 216

Time: 150 Minutes



Corporate Office : AESL, 3rd Floor, Incuspaze Campus-2, Plot-13, Sector-18,
Udyog Vihar, Gurugram, Haryana-122015

Answers & Solutions

For

INDIAN ASSOCIATION OF PHYSICS TEACHERS Standard Examination in High School Science (SEHSS-2025)

INSTRUCTIONS TO CANDIDATES

1. Use of mobile phone, smart watch, and iPad during examination is **STRICTLY PROHIBITED**.
2. On the OMR Sheet, make all the entries carefully in the space provided **ONLY** in **BLOCK CAPITALS** as well as by properly darkening the appropriate bubbles.
Incomplete/ incorrect/ carelessly filled information may disqualify your candidature.
3. On the OMR Answer Sheet, use only **BLUE** or **BLACK BALL POINT PEN** for making entries and filling the bubbles.
4. There are 60 questions in this paper. Attempt All the 60 Questions.
5. Question paper has two parts. In part A (Q. No. 1 to 48) each question has four alternatives, out of which **only one** is correct. Choose the correct alternative and fill the appropriate bubble, as shown.

Q. No. 12 a c d

In part B (Q. No. 49 to 60) each question has four alternatives out of which any number of alternative(s) (1, 2, 3 or 4) may be correct. You have to choose **all** correct alternative(s) and fill the appropriate bubble(s), as shown

Q. No. 52 a c

6. For **Part A**, each correct answer carries 3 marks whereas 1 mark will be deducted for each wrong answer. In **Part B**, you get 6 marks if all the correct alternatives are marked and no incorrect. No negative marks in this part.
7. Rough work should be done in the space provided.
8. Calculator is **not** allowed.
9. No candidate should leave the examination hall before the completion of the examination.
10. After submitting answer paper, take away the question paper & candidate's copy of the OMR for your future reference.

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ATTEMPT ALL SIXTY QUESTIONS

Part A

Out of the Four Options only One is Correct. Bubble the Correct Option.

1. A point particle of mass m moving with velocity u in a straight line is subjected to a constant acceleration at an instant $t = 0$. Sometime later, at time $t = n$, its velocity is found to be n time the initial velocity. The distance covered by the particle during the time interval $t = 0$ to $t = n$ is expressed as

(a) $\frac{n(n+1)u}{2}$

(b) $\frac{(n-1)u}{2}$

(c) $\frac{1}{2}nu^2$

(d) $\frac{2u(n-1)}{n}$

Answer (a)

Sol. Using first equation of motion

$$v = u + at$$

At $t = n$

$$un = u + an$$

$$\Rightarrow a = \frac{u(n-1)}{n} \quad \dots(i)$$

Using second equation of motion

$$s = ut + \frac{1}{2}at^2$$

At $t = n$

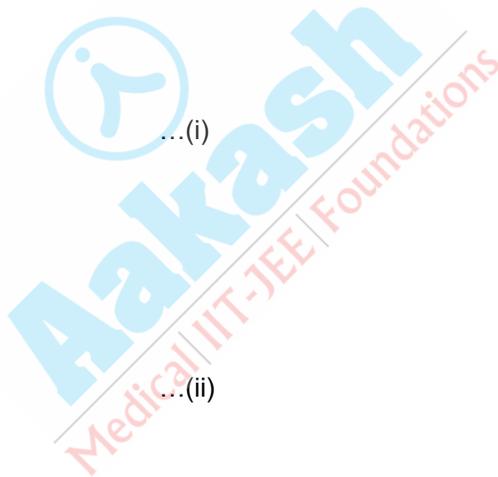
$$s = un + \frac{1}{2}an^2 \quad \dots(ii)$$

From equations (i) and (ii)

$$s = un + \frac{1}{2} \left(\frac{u(n-1)}{n} \right) n^2$$

$$= un + \frac{un^2}{2} - \frac{un}{2}$$

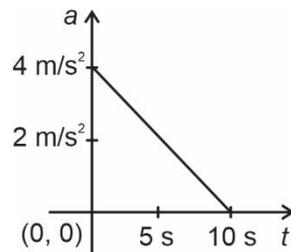
$$s_n = \frac{un}{2}(1+n)$$



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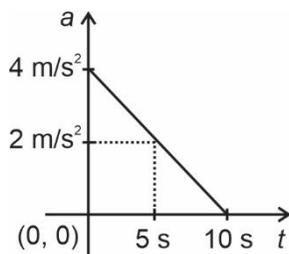
2. The following figure represents the acceleration versus time graph of a particle which starts its journey from the rest position at time $t = 0$. The velocity of the particle at $t = 5$ s is



- (a) 80 m/s
(b) 40 m/s
(c) 25 m/s
(d) 15 m/s

Answer (d)

Sol. From the given figure



Velocity of the particle = area under $a-t$ graph

$$v = \frac{1}{2} \times 5 \times (4 - 2) + 2 \times 5$$

$$= 5 + 10 = 15 \text{ m/s}$$

3. The heart of an animal pumps 40 cc of blood per second under the pressure 15000 N/m². The power of the heart of the animal is
- (a) 6 W
(b) 0.6 W
(c) 6×10^5 W
(d) 0.06 W

Answer (b)

$$\text{Sol. Power} = \frac{W}{t} = \frac{F \cdot d}{t} = \frac{P \cdot A \cdot d}{t} = \frac{P \cdot V}{t}$$

$$\text{Power} = \frac{15000 \times 40 \times 10^{-6}}{1}$$

$$= 0.6 \text{ W}$$

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4. A small metallic spherical ball is dropped from height h on the wet clay on the Earth surface. It travels distance S inside the wet clay before it stops. The uniform resistive force offered by the clay to the ball, as it penetrates a vertical distance S through the clay, is (the size of the ball is ignored as compared to S)

(a) $mg\left(1 + \frac{S}{h}\right)$

(b) mg

(c) $mg\left(1 + \frac{h}{S}\right)$

(d) $mg\left(1 + \frac{h}{S}\right)^2$

Answer (c)

Sol. By work-energy theorem $w_f + w_{mg} = \Delta K.E.$

$$-FS + mgS = 0 - mgh$$

$$FS = mg(S + h)$$

$$F = mg\left(1 + \frac{h}{S}\right)$$

5. A bullet of mass 10 g is moving with a speed u when it enters a bunch of a certain identical fixed wooden blocks kept in sequence in line. The velocity of the bullet drops to zero as it just leaves the third plank. How many such planks will the same bullet can penetrate when the initial speed of the bullet is doubled (assume all the planks to be fixed on the floor and the bullet travels horizontally)

(a) 4

(b) 6

(c) 12

(d) 10

Answer (c)

Sol. $KE = \frac{1}{2}mu^2$

Loss in energy in each plank = $\frac{KE}{3}$

$$KE' = \frac{1}{2}m(2u)^2$$

$$KE' = 4KE$$

Number of planks penetrated = $\frac{KE'}{\text{Loss in energy in each plank}}$

$$= \frac{4KE}{\left(\frac{KE}{3}\right)} = 12$$

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8. The mass of the Moon is $\frac{1}{81}$ times the mass of Earth while the radius of the Moon is $\frac{1}{3.7}$ times the radius (R) of the Earth. At what height h above the surface of Earth, an object will have the same weight as it weighs on the surface of the Moon?
- (a) $h = 21.9 R$ (b) $h = 3.68 R$
(c) $h = 2.43 R$ (d) $h = 1.43 R$

Answer (d)

Sol. Weight on moon surface

$$W_m = \frac{G \left(\frac{M_E}{81} \right) m}{\left(\frac{R_E}{3.7} \right)^2} = 0.169 W_E \quad \dots(i)$$

Weight on Earth at height h

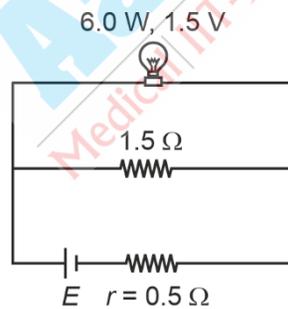
$$W(h) = W_E \left[\frac{R_E^2}{(R_E + h)^2} \right] \quad \dots(ii)$$

From equation (i) and (ii)

$$W_E \left[\frac{R_E^2}{(R_E + h)^2} \right] = 0.169 W_E$$

$$h = 1.43 R_E$$

9. A torch bulb rated as 6 W, 1.5 V is connected in a circuit as shown in the figure. The *e.m.f.* of the cell needed to make the bulb glow normally is



- (a) 4.5 V (b) 4.0 V
(c) 2.0 V (d) 1.5 V

Answer (b)

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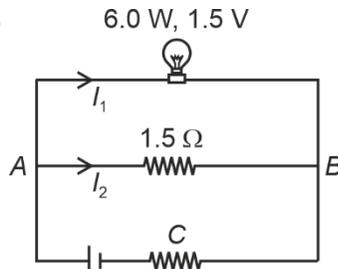
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Sol.



$$R = \frac{V^2}{P} = \frac{(1.5)^2}{6}$$

$$= \frac{3}{8} \Omega$$

$$I_1 = \frac{V}{R} = \frac{1.5}{\frac{3}{8}} = 4 \text{ A}$$

$$V_{AB} = I_2 \times 1.5$$

$$\Rightarrow 1.5 = I_2 \times 1.5$$

$$\therefore I_2 = 1 \text{ A}$$

$$I = I_1 + I_2$$

$$= 4 + 1$$

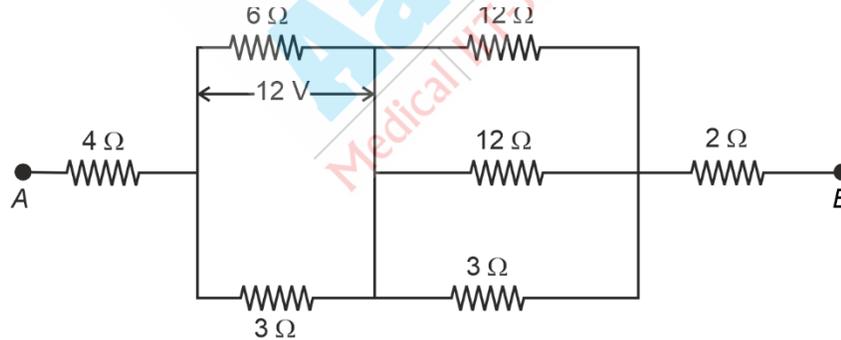
$$= 5 \text{ A}$$

$$\varepsilon = V_{AB} + I r$$

$$= 1.5 + 5 \times 0.5$$

$$= 4 \text{ V}$$

10. The given network of resistances is a part of an electric circuit containing the sources of EMF providing current. The potential difference across 6Ω resistance is measured to be 12 volt as shown in the figure. The value of potential difference across the terminal A and B is



- (a) 120 volt
(c) 48 volt

- (b) 60 volt
(d) 24 volt

Answer (b)

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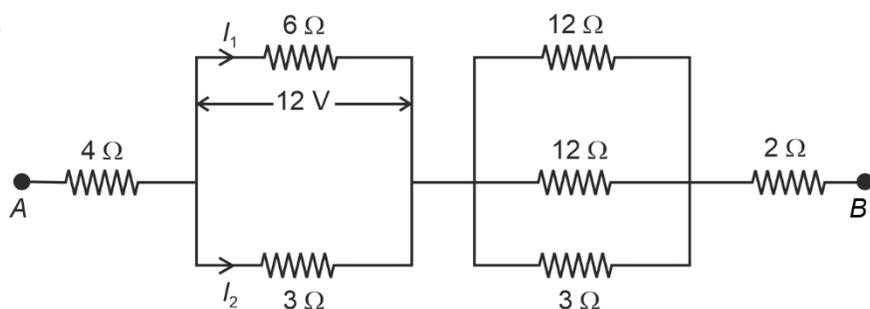
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Sol.



$$I_1 = \frac{12}{6} = 2 \text{ A}$$

$$I_2 = \frac{12}{3} = 4 \text{ A}$$

$$I = I_1 + I_2 = 2 + 4 = 6 \text{ A}$$

$$\frac{1}{R_1} = \frac{1}{6} + \frac{1}{3}$$

$$\therefore R_1 = 2 \Omega$$

$$\frac{1}{R_2} = \frac{1}{12} + \frac{1}{12} + \frac{1}{3}$$

$$\therefore R_2 = 2 \Omega$$

$$\therefore R_{\text{eq}} = 4 + 2 + 2 + 2 = 10 \Omega$$

$$\therefore V_{AB} = IR_{\text{eq}} = 6 \times 10 = 60 \text{ V}$$

11. A solid cylinder, made up of a material of resistivity ρ , has length ℓ and radius $r\sqrt{3}$. Three coaxial cylinders A, B and C of equal length ℓ have been cut from this thick cylinder. The cylinder A is a solid cylinder of radius r . B is a hollow cylinder with inner radius r and uniform wall thickness $(\sqrt{2} - 1)r$ while the hollow cylinder C has inner radius $r\sqrt{2}$ and r radius $r\sqrt{3}$. The relationship between their end-to-end resistance is

- (a) $R_A = R_B = R_C$
 (b) $R_A > R_B > R_C$
 (c) $R_A < R_B < R_C$
 (d) $R_A = 2R_B = 3R_C$

Answer (a)

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Sol. $R = \frac{\rho \ell}{A}$

$$R_A = \frac{\rho \ell}{\pi r^2}$$

$$R_B = \frac{\rho \ell}{\pi [(\sqrt{2}r)^2 - r^2]} = \frac{\rho \ell}{\pi r^2}$$

$$R_C = \frac{\rho \ell}{\pi [(\sqrt{3}r)^2 - (\sqrt{2}r)^2]}$$

$$= \frac{\rho \ell}{\pi r^2}$$

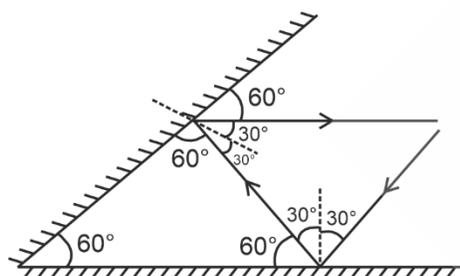
$$\therefore R_A = R_B = R_C$$

12. Two plane mirrors are inclined at an angle of 60° with each other. A ray of light is incident on one of the mirrors at an arbitrary angle of incidence $\angle i$. The ray is reflected from this mirror and falls on the second mirror where it further gets reflected parallel to the first mirror. The angle of incidence $\angle i$ is

- (a) 60° (b) 30°
 (c) 45° (d) 15°

Answer (b)

Sol.



$$\therefore \angle i = 30^\circ$$

13. Which of the following forms 'Fried-egg' like structures during lab-culture?

- (a) Mycoplasma (b) Ricketts
 (c) Spirochetes (d) *Escherichia coli*

Answer (a)

Sol. *Mycoplasma* when grow on artificial agar media, their colonies spread out in the centre and periphery, forming a distinctive 'fried egg' like appearance.

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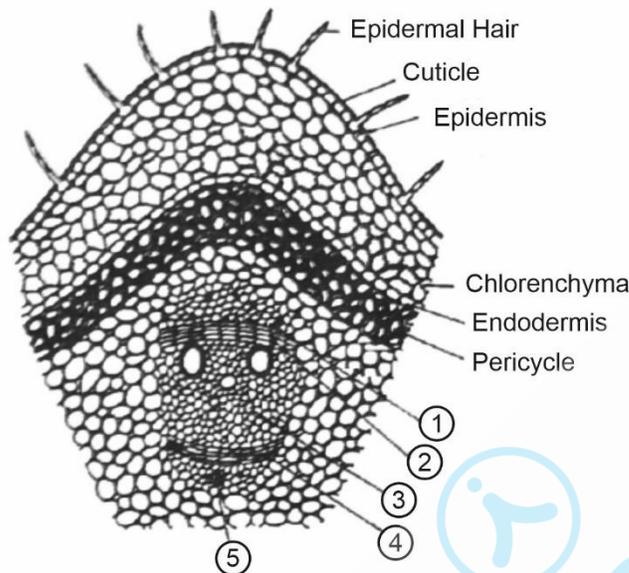
14. Which of the following is India's first cloned Gir cow, born on March 16, 2023 at the National Dairy Research Institute (NDRI) Karnal (Haryana)?

- (a) Karishma (b) Garima
(c) Mahima (d) Ganga

Answer (d)

Sol. Ganga is India's first cloned Gir cow, born on March 16, 2023 at the NDRI Karnal, Haryana.

15. Study the following T.S. of Cucurbita stem:



Choose the option showing the correct sequence of labeled parts 1 to 5:

- (a) Hypodermis, Outer Cambium, Xylem, Inner Cambium & Inner Xylem
(b) Outer Phloem, Outer Cambium, Xylem, Inner Cambium & Inner Phloem
(c) Inner Phloem, Inner Xylem, Cambium, Outer Xylem & Outer Phloem
(d) Adaxial Phloem, Adaxial Cambium, Ground Tissue, Abaxial Cambium & Abaxial Phloem

Answer (b)

Sol. Here, the labelled part

- (1) is outer phloem
(2) is outer cambium
(3) is xylem
(4) is inner cambium and
(5) is inner phloem.

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16. Following is the list (COLUMN I) of characteristics related to some animals. Make the correct matches with the animals listed under COLUMN II:

	CHARACTERISTICS		ANIMALS
(i)	Brow Spot	(a)	Viper
(ii)	Coprophagy	(b)	Man
(iii)	Ambulacra	(c)	Frog
(iv)	Viviparous	(d)	Rabbit
(v)	Coccyx	(e)	Ophioderma

Choose the correct option:

- (a) (i)-(b); (ii)-(e); (iii)-(c); (iv)-(a); (v)-(d)
 (b) (i)-(c); (ii)-(d); (iii)-(e); (iv)- (a); (v)-(b)
 (c) (i)-(d); (ii)-(c); (iii)- (b); (iv)-(a); (v)-(e)
 (d) (i)-(c); (ii)-(a); (iii)- (d); (iv)- (c); (v)-(b)

Answer (b)

Sol.

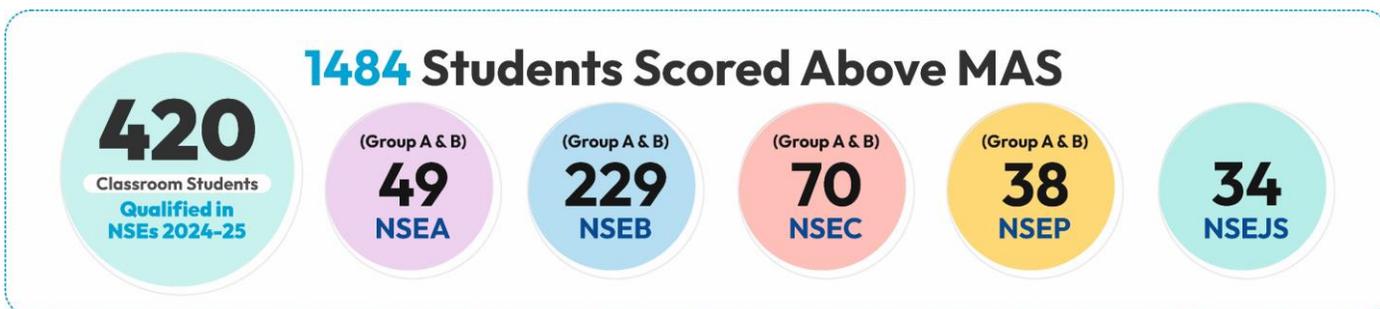
	CHARACTERISTICS		ANIMALS
(i)	Brow Spot	(c)	Frog
(ii)	Coprophagy	(d)	Rabbit
(iii)	Ambulacra	(e)	<i>Ophioderma</i>
(iv)	Viviparous	(a)	Viper
(v)	Coccyx	(b)	Man

17. Which of the following has the largest number of protected wetlands designated under the Ramsar Convention?

- (a) Mexico
 (b) India
 (c) UK
 (d) China

Answer (c)

Sol. United Kingdom (UK) has the largest number of protected wetlands designated under the Ramsar Convention.



18. Given below are two statements, one labeled as Assertion (A) and other labeled as Reason (R). Choose the correct option from the codes given below.

Assertion (A) : Complex food molecules, like proteins, carbohydrates and fats are broken down into simpler substances (e.g. amino acids, glucose and fatty acids) through hydrolysis.

Reason (R): The process of breaking down a water molecule (H_2O) into its components, hydrogen (H_2) and oxygen (O_2), is known as electrolysis. Hydrolysis, on the other hand, occurs when water reacts with another compound and splits it apart—like in the digestion of food or the breakdown of ATP in cells.

Code:

- (a) Both A and R are true and R is the correct explanation of A
- (b) Both A and R are true but R is not the correct explanation of A
- (c) A is true but R is false
- (d) R is true but A is false

Answer (b)

Sol. Electrolysis does not take place during the normal digestion of food in the human body. Digestion is primarily a series of decomposition reactions driven by enzymes and acids not by the passage of direct electric current.

19. Which of the following are known to possess two types of nuclei, Macro and Micronuclei?

- (a) Sporozoans
- (b) Ciliates
- (c) Cnidarians
- (d) Cnidosporans

Answer (b)

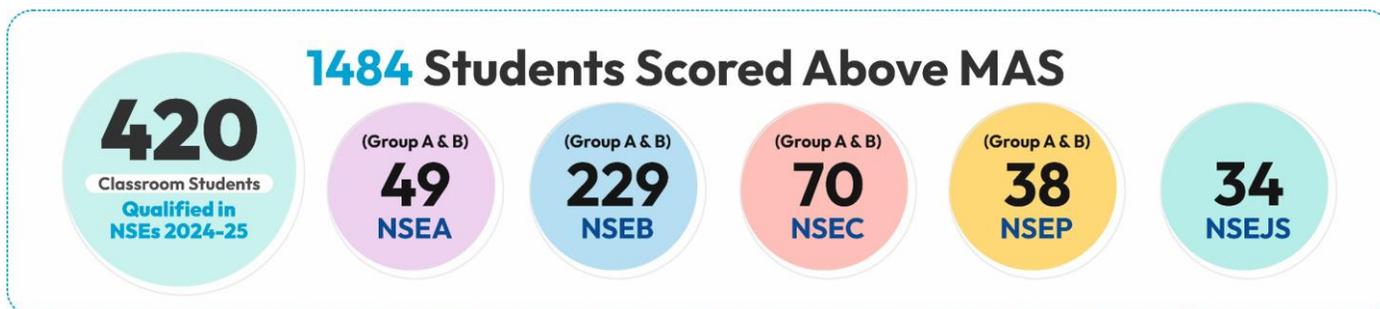
Sol. Ciliates are described as having two kinds of nuclei that is macro and micronuclei.

20. Cholesterol serves as the precursor for the synthesis of various steroid hormones. Which of the following is the source of C19 Steroidal Hormone, Androsterone?

- (a) Corpus Luteum
- (b) Kidneys
- (c) Testes
- (d) Adrenal Medulla

Answer (c)

Sol. Testes produce androgens like testosterone and androsterone from cholesterol.



23. Some characters of human beings follow a 'criss-cross' pattern of inheritance. Which of the following exemplifies this?
- (a) Sex-limited Inheritance (b) Sex-influenced Inheritance
(c) Sex-dominated Inheritance (d) Sex-linked Inheritance

Answer (d)

Sol. Sex-linked inheritance follows 'criss-cross' pattern of inheritance.

24. The periplastidial and perimitochondrial spaces are
- (a) 100-300 Å and 40-70 Å. respectively (b) 400-450 Å and 80-100 Å, respectively
(c) 350-550 Å and 10-20 Å. respectively (d) 50-100 Å and 20-30 Å, respectively

Answer (a)

Sol. The periplastidial space is about 100-300 Å.

The perimitochondrial space is about 40-70 Å.

25. An alkane having 16 covalent bonds is the m^{th} member of alkane homologous series. The ratio of carbon to hydrogen by weight in the m^{th} member of alkyne homologous series is
- (a) 15 : 2 (b) 5 : 1
(c) 36 : 5 (d) 6 : 1

Answer (c)

Sol. The alkane having 16 covalent bonds = C_5H_{12}

So, it is the 5th member of alkane homologous series.

$$\therefore m = 5$$

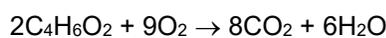
Now, 5th member of alkyne homologous series is hexyne (C_6H_{10}).

$$\begin{aligned} \therefore \text{Ratio of carbon to hydrogen by weight} \\ &= 6 \times 12 : 10 \times 1 \\ &= 72 : 10 \\ &= 36 : 5 \end{aligned}$$

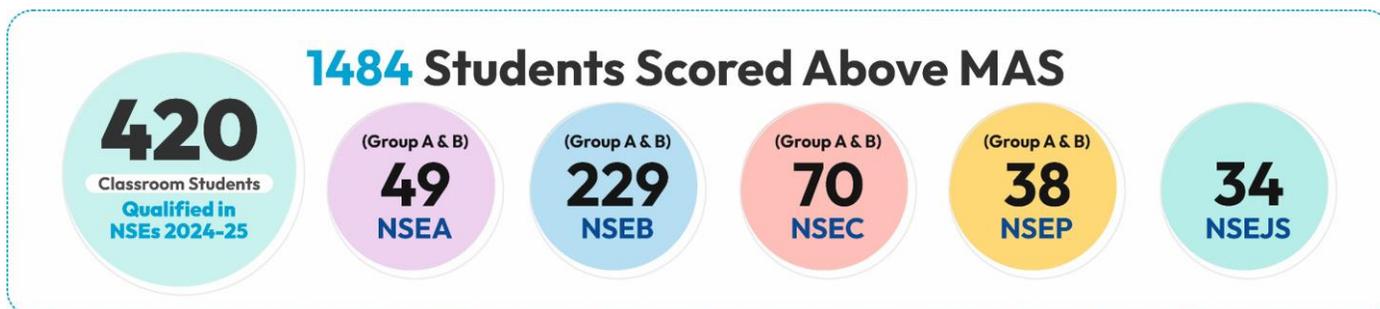
26. The IUPAC nomenclature of organic compound 'A' is But-2-enoic acid. The weight of carbon dioxide produced by complete combustion of 44 g of the organic compound 'A' would be
- (a) 44 g (b) 88 g
(c) greater than 88 g (d) greater than 44 g, but less than 88 g

Answer (c)

Sol. The balanced chemical equation for complete combustion of But-2-enoic acid:



\therefore 2 moles of But-2-enoic acid gives 8 moles of CO_2



∴ 1 mole of But-2-enoic acid gives 4 moles of CO₂

∴ No. of moles (n) of the given acid = $\frac{44}{86} \approx 0.5116$ mol

So, moles of CO₂ produced = 0.5116 × 4 = 2.0464 mol

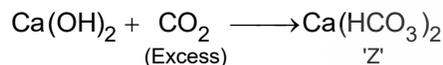
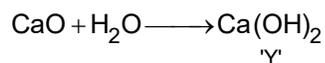
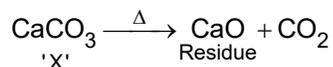
∴ Mass of CO₂ produced = Moles of CO₂ × Molar mass of CO₂
 = 2.0464 × 44
 = 90.0416 g

27. A solid compound 'X' on heating gives CO₂ gas and a residue. The residue when mixed with water forms compound 'Y'. On passing an excess of CO₂ through 'Y' in water, a clear solution of 'Z' is obtained. On boiling 'Z', the compound 'X' is reformed. The pH of aqueous solution of compound 'X' at 25°C is

- (a) 7 (b) less than 7
 (c) more than 7 (d) cannot predict

Answer (c)

Sol. According to the question

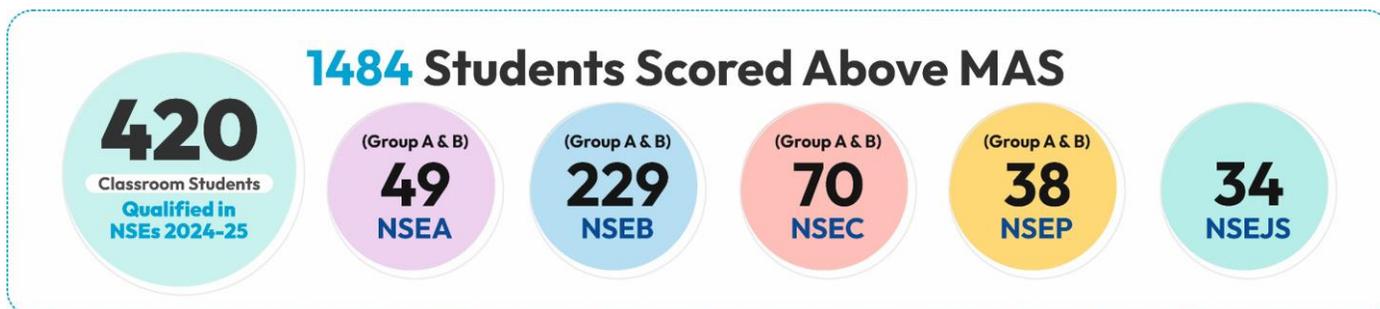


The nature of aqueous solution of CaCO₃(X) is slightly basic. So, its pH will be more than 7.

28. In an organic compound of molar mass greater than 100 containing only C, H and N, the percentage of C is 6 times the percentage of H while the sum of the percentages of C and H is 1.5 times the percentage of N. Knowing that the percentage is taken by mass, the least value of the molar mass of the organic compound is

- (a) 105
 (b) 140
 (c) 175
 (d) 210

Answer (b)



Sol. Let the % of mass of hydrogen = $x\%$

% of mass of carbon = $6x\%$

Now, $6x + x = 1.5 \times$ % of mass of nitrogen

$$\therefore \text{ % of mass of nitrogen} = \frac{7x}{1.5}$$

Element	% of mass	% of mole	Simplest ratio
H	x	$\frac{x}{1} = x$	6
C	$6x$	$\frac{6x}{12} = \frac{x}{2}$	3
N	$\frac{7x}{1.5}$	$\frac{7x}{1.5 \times 14} = \frac{x}{3}$	2

\therefore Empirical formula = $C_3H_6N_2$

Empirical formula mass = $(3 \times 12) + (6 \times 1) + (2 \times 14)$

$$= 70 \text{ g (70 } \neq 100)$$

Least molar mass = $70 \times 2 = 140$

29. A hypothetical element 'Coronium' has two isotopes A_1 and A_2 . The mass of 3×10^{22} atoms of A_1 is 20 g while the mass 1.5×10^{22} atoms of A_2 is 10.5 g. Then average atomic weight of element 'Coronium' in isotopic mixture (3×10^{22} atoms of A_1 and 1.5×10^{22} atoms of A_2) would be approximately

- (a) 418.30 (b) 408.23
(c) 406.67 (d) data insufficient

Answer (b)

Sol. For isotope A_1 :

Let molar mass = ' M_1 ' g/mol

$$\text{Molar mass} = \frac{\text{Mass}}{\text{Number of atoms}} \times N_A$$

$$M_1 = \frac{20 \text{ g}}{3 \times 10^{22}} \times 6.022 \times 10^{23}$$

$$M_1 = 401.47 \text{ g/mol}$$

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$$\Rightarrow x = \frac{300}{3}$$

$$= 100 \text{ g of A}$$

$$\therefore \text{Maximum weight of solution is} = (100 + 300) \text{ g}$$

$$= 400 \text{ g}$$

31. The nucleus of the element X with mass number 81 contains 31% more neutrons as compared to protons. Then the relationship between the nuclei of element X with nuclei of element ^{79}As is that they are
- (a) Isotopes (b) Isotones
(c) Isobars (d) Isoelectronic

Answer (b)

Sol. Let the number of protons in element 'X' = x

$$\text{So, number of neutrons} = x + 0.31x = 1.31x$$

$$\therefore \text{Mass number} = \text{Number of protons} + \text{Number of neutrons}$$

$$\therefore 81 = x + 1.31x$$

$$x = \frac{81}{2.31} \approx 35$$

Hence, element has 35 protons and 46 neutrons

So, element 'X' is $^{81}_{35}\text{Br}$

As, arsenic (As) has atomic number = 33

$$\text{So, number of neutrons in arsenic} = 79 - 33 = 46$$

\therefore Element 'X' i.e. $^{81}_{35}\text{Br}$ and $^{79}_{33}\text{As}$ are isotones.

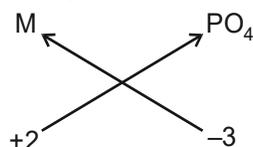
32. If the atomic weight of the most stable isotope of the element M is 40 times that of the lightest element, then formula of the compound of its phosphate is
- (a) $\text{M}_3(\text{PO}_4)_2$ (b) $\text{M}_2(\text{PO}_4)_3$
(c) MPO_4 (d) M_3PO_4

Answer (a)

Sol. Lightest element = Hydrogen (Mass = 1 u)

Atomic mass of M = 40 u i.e. calcium.

Charge on calcium ion is +2.



Formula of phosphate of M is $\text{M}_3(\text{PO}_4)_2$.

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33. An oxide of nitrogen has molecular weight 30. The total number of electrons, in a sample containing three molecules of the oxide would be (assuming that nitrogen and oxygen are present in their most stable isotopic state)
- (a) 15 (b) 30
(c) 90 (d) 45

Answer (d)

Sol. Molecular weight of oxide of nitrogen = 30 u

So, it will be NO

1 molecule of NO has 15 electrons

So 3 molecules of NO will have 45 electrons

34. Elements P, Q, R and S belong to the same group in periodic table. The oxide of P is acidic, oxide of Q and R are amphoteric while the oxide of S is basic. The most electropositive element among them is
- (a) P (b) Q
(c) R (d) S

Answer (d)

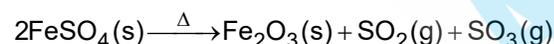
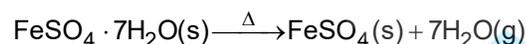
Sol. Electropositive character of elements and basic nature of their oxides increases down the group.

35. An element X, which is a yellow solid at room temperature, shows catenation and allotropy. The element X forms mainly two oxides which are also formed during the thermal decomposition of ferrous sulphate crystals and are the major air pollutants. Most likely the element X is
- (a) Carbon (b) Silicon
(c) Nitrogen (d) Sulphur

Answer (d)

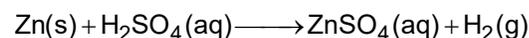
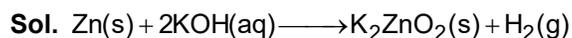
Sol. Element 'X' is Sulphur

Sulphur is yellow solid at room temperature and shows catenation and allotropy.



36. Ram treated a lustrous divalent element M with potassium hydroxide. He observed the formation of bubbles in the reaction mixture. He made the same observations when this element was treated with sulphuric acid. Then element M would be
- (a) Zinc (b) Calcium
(c) Aluminium (d) Copper

Answer (a)



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37. The unit digit of 3^{27} is

- (a) 3 (b) 1
(c) 7 (d) 9

Answer (c)

Sol. To find the unit digit of 3^{27} look at the patten of unit digits of powers of 3

$$3^1 = 3$$

$$3^2 = 9$$

$$3^3 = 27$$

$$3^4 = 81$$

The patterns repeat every 4 powers

$$3^{27} = 3^{24+3}$$

$$\Rightarrow 3^3 = 27$$

Unit digit is 7

38. The given function $f(x) = 2x^4 - 6x^3 + 3x^2 + 3x - 2$ is not divisible by $g(x)$, where the function $g(x)$ is

- (a) $g(x) = x^2 - 3x + 2$ (b) $g(x) = x - 2$
(c) $g(x) = x - 1$ (d) $g(x) = x^2 - 2x + 2$

Answer (d)

Sol. $f(x) = 2x^4 - 6x^3 + 3x^2 + 3x - 2$

$$\begin{aligned} f(1) &= 2(1)^4 - 6(1)^3 + 3(1)^2 + 3(1) - 2 \\ &= 2 - 6 + 3 + 3 - 2 \\ &= 0 \end{aligned}$$

$$\begin{aligned} f(2) &= 2(2)^4 - 6(2)^3 + 3(2)^2 + 3(2) - 2 \\ &= 32 - 48 + 12 + 6 - 2 \\ &= -16 + 16 = 0 \end{aligned}$$

So, $(x - 1)$ and $(x - 2)$ are the factors of $f(x)$

It means $(x - 1)(x - 2)$ is also factor of $f(x)$

$$\begin{aligned} (x - 1)(x - 2) &= x^2 - 2x - x + 2 \\ &= x^2 - 3x + 2 \end{aligned}$$

We can say that $f(x)$ is divisible by $(x - 1)$, $(x - 2)$ and $(x^2 - 3x + 2)$

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39. Mr. Venkat takes a trip from Chennai to Bengaluru and back. While going his speed is 40 km/hr half the way and 60 km/hr for the remaining half of the distance. When he returns he drives at 40 km/hr for half the time and at 60 km/hr for the remaining half time of travel back. His average speed in the entire trip is
- (a) 48 km/hr (b) 48.98 km/hr
(c) 49.12 km/hr (d) 50 km/hr

Answer (b)

Sol. Let distance between Chennai to Bengaluru be D km

While going

$$\begin{aligned} \text{Time taken by Venkat} &= \frac{D}{40} + \frac{D}{60} \\ &= \frac{D}{80} + \frac{D}{120} \\ &= D \left(\frac{3+2}{240} \right) \\ &= \frac{D}{48} \end{aligned}$$

$$\text{Average speed going} = \frac{D}{\frac{D}{48}} = 48 \text{ km/hr}$$

While returning

Let return time be = T

$$\text{Distance covered on return} = 40 \cdot \frac{T}{2} + 60 \cdot \frac{T}{2} = 50T$$

$$\text{Time} = \frac{\text{Distance}}{50}$$

$$\text{Return average speed} = \frac{D}{T}$$

$$\text{Total distance} = 2D, \text{ Total time} = \frac{D}{48} + \frac{D}{50} = D \left(\frac{98}{2400} \right) = \frac{49D}{1200}$$

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Average speed of entire trip(V)

$$= \frac{\text{Total distance}}{\text{Total time}}$$

$$= \frac{2D}{\left(\frac{49D}{1200}\right)}$$

$$= \frac{2400}{49}$$

$$= 48.98 \text{ km/hr}$$

40. The factorization over Z of $(a + b + c)^3 - (a^3 + b^3 + c^3)$ is

(a) $(a + b)(b + c)(c + a)$

(b) $(a + 3b)(b + 3c)(c + 3a)$

(c) $3(a + b)(b + c)(c + a)$

(d) $2(a + b + c)(a^2 + b^2 + c^2)$

Answer (c)

Sol. $(a + b + c)^3 - (a^3 + b^3 + c^3)$

$$= a^3 + (b + c)^3 + 3a(b + c)(a + b + c) - a^3 - b^3 - c^3$$

$$= a^3 + b^3 + c^3 + 3bc(b + c) + 3a(b + c)(a + b + c) - a^3 - b^3 - c^3$$

$$= 3bc(b + c) + 3a(b + c)(a + b + c)$$

$$= 3(b + c) [bc + a(a + b + c)]$$

$$= 3(b + c) [bc + a^2 + ab + ac]$$

$$= 3(b + c) [bc + ac + a^2 + ab]$$

$$= 3(b + c) [c(a + b) + a(a + b)]$$

$$= 3(b + c) (a + b)(c + a)$$

41. The area of the square having end points of one of its diagonals as $(1, 3)$ and $(5, 1)$ in appropriate units, is

(a) 100

(b) 10

(c) 20

(d) 40

Answer (b)

Sol. Length of diagonal of square $= \sqrt{(1-5)^2 + (3-1)^2}$

$$= \sqrt{16 + 4} = \sqrt{20}$$

$$= 2\sqrt{5}$$

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$$\text{Side} = \frac{\text{Diagonal}}{\sqrt{2}} = \frac{2\sqrt{5}}{\sqrt{2}}$$

$$\text{Area of square} = (\text{side})^2 = \left(\frac{2\sqrt{5}}{\sqrt{2}}\right)^2$$

$$= \frac{4 \times 5}{2}$$

$$= 10 \text{ square units}$$

42. How many total terms, 'the square terms' and 'the product terms' will the expansion of $(x_1 + x_2 + \dots + x_{20})^2$ contain?

(a) 1.8×10^2

(b) $20 + 170$

(c) 200

(d) 210

Answer (d)

Sol. $(x_1 + x_2 + \dots + x_{20})^2$

$$= x_1^2 + x_2^2 + x_3^2 + \dots + x_n^2 + 2(x_1x_2 + x_2x_3 + \dots + x_{19}x_{20})$$

$$\text{Square terms} = 20$$

$$\text{Product terms} = {}^{20}C_2$$

$$= \frac{20 \times 19}{2} = 190$$

$$\text{Total terms} = 20 + 190 = 210$$

43. Given that α and β are the roots of the quadratic equation $x^2 - 2bx + c = 0$. The value of $\alpha^4\beta^4 + \alpha^4\beta^3 + \alpha^3\beta^4$ is equal to

(a) $c^3(c + 2b)$

(b) $c^3(c - 2b)$

(c) $c^3(2c + b)$

(d) $c^3(2c - b)$

Answer (a)

Sol. Given equation is

$$x^2 - 2bx + c = 0$$

$$\text{A.T.Q, } \alpha + \beta = \frac{-(-2b)}{1} = 2b$$

$$\alpha\beta = \frac{c}{1} = c$$

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$$\begin{aligned} \text{So, } & \alpha^4\beta^4 + \alpha^4\beta^3 + \alpha^3\beta^4 \\ & = (\alpha\beta)^4 + (\alpha\beta)^3(\alpha + \beta) \\ & = c^4 + c^3(2b) \\ & = c^3(c + 2b) \end{aligned}$$

44. The lengths of six non-collinear line-segments are 3, 4, 5, 6, 7 and 8 units. The maximum number of scalene triangles that can be formed by using these line segments is
- (a) 15 (b) 17
(c) 19 (d) 20

Answer (b)

Sol. As all lengths are different, so, in selecting 3 line segments at a time out of total 6 line segments, there are 6C_3 ways

$$\begin{aligned} {}^6C_3 &= \frac{6!}{3!3!} \\ &= \frac{6 \times 5 \times 4}{6} = 20 \text{ ways} \end{aligned}$$

But in these 20 ways,

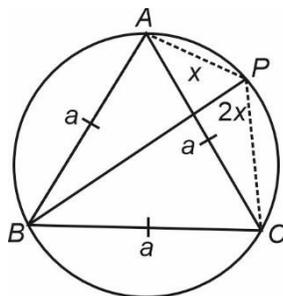
Combinations, (3, 5, 8), (3, 4, 8) and (3, 4, 7) will not hold triangular inequality.

So, maximum number of scalene triangles will be given by (20 – 3) or 17 ways

45. Given that P is a point on the circum-circle (on arc AC) of an equilateral triangle ABC other than its vertices such that $2PA = PC$, then $PA : PB$ is
- (a) 1 : 3 (b) 1 : 2
(c) 3 : 5 (d) 2 : 3

Answer (a)

Sol. Given,



$$2PA = PC$$

$$\text{Let, } AP = x \text{ then } PC = 2x$$

Also, consider, side length of $\triangle ABC$ be 'a' units

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Now, by Ptolemy theorem,

$$AP \times BC + AB \times PC = AC \times PB$$

$$x \times a + a \times 2x = a \times PB$$

$$3ax = a \times PB$$

$$\therefore PB = 3x$$

$$\text{Now, } PA : PB = x : 3x$$

$$= 1 : 3$$

46. There are 2025 cards numbered from 01 to 2025 (i.e. 1, 2, 3 2025). One card is drawn at random, then the probability that the number on the selected card leaves remainder of 25 when it divides 2025, is

(a) $\frac{2}{405}$

(b) $\frac{11}{2025}$

(c) $\frac{4}{675}$

(d) $\frac{4}{405}$

Answer (b)

Sol. Total number of cards 2025 i.e., {1, 2, 3, ..., 2025}

According to question,

$$\begin{array}{r} n \quad 2025 \quad m \\ \quad \vdots \\ \quad \hline \quad 25 \end{array}$$

$$\Rightarrow 2025 = m \times n + 25$$

$$\Rightarrow m \times n = 2000, n > 25$$

$$= 2^4 \times 5^3$$

Total number of factors of $2^4 \times 5^3$ (i.e., 2000) is

$$(4 + 1)(3 + 1) = 20$$

1, 2, 4, 5, 8, 10, 16, 20, 25 are values of n which are less than 25 i.e., 9 possibilities.

So, required probability i.e., selected card number leaves remainder 25 when it divides 2025 is

$$= \frac{20 - 9}{2025}$$

$$= \frac{11}{2025}$$

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48. If the two quadratic equations $ax^2 + 2bx + c = 0$ and $ax^2 + 8bx + 7c = 0$, have a common root, then a , b and c are in
- (a) Arithmetic Progression (b) Geometric Progression
 (c) Harmonic Progression (d) None of the above

Answer (b)

Sol. Given, $ax^2 + 2bx + c = 0$... (i)

$$ax^2 + 8bx + 7c = 0 \quad \dots \text{(ii)}$$

Both equation (i) and (ii) have a common root, let common root be α , then

$$a\alpha^2 + 2b\alpha + c = 0$$

$$a\alpha^2 + 8b\alpha + 7c = 0$$

$$\begin{array}{r} - \\ - \\ - \\ \hline \end{array}$$

$$-6b\alpha - 6c = 0$$

$$\therefore \alpha = \frac{-c}{b}$$

\therefore α is common root so put $\alpha = \frac{-c}{b}$ in equation (ii)

$$a\left(\frac{-c}{b}\right)^2 + 8b\left(\frac{-c}{b}\right) + 7c = 0$$

$$\frac{ac^2}{b^2} - 8c + 7c = 0$$

$$\frac{ac^2}{b^2} = c$$

$$ac = b^2 \text{ or } b = \sqrt{ac}$$

\therefore a, b, c are in G.P.

Part B

ANY NUMBER OF OPTIONS (4, 3, 2 OR 1) MAY BE CORRECT

Marks will be awarded only if all the correct options are bubbled and no incorrect.

49. A ball of mass $m = 100$ g is thrown vertically up with an initial velocity $u = 98$ ms⁻¹. The ball goes up in the space and falls back to the ground. During its motion, the ball is observed to be at a certain height h at time t_1 and at time t_2 . Also the speed of the ball is equal after time t_3 and t_4 from the start of its journey. With the given observation one can conclude that
- (a) the algebraic sum $t_1 + t_2 = 20$ s
 (b) the algebraic sum $t_3 + t_4 = 20$ s
 (c) the ball can reach a maximum height of 980 m
 (d) if $t_1 t_2 = 50$ s². the ball will rise to a height $h = 245$ m at time $t = t_1$

Answer (a, b, d)

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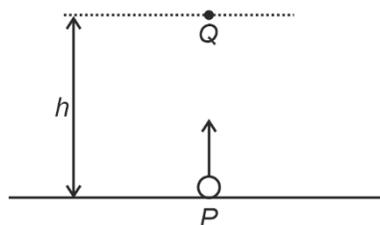
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Sol. $t_{PQ} = t_1$

$$t_{PQRQ} = t_2$$

$$t_{QRQ} = t_2 - t_1$$

R



From first equation of motion

$$t_{PR} = \frac{u}{g} = \frac{98}{9.8} = 10 \text{ s}$$

$$t_{PR} = t_{PQ} + \frac{t_{QRQ}}{2} = t_1 + \frac{t_2 - t_1}{2}$$

$$\Rightarrow t_2 + t_1 = 20 \text{ s} \quad \dots(i)$$

Similarly,

$$t_3 + t_4 = \frac{2u}{g}$$

$$t_3 + t_4 = \frac{2 \times 98}{9.8} = 20 \text{ s}$$

$$\text{Also, } H = \frac{u^2}{2g} = \frac{(98)^2}{2 \times 9.8} = 490 \text{ m}$$

If $t_1 t_2 = 50 \text{ s}^2$, then at time $t = t_1$, using equation (i) we get $t_1 = 2.93 \text{ s}$

$$h = 98t_1 - \frac{1}{2}gt_1^2$$

$$= 98 \times 2.93 - 4.9 \times (2.93)^2$$

$$= 245 \text{ m}$$

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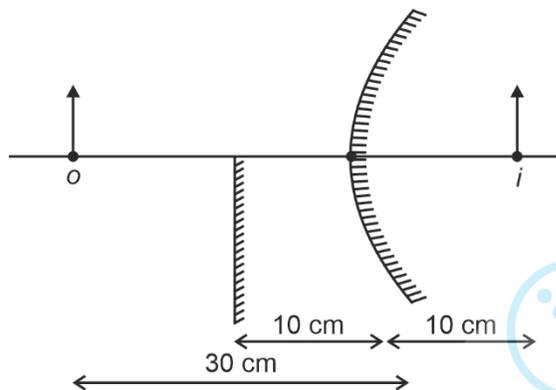
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50. A 3 cm long object pin is kept vertical on the horizontal principal axis of a convex mirror in front of it. The distance of the object pin (standing above the principal axis) is 30 cm from the pole of the convex mirror. A plane mirror facing the pin is placed perpendicular to the principal axis at a distance of 10 cm from and in front of the same convex mirror covering just the lower half of it. The images of the object pin formed by the two mirrors, are found to coincide. Then
- the focal length of the convex mirror is $f = 15$ cm
 - the linear magnification produced by convex mirror is $\frac{1}{3}$
 - the image formed by the convex mirror is virtual and inverted
 - the image formed by the plane mirror stands above the principal axis of the convex mirror

Answer (a, b, d)

Sol.



For the plane mirror :

Object distance = $30 - 10 = 20$ cm

Hence image formed by plane mirror is 10 cm from convex mirror.

By mirror formula

$$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{10} - \frac{1}{30} = \frac{1}{f}$$

$$f = 15 \text{ cm}$$

$$\text{Magnification } (m) = -\frac{10}{(-30)} = \frac{1}{3}$$

Image formed by convex mirror is virtual and erect.

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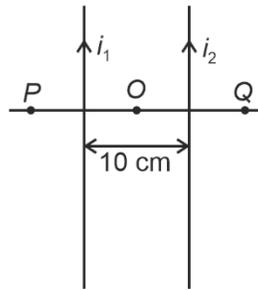
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51. Two long straight copper wires, carrying parallel currents of $i_1 = 2\text{ A}$ and $i_2 = 5\text{ A}$ respectively, lie 10 cm apart in the plane of paper as shown. Knowing that the steady current through a wire produces magnetic field. One can argue that



- because of the magnetic field produced by current i_1 , it attracts the wire carrying current i_2
- the resultant magnetic field produced by both the wires at the midpoint O is directed outward perpendicular to the plane of paper
- the resultant magnetic field produced by both the wires at point P on the left of the wire carrying current i_1 is directed outward perpendicular to the plane of paper
- the resultant magnetic field at point Q on the right of current i_2 is directed outward perpendicular to the plane of paper

Answer (a, b, c)

Sol. Current is flowing in the same direction in two wires. So, by Fleming's left hand rule both the wires will attract each other.

As, $i_2 > i_1$

\therefore Magnetic field produced by both the wires at midpoint O is direction outward perpendicular to the plane of paper.

By Right hand thumb rule. Net magnetic field at P will be outward perpendicular to the plane of paper and at Q it will be inward perpendicular to the plane of paper.

52. In Samara fruits, wings for dispersal are modified outgrowths of the pericarp. Which of the following winged fruits is/are not samara?
- Shorea* (Sal)
 - Fraxinus* (Ash)
 - Dipterocarpus* (New Guinea rosewood)
 - Holoptelea* (Indian Elm)

Answer (a, c)

Sol. Samara is a winged fruit in which the wing is formed from the pericarp and wings for dispersal are modified outgrowths of pericarp. In *Shorea* (Sal) and *Dipterocarpus* (New Guinea rosewood), the wings are formed from other floral parts (sepals) which enlarge and act as wings of disposal.

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53. Study the following statements and choose the correct option(s) :

- (a) Kupffer cells are found in pancreas.
- (b) Mast cells secrete a vasoconstrictor called Heparin.
- (c) Plasma cells superficially resemble lymphocytes.
- (d) Supporting framework of bone marrow is formed by reticular connective tissue.

Answer (c, d)

Sol. Kupffer cells are present in the liver. Mast cells release heparin that prevents blood clotting (anticoagulant).

54. In the following set-up the leaf was destarched by keeping it in dark overnight. The bottle contains a solution of Pyrogallol. After exposing the set-up to sun light for a few hours, the entire leaf was tested for the presence of starch by iodine test.



Choose the option(s) showing correct observation(s):

- (a) The leaf will not show any starch.
- (b) The part of leaf inside the bottle will show positive starch test.
- (c) The part of leaf outside the bottle will show positive starch test.
- (d) The part of leaf inside will show positive starch test while outer part will not show the presence of starch.

Answer (b, c)

Sol. Pyrogallol solution absorbs oxygen, so photosynthesis will occur inside and outside the bottle and both the parts of leaf will show positive starch test.

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55. Which of the following statement(s) is/are correct regarding the different atom models?
- Rutherford's atom model establishes that the α -particle is four times as heavy as a hydrogen atom.
 - Thomson's atom model assumes that the mass of the atom is uniformly distributed over the entire atom.
 - Bohr's atom model assumes that there are a large number of circular electron orbits around the nucleus.
 - Rutherford's α -particle scattering experiment establishes that most of the space in the atom is empty.

Answer (b, d)

- Sol.**
- Rutherford's atomic model explains the structure of atom but it does not establish the relation between the mass of alpha particle and hydrogen atom.
 - According to Bohr's model only certain special orbits known as discrete orbits of electrons, are allowed inside the atom.

56. What happens when an iron nail is dipped into a copper sulphate solution?

- The solution turns pale green
- The iron nail dissolves in the solution
- Copper (Cu) is deposited on the iron nail
- A reddish-brown coating forms on the iron nail

Answer (a, c, d)

Sol. Iron nail does not dissolve in the CuSO_4 solution.

57. Two Solutions are available as sample:

Solution A: 2 L of 0.1 M H_2SO_4 solution, and

Solution B: 1 L of 0.2 M NaOH solution

Then the correct statement(s) is/are

- pH of Solution A increases and pH of Solution B decreases with increasing dilution
- Final pH of both solutions would be approximately 7 after infinite dilution at 25°C temperature
- pH would be 7 after mixing of Solution A and Solution B at 25°C temperature
- pH of Solution A increases and pH of Solution B decreases with slight increase in temperature

Answer (a, b)

- Sol.**
- Mixing an acid or base with water results in decrease in the concentration of ions ($\text{H}_3\text{O}^+/\text{OH}^-$) per unit volume
 \therefore pH increases on decrease in concentration of H_3O^+ ions, whereas pH decreases on decrease in concentration of OH^- ions.
 - Infinite dilution means the concentration of the added solute (H_2SO_4 or NaOH) becomes negligible compared to the concentration of H^+ and OH^- ions naturally present from the autoionisation of water ($K_w = 10^{-14}$ at 25°C).

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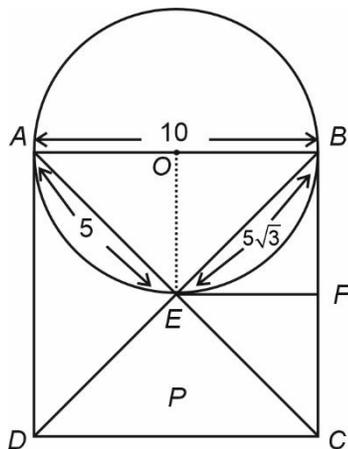
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58. $ABCD$ is a rhombus with diagonals $AC = 10$ cm and $BD = 10\sqrt{3}$ cm intersecting at point E . A circle is drawn passing through three points A , E and B with its center at O . Straight-line EF is drawn parallel to AB such that the point F lies on the side BC . Also there lies a point P somewhere inside the rhombus then,
- $OE : BC = 1 : 2$
 - $FB = 5.0$ cm
 - The probability that the point P lies inside the trapezium $AEFB$ is 0.375
 - The probability that the point P lies inside the triangle EFC is $\frac{1}{8}$

Answer (a, b, c, d)

Sol.



$$AE = 5$$

$$BE = 5\sqrt{3}$$

$\angle AEB = 90^\circ$ [$ABCD$ is a rhombus and diagonals of rhombus bisect each other at 90°]

AB is diameter of circle

$$OE = 5$$

$$BC = 10$$

$$OE : BC = 1 : 2$$

$EF \parallel AB$ (Given)

F is mid point of BC

$$FB = \frac{10}{2} = 5 \text{ cm}$$

$$EF = 5$$

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$$\begin{aligned} \text{Area of Rhombus} &= \frac{1}{2} \times 10 \times \sqrt{3} \times 10 \\ &= 50\sqrt{3} \end{aligned}$$

$$\begin{aligned} \text{Area of } \triangle EFC &= \frac{\sqrt{3}}{4} \times (5)^2 \\ &= \frac{25\sqrt{3}}{4} \end{aligned}$$

$$\begin{aligned} \text{Probability that } P \text{ lies inside the triangle } EFC &= \frac{25\sqrt{3}}{4 \times 50\sqrt{3}} \\ &= \frac{1}{8} \end{aligned}$$

Let area of $\triangle EBF = \alpha$

Area of $\triangle EFC = \alpha$ [F is mid point]

Area of $\triangle OBE = \text{Area of } \triangle EBF$
 $= \text{Area of } \triangle AOE = \alpha$

Area of $\triangle ABC = 4\alpha$

\Rightarrow Area of $\triangle ADC = 4\alpha$

Area of Rhombus $ABCD = 8\alpha$

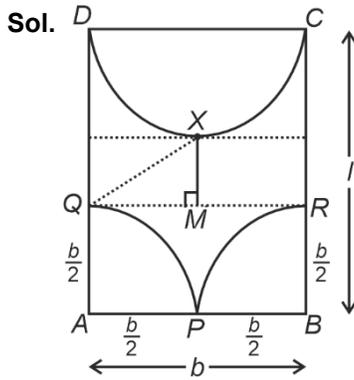
$$\begin{aligned} \text{Probability that point } P \text{ lies inside the trapezium } AEFB &= \frac{3\alpha}{8\alpha} \\ &= \frac{3}{8} \\ &= 0.375 \end{aligned}$$

59. $ABCD$ is a rectangle length l and breadth b . The breadth is two-seventh $\left(\frac{2}{7}\right)$ of its length l . P is the mid-point of side AB . As shown in the figure, APQ & BPR are the two quadrants while CXD is a semicircle with X as the mid-point of the arc CXD , then
- $CR : AB :: 3 : 1$
 - $XQ : AQ :: \sqrt{26} : 1$
 - $\triangle XQR$ is a scalene triangle
 - The ratio of area of rectangle to the area of shaded region is $14 : (14 - \pi)$

Answer (a, b, d)

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$$AB = b = \frac{2}{7}l, BC = l$$

$$AP = PB = \frac{b}{2} = AQ$$

$$\therefore AQ = \frac{1}{2} \times \frac{2}{7}l = \frac{l}{7}$$

$$CR = BC - BR$$

$$= l - \frac{b}{2} = l - \frac{1}{2} \times \frac{2}{7}l = \frac{6l}{7}$$

$$\therefore \frac{CR}{AB} = \frac{\frac{6l}{7}}{\frac{2l}{7}} = \frac{6l}{2l} = 3:1$$

Draw $XM \perp QR$ Join XQ

$$XM = l - \frac{b}{2} - \frac{b}{2} = l - b = l - \frac{2}{7}l = \frac{5l}{7}$$

$$QM = \frac{b}{2} = \frac{l}{7}$$

\therefore In ΔXQM

$$XQ = \sqrt{XM^2 + QM^2}$$

$$= \sqrt{\left(\frac{5l}{7}\right)^2 + \left(\frac{l}{7}\right)^2}$$

$$= \frac{\sqrt{26}l}{7}$$



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Similarly, $XR = \frac{\sqrt{26l}}{7}$

$$\therefore \frac{XQ}{AQ} = \frac{\frac{\sqrt{26l}}{7}}{\frac{l}{7}} = \sqrt{26} : 1$$

Also, $XQ = XR$

$\therefore \Delta XQR$ is an isosceles triangle

$\frac{\text{Area of rectangle}}{\text{Area of shaded region}}$

$$= \frac{lb}{lb - \left[2 \times \frac{1}{4} \times \pi \left(\frac{b}{2} \right)^2 + \frac{1}{2} \times \pi \left(\frac{b}{2} \right)^2 \right]}$$

$$= \frac{l \times \frac{2}{7}l}{l \times \frac{2}{7}l - \pi \times \left(\frac{1}{2} \times \frac{2}{7}l \right)^2}$$

$$= \frac{\frac{2}{7}l^2}{l^2(14 - \pi)}$$

$$= 14 : (14 - \pi)$$

60. Given that k is the number of distinct ordered pair (x, y) of real numbers satisfying equations $x + y = xy$ and $x - y = 3xy$ then k is one of the roots of the quadratic equation(s)

(a) $x^2 - 3x + 2 = 0$

(b) $x^2 - 4x + 3 = 0$

(c) $x^2 - 6x + 8 = 0$

(d) $x^2 - 7x + 12 = 0$

Answer (a, c)

Sol. The given equations are

$$x + y = xy \quad \dots(i)$$

$$x - y = 3xy \quad \dots(ii)$$

To solve equations (i) and (ii) we add them so,

$$\begin{array}{r} x + y = xy \\ x - y = 3xy \\ \hline \end{array}$$

$$2x = 4xy$$

$$\Rightarrow x = 2xy$$

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$$\Rightarrow x(1 - 2y) = 0$$

$$\therefore x = 0 \text{ or } y = \frac{1}{2}$$

$$\text{If } x = 0$$

Then

$$0 + y = 0 \times y$$

$$\Rightarrow y = 0$$

So, (0, 0) is one ordered pair

$$\text{Also, if } y = \frac{1}{2}$$

$$\text{Then } x + \frac{1}{2} = x \times \frac{1}{2}$$

$$\Rightarrow x - \frac{x}{2} = \frac{-1}{2}$$

$$\Rightarrow \frac{x}{2} = \frac{-1}{2}$$

So, $\left(-1, \frac{1}{2}\right)$ is other ordered pair so, total 2 ordered pair are possible.

$$\therefore k = 2$$

Now, we will check the given quadratic equation for 2 as their solution

$$(a) \quad x^2 - 3x + 2 = 0$$

L.H.S Put $x = 2$,

$$2^2 - 3 \times 2 + 2$$

$$= 4 - 6 + 2$$

$$= 0$$

So, 2 is a solution

$$(b) \quad x^2 - 4x + 3 = 0$$

L.H.S Put $x = 2$

$$2^2 - 4 \times 2 + 3 = 7 - 8 = -1 \neq 0$$

So, 2 is not a solution

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(c) $x^2 - 6x + 8 = 0$

L.H.S Put $x = 2$

$$2^2 - 6 \times 2 + 8$$

$$= 4 - 12 + 8$$

$$= 0$$

So, 2 is a solution

(d) $x^2 - 7x + 12 = 0$

L.H.S put $x = 2$

$$2^2 - 7 \times 2 + 12$$

$$\neq 0$$

So, 2 is not a solution

So, options (a) and (c) are true

