Indian National Junior Science Olympiad-2019

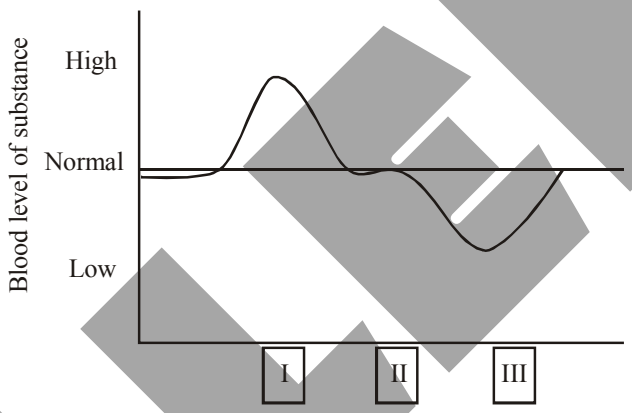
Date of Examination : 2nd February, 2019

SOLUTIONS

SECTION A

Questions 1 to 30 are Multiple Choice questions with every correct answer carrying 1 mark and every wrong answer carrying –0.25 mark.

1. Liver is an organ that maintains constant levels of different substances in the blood. Levels of one such substance entering the liver during three types of body activities (I-III) are shown.



The substance and three activities I-III respectively must be :

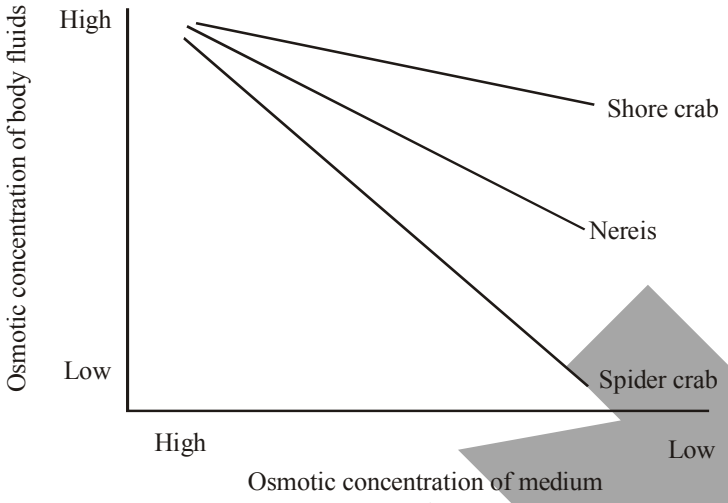
	Substance	Activity		
		I	II	III
(A)	Glucose	Exercise	Resting	Sleep
(B)	CO_3	Exercise	Sleep	After meals
(C)	Glucose	After meals	Resting	Exercise
(D)	O_2	Exercise	Sleep	Resting

Ans. Option (C) is correct.

Sol. According to graph, the substance is glucose, because after meals the glucose convert into glycogen and stored in liver.

- During resting the level remain normal
- During exercise, liver start to Break down glycogen into glucose, with the help of process glycogenolysis, and that glucose used by cells so its level decreases.

2. Maintaining a proper internal fluid environment is essential for any organism. Marine invertebrates whose body fluids are isotonic to sea water can face several problems when exposed to brackish water of estuaries or fresh water of lakes and rivers. Variation of internal osmotic concentration with external osmotic concentration in three marine invertebrates is shown in the graph.



Choose the correct statement.

(A) Nereis shows a better osmoregulatory capacity than shore crab.

(B) Spider crab shows the most effective regulation of osmotic concentration of body fluids among the three invertebrates.

(C) 'When in low salt conditions, body fluid of shore crab is hypertonic compared to surrounding medium.

(D)In order to survive in low salt conditions, spider crab has to take in salts from surrounding water.

Ans. Option (C) is correct.

Sol. According to graph, shore crab is showing less osmoregulation. So, after exposed to luke water shore crab body fluids remains hypertonic luke water become hypotariz (low salt conditions)

3. A newly hatched chick grows to fully adult male or female in about 18 weeks' time. During this time, different body parts show characteristic growth pattern. In an experiment, a pair of goggles were fixed on the eyes of a chick immediately after hatching such that only red wavelength of light passes through them. When the goggles are removed at the end of 7 days, the chick develops a peculiar eye defect. Given that longer wavelengths of light focus most posteriorly in the eye, the most likely defect that the chick has developed is:

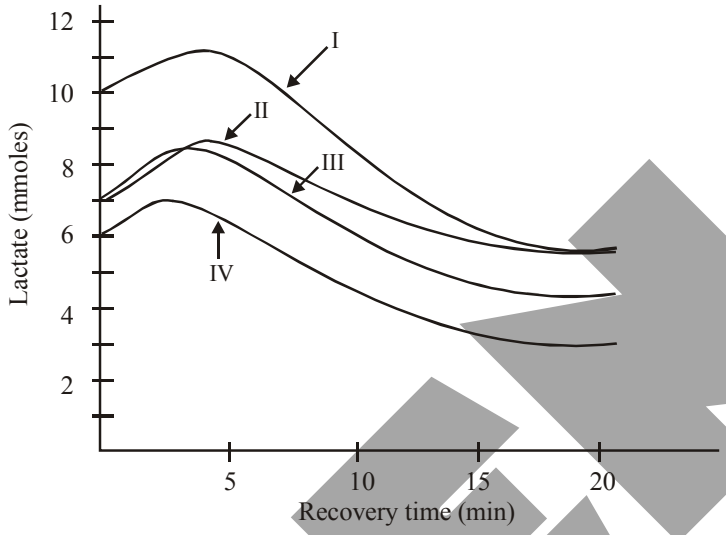
(A) Myopia (B) Hypermetropia

(C) Astigmatism (D) Colour blindness

Ans. Option (A) is correct.

Sol. Violet rays are converging infront of retina hence the disease is myopia.

4. During extensive activity, there is accumulation of lactic acid in muscles. This could lead cramps and fatigue. Training of any athletic activity helps body remove lactate from the muscles and shuttle it to other non-muscular parts. Lactate levels of 4 swimmers during recovery period are shown. Which of these represents the best quality of clearance?



(A) I (B) II (C) III (D) IV

Ans. Option (A) is correct.

Sol. According to graph, swimmer I has highest level of lactate accumulation, and clearance within recover time (min).

5. Study the following three reactions :

(i) $CO_2 + H_2S \longrightarrow (CH_2O)_n + 2S + H_2O$

(ii) $CO_2 + S + H_2O \longrightarrow (CH_2O)_n + H_2SO_4$

(iii) $CO_2 + H_2O \longrightarrow C_6H_{12}O_6 + O_2$

Which reaction/s represents autotrophic nutrition?

(A) (iii) only (B) (i) and (iii) only

(C) (ii) and (iii) only (D) (i), (ii) and (iii)

Ans. Option (D) is correct.

Sol. In autotrophic nutrition organism show photosynthesis.

Two types of photosynthesis

(1) Oxygenic photosynthesis : In which water used for food formation and O_2 evolved e.g. Higher plant.

(2) Anoxygenic photosynthesis : In which H_2S used for food formation and S evolved e.g. Sulphur bacteria.

6. The oxygen consumption for four animals is tabulated below.

Animal	Oxygen consumption per kg body mass per hour (Litre O^2 kg^{-1} h^{-1}
I	0.68
II	0.21
III	1.65
IV	0.07

Animals I - IV most likely could be respectively :

(A) Elephant, Cat, Human and Mouse (B) Cat, Mouse, Elephant and Human

(C) Human, Cat, Elephant and Mouse (D) Cat, Human, Mouse and Elephant

Ans. Option (D) is correct.

Sol. Smaller animals has higher metabolic rate and for that they need more Oxygen in their tissue and cell.

According to table

Animal Oxygen consumption

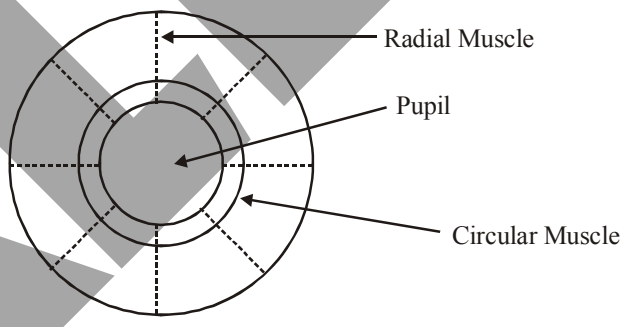
I - Cat

II - Human

III - Mouse

IV - Elephant

7. It was 3.30 in the afternoon when Ajay reached the cinema hall after 20 minutes walk from his house. He entered the cinema hall in a hurry. It took him a few moments to see the surroundings clearly. What changes must have occurred in his eyes during this period?



(A) Circular muscles relax, radial muscles relax and pupil contracts.

(B) Circular muscles relax, radial muscles contract and pupil dilates.

(C) Circular muscles contract, radial muscle contract and pupil dilates.

(D) Circular muscle contract, radial muscles relax and pupil contracts.

Ans. Option (B) is correct.

Sol. In According to Diagramme. Circular muscles relax, radial muscle contract and pupil dilates in order to pass more light in eye.

8. In case of kidney failure, dialysis is recommended using artificial kidneys. An artificial kidney contains numerous semipermeable tubes suspended in a dialyzing fluid. The dialyzing fluid is iso-osmotic to blood. These semi-permeable tubes are similar to the nephrons, the structural and functional units of kidney.

While the artificial kidney simulates a normal kidney, which of the following processes does not occur in an artificial kidney?

(A) Reabsorption of water

(B) Filtration of urea

(C) Retaining of plasma salts and clotting factors in the blood

(D) Retaining of platelets in the blood

Ans. Option (A) is correct.

Sol. Artificial kidney/Dialyzing unit has cellophane tube which is devoid of cells, But in kidney tubular part of nephron (descending limb of loop of Henle) has squamous epithelium cells. Which can reabsorb water.

9. A researcher centrifuged human blood at low speed to separate the red blood cells (RBCs) and white blood cells (WBCs). She then suspended the pellet of RBCs in saline (0.9% NaCl). She subsequently put a drop of the RBC suspension into three different solutions as indicated below. What will be her observations for solutions I, II and III respectively?

Solution I	Solution II	Solution III
Detergent	Distilled water	5% NaCl

(A) Lysis, lysis, swelling.

(B) Swelling, no change, shrinkage.

(C) Lysis, lysis, shrinkage.

(D)No change, shrinkage, swelling.

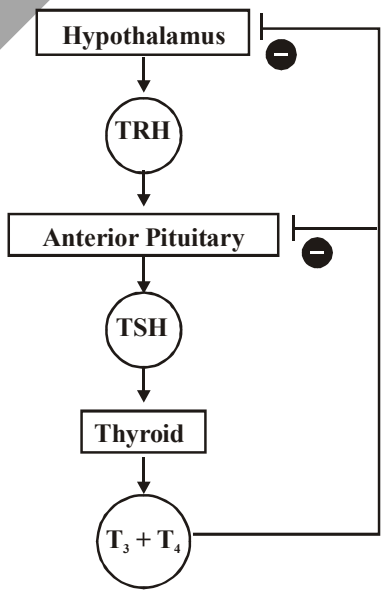
Ans. Option (C) is correct.

Sol. Sol-I. Disrupt the cell-membrane of RBC, so lysis occur.

Sol.II - Distilled water become hypotonic for RBC so water enter into RBC and Burst (lyse) it

Sol. III - Hypertonic, exosmosis occur so RBC - Shrink

10. The thyroid gland secretes thyroxine (T_4) and triiodothyronine (T_3), together known as thyroid hormone. The secretion of thyroid hormone is regulated by thyrotropin-releasing hormone (TRH) and thyroid-stimulating hormone (TSH) as schematically represented below:



One of the actions of thyroid hormone is to increase the basal metabolic rate (BMR) of a person. A person who has suddenly gained weight and has a swoolen neck goes to a doctor. The person also feels tired and mentally dull. Clinical analysis shown that the person has low levels of T_4. The doctor feels that either the pituitary or the thyroid is non-functional. In order to identify the impaired organ the person is given TSH stimulation.

Which one of the following observations and the conclusions made is correct?

(A) If there is no change in the T_4 levels, it indicates problem of the pituitary.

(B) If it leads to increase in the T_4 levels, it indicates problem of the pituitary.

(C) If it leads to increase in the T_4 levels, it indicates problem of the thyroid.

(D) If it leads to further decrease in the T_4 levels, it indicates problem of the thyroid.

Ans. Option (B) is correct.

Sol. According to conditions given in questions person is suffering from hypothyrodism, after giving TSH stimulation T4 secretion increase because pitutary is not producing more potent TSH (means thyroid is not in control of pituitary).

11. Consider a hypothetical situation where the mass of neutron in argon is made half and the mass of electron in argon is doubled with respect to their actual masses. In this case, the atomic mass of $_{18}Ar^{40}$ will approximately

(A) remain the same (B) become half (C) increase by 45% (D) reduce by 27%

Ans. Option (D) is correct.

Sol. Number of proton = 18; mass = 18 amu

Number of neutron = 22; mass = 22 amu (assumed that mass of neutron = mass of proton)

If mass of neutron assumed as half then it will be 11 amu

$$\% \text{ descrese in mass} = \frac{11}{40} \times 100 = 27.5\% \text{ (approximately 27\%)}$$

12. One spoon of a sample of common salt weighs approximately 0.5 g. It contains 40% sodium and 380 micrograms of iodine. Assuming that the sample contains only sodium, iodide and chloride ions, the number of chloride ions present in one spoon of this sample is closest to

(A) 5×10^{20} (B) 5×10^{21} (C) 5×10^{22} (D) 5×10^{23}

Ans. Option (B) is correct.

Sol. Common salt = 0.5g

40% constituent Na^+ = 0.2g

mass of I_2 = 0.000380 g

Mass of Cl^- = 0.5 – 0.2 – 0.000380

= 0.29962 g

$$\text{Number of } Cl^- \text{ ions in the sample} = \frac{0.29962}{35.5} \times 6.022 \times 10^{23}$$

$$= 5.08 \times 10^{21} \text{ ions (approximately } 5 \times 10^{21} \text{)}$$

PNCF Head Office: "SAMANVAYA" C-210/2 Talwandi, Kota (Rajasthan) INDIA-324005
Ph: 0744-2752600 | Email: prenurture@allen.ac.in

13. An LPG gas cylinder regularly used in the household contains a mixture of butane and propane. If 5 litres of this mixture on complete combustion produces 17 litres of CO_2 at atmospheric pressure and 25°C, then the ratio of butane to propane in the mixture is (Assume that both the gases in the cylinder are in vapour phase.)

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

Ans. Option (B) is correct.

Sol. According to Avogadro's Law $v \propto n$

$$C_4H_{10} + \frac{13}{2}O_2 \longrightarrow 4CO_2 + 5H_2O$$

x L 4x L

$$C_3H_8 + 5O_2 \longrightarrow 3CO_2 + 4H_2O$$

(5 – x)L 3(5 – x) L

Total volume $4x + 3(5 - x) = 17$

$\Rightarrow x = 2$

$$\text{Ratio } \frac{\text{Butane}}{\text{Propane}} = \frac{2}{3}$$

14. In a chemistry laboratory, a student found a bottle labelled 'Acid'. As it was a solid, she was curious to find out what it is. She weighed 0.42g of this and made a solution of it and titrated it with 0.17 M NaOH solution. The volume of NaOH required to obtain the end point was 33.8 mL. If the molecular formula of the acid is $C_6H_{10}O_4$, find out the number of protons per acid molecule that take part in the reaction and the amount of acid required to neutralize 1 mole of the alkali.

(A) 1 proton and 73g (B) 2 protons and 146g (C) I proton and 46g (D) 2 protons and 73 g

Ans. Option (D) is correct.

Sol. Solid acid $C_6H_{10}O_4 = 0.42$ g

$$\text{Moles of acid} = \frac{0.42}{146} = 0.002876 \text{ moles at end point}$$

Number of milli equivalents of base = Number of milli equivalents of acid

$\Rightarrow 0.17 \times 33.8 = n_f (0.002876 \times 1000)$

$\Rightarrow n_f = 2$ (gives $2H^+$ ions per molecule)

Hence reaction occurs as follows

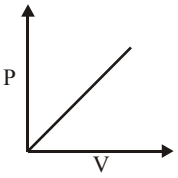
$$2NaOH + C_6H_8O_4 \longrightarrow \text{Salt} + H_2O$$

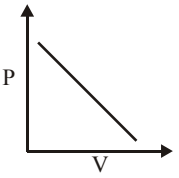
1 mole acid = 2 NaOH

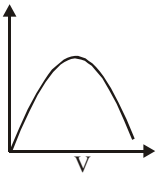
$\frac{1}{2}$ mole acid = 1 mole base

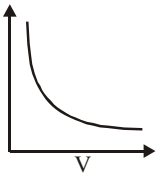
$\frac{1}{2}$ mole of acid = 73 g ($\because$ weight of 1 mole of acid = 146)

15. The graph that indicates the relation between the variables P and V for an ideal gas at a constant temperature is:

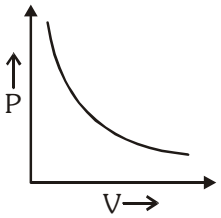
(A) 

(B) 

(C) 

(D) 

Ans. Option (D) is correct.

Sol. 

According to Boyle's Law, $P \propto \frac{1}{V}$

16. The position of some metals in the electrochemical series in decreasing electropositive character is Mg > Aℓ > Zn > Cu > Ag. In a chemical factory, a worker by accident used a copper rod to stir a solution of aluminum nitrate; he was scared that now there would be some reaction in the solution, so he hurriedly removed the rod from the solution and observed that

(A) the rod was coated with Aℓ.

(B) an alloy of Cu and Aℓ was being formed.

(C) the solution turned blue in colour.

(D) there was no reaction.

Ans. Option (D) is correct.

Sol. According to electrochemical series, oxidation potential of Al is greater than Cu. So that Cu can not reduce Al^{3+} to Al.

Hence Cu + Al $(NO_3)_2$ ⟶ No reaction

17. A white compound P was dissolved in water and electricity was passed through it resulting in the formation of a gas Q. This gas was then passed through a slurry of another white compound R. The product obtained from this reaction is commonly used a germicide. P, Q and R respectively, are

(A) NaCI, CI_2,$Ca(OH)_2$

(B) Na_2SO_4,SO_2,$AI(OH)_3$

(C) $NaHCO_3$,CO_2,Na_2CO_3

(D) $AlCl_3$. Cl_2,$AI(OH)_3$

Ans. Option (A) is correct.

Sol. Aqueous solution of P $\xrightarrow{\text{electrolysis}}$ Q (gas) $\xrightarrow{+R}$ germicide

$$\underset{(P)}{NaCl(aq)} \xrightarrow{\text{electricity}} \underset{\text{(Cathode)}}{H_2\uparrow} + \underset{\text{(Anode)}}{Cl_2\uparrow}$$
Q

$$\underset{(Q)}{Cl_2} + \underset{(R)\ \text{Slurry}}{Ca(OH)_2} \longrightarrow \underset{\text{germicide}}{CaOCl_2} + H_2O$$

18. Iron present in spinach can be estimated by titrating it with potassium permanganate. Small amounts of spinach leaves are weighed and dissolved in acid to extract the iron in solution. The solution is then titrated and the following reaction takes place during this titration.

$\_\_ Fe^{2+} + \_\_ MnO_4^- + \_\_ H^+ \longrightarrow Mn^{2+} + \_\_ Fe^{3+} + \_\_ H_2O$

When properly balanced with the simplest set of whole number coefficients, the sum of the coefficients in the balanced equation is

(A) 16 (B) 18 (C) 22 (D) 24

Ans. Option (D) is correct.

Sol. Balanced Equation

$5Fe^{2+} + 1MnO_4^- + 8H^+ \longrightarrow 1Mn^{2+} + 5Fe^{3+} + 4H_2O$

sum of the coefficients in the balanced equation is **24**

19. A disproportionation reaction occurs with a simultaneous oxidation and reduction of the same species in the reaction. Which of the following is NOT a disproportionation reaction?

(A) $2NO_2 + H_2O \longrightarrow HNO_3 + HNO_2$ (B) $3S + 2H_2O \longrightarrow SO_2 + 2H_2S$

(C) $NH_4NO_3 \longrightarrow N_2O + 2H_2O$ (D) $3Cl_2 + 6OH^- \longrightarrow 5Cl^- + ClO_3^- + 3H_2O$

Ans. Option (C) is correct.

Sol. (A) $2NO_2 + H_2O \longrightarrow HNO_3 + HNO_2$ Disproportionation

(B) $3S + 2H_2O \longrightarrow SO_2 + 2H_2S$ Disproportionation

(C) $NH_4NO_3 \longrightarrow N_2O + 2H_2O$ (Not disproportionation) (Intramolecular redox reaction)

(D) $3Cl_2 + 6OH^- \longrightarrow 5Cl^- + ClO_3^- + 3H_2O$ Disproportionation

20. Some metals impart very bright colours such as red, pink, yellow to the flame when heated. The cause of this phenomenon is the excitation of electrons in the outermost electronic shell. The electronic configuration in the outermost shell of these metals is represented as

(A) $(n-1)\,s^2p^6, ns^2\,p^1$ (B) $(n-1)s^2p^6\,d^{10}, ns^1$ (C) $(n-1)s^2p^6, ns^1$ (D) $ns^2p^6d^1$

Ans. Option (C) is correct.

Sol. s-block elements generally give colouration to flame by the phenomenon of excitation of electrons in outermost shell.

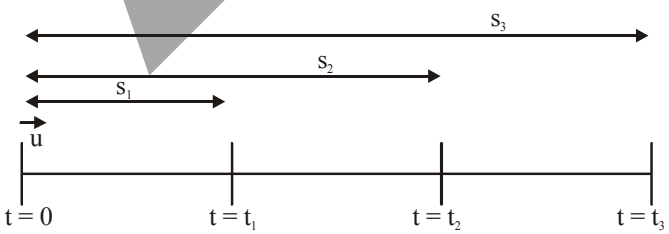
21. A particle is travelling with uniform acceleration of magnitude a. During successive time intervals Δt_1, Δt_2, and Δt_3 its average velocities are v_1, v_2 and v_3 respectively. Then

(A) $\dfrac{v_2 - v_1}{\Delta t_2 - \Delta t_1} = \dfrac{v_3 - v_2}{\Delta t_3 - \Delta t_2}$ (B) $\dfrac{v_2 - v_1}{\Delta t_1 + \Delta t_2} = \dfrac{v_3 - v_2}{\Delta t_3 + \Delta t_2}$

(C) $\dfrac{v_1 + v_2}{\Delta t_1 + \Delta t_2} = \dfrac{v_2 + v_3}{\Delta t_2 + \Delta t_3}$ (D) $\dfrac{v_2 + v_1}{\Delta t_2 - \Delta t_1} = \dfrac{v_3 + v_2}{\Delta t_3 - \Delta t_2}$

Ans. Option (B) is correct.

Sol.



$\Delta t_1 = t_1$

$\Delta t_2 = t_2 - t_1$

$\Delta t_3 = t_3 - t_2$

Now,

$\because \quad S_1 = ut_1 + \frac{1}{2}at_1^2$ ...(1)

$S_2 = ut_2 + \frac{1}{2}at_2^2$ ...(2)

$S_3 = ut_3 + \frac{1}{2}at_3^2$ ...(3)

$v_1 = \frac{S_1}{t_1} = u + \frac{1}{2}at_1$ ...(4)

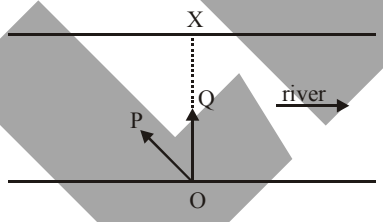
$v_2 = \frac{S_2 - S_1}{t_2 - t_1} = u + \frac{1}{2}a\,(t_1 + t_2)$ ...(5)

$v_3 = \frac{S_3 - S_2}{t_3 - t_2} = u + \frac{1}{2}a\,(t_2 + t_3)$ ...(6)

Now, $v_2 - v_1 = \frac{1}{2}at_2$ and $v_3 - v_2 = \frac{1}{2}\,a\,(t_3 - t_1)$

$$\frac{v_2 - v_1}{v_3 - v_2} = \frac{t_2}{t_3 - t_1} = \frac{(t_2 - t_1) + t_1}{(t_3 - t_2) + (t_2 - t_1)} = \frac{\Delta t_1 + \Delta t_2}{\Delta t_3 + \Delta t_2}$$

22. A river is flowing at 4 km/hr from west to east. Two swimmers P and Q can both swim at 2 km/hr in still water. The minimum time in which it is possible for the swimmers to cross the river is t_{min}. Both of them start swimming from the same point O on the bank of the river in different directions as shown. The point X is directly across from the point O.



Choose the correct statement.

(A) P will reach the point X in time $_{tmin}$.

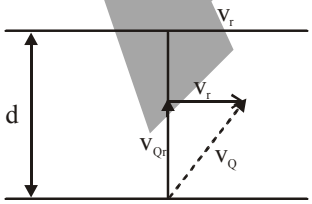
(B) Q will reach the point X in time t_{min}.

(C) P will reach a point somewhere east of X in time T_{min}.

(D) Q will reach a point somewhere east of X in time t_{min}.

Ans. Option (D) is correct.

Sol.



For Q $\longrightarrow$ $t_{min} = \frac{d}{V_{Qr}}$

Option D is correct

23. A stone of mass m falls from a height H on soft muddy ground and sinks to a depth of H/2. Assume that the mud exerts a constant resistive force of magnitude F. Neglecting air resistance, F is

(A) 2 mg (B) mg/2 (C) 3mg (D) mg

Ans. Option (C) is correct.

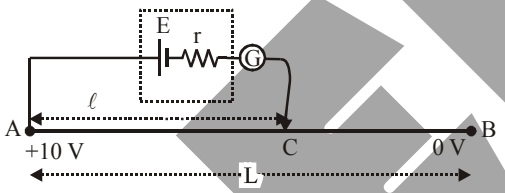
Sol. By work energy theorem

$$W_g + W_F = 0$$

$$mg\,(H + H/2) - F\frac{H}{2} = 0$$

$$\Rightarrow F = 3mg$$

24. A wire of length L and resistance R has uniform cross section. A potential difference of 10 volt is applied across the wire as shown. A cell of emf E(< 10 volt) and of internal resistance r is connected through a galvanometer between points A and C. The point C, at a distance ℓ from A, is chosen such that the galvanometer reads zero. The length ℓ depends on



(A) E only (B) E and L only (C) E and r only (D) E, r and L only

Ans. Option (B) is correct.

Sol. Emf is balanced with potential difference between A and C

$$V_{AC} = E = i \times R_{AC}$$

$$E = \frac{10}{R_{AB}} \times R_{AC}$$

$$E = \frac{10 \times \ell}{L}$$

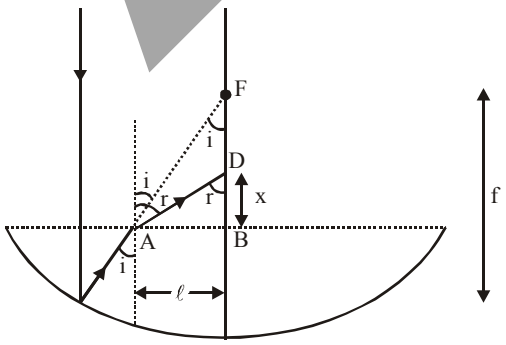
$$\ell = \frac{EL}{10}$$

25. A concave mirror of focal length f and diameter d(d << f)is kept horizontally and filled with water. Rays of light parallel to the mirror axis are incident on it. After reflection, the rays will focus close to

(A) 0.25f (B) 1.33f (C) f (D) 0.75f

Ans. Option (D) is correct.

Sol.



Since d << f so

i and r are small

now from snell's law :

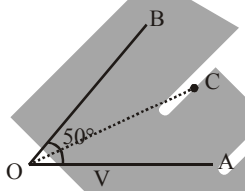
$$\frac{\sin i}{\sin r} = \frac{1}{4/3}$$

but i and r are small so

$$\frac{i}{r} = \frac{3}{4} \Rightarrow \frac{\frac{\ell}{BF}}{\frac{\ell}{BD}} = \frac{3}{4}$$

BD = 0.75 f [BF ≈ f]

26. Two mirrors OA and OB make an angle of 50° with each other. An object C is placed on the angular bisector of angle AOB.

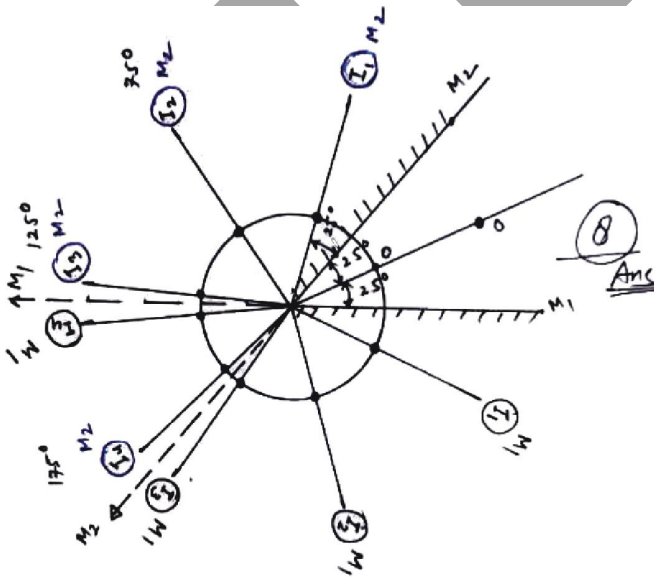


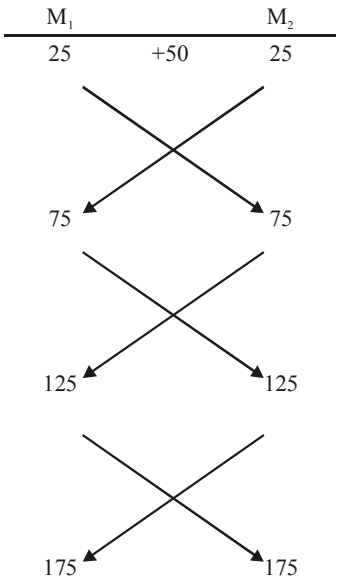
The total number of images of the object formed by the mirrors will be:

(A) 5 (B) 6 (C)7 (D) 8

Ans. Option (D) is correct.

Sol.





$\therefore$ Total number of images = 8

27. A 420.0 W heater is used to raise the temperature of water flowing through a tube of length 2.4 m by 5.0°C. Assuming that the efficiency of heating is 50%, the flow rate of water (in litre/minute) is

(A) 0.3 (B) 0.6 (C) 1.2 (D) 1.8

Ans. Option (B) is correct.

Sol. $\because$ $Q = P \times t \times \eta$

$$mS\Delta T = 420 \times t \times \frac{1}{2}$$

$$\Rightarrow \frac{m}{t} = \frac{1}{100} \text{ kg/sec.} = \frac{0.01}{\rho_w} \text{ m}^3\text{/sec.} = \frac{0.01}{10^3} \text{ m}^3\text{/sec.}$$

= 0.6 lit/min.

28. Consider two arrangements of N identical resistors, one in parallel and the other in series. Each of these arrangements are connected to batteries of the same voltage. The ratio of power dissipated in the parallel arrangement to the series arrangement is

(A) N B) 1/N (C) N^2 (D)$1/N^2$

Ans. Option (C) is correct.

Sol. For series combination

$R_s = NR$

$$P_s = \frac{v^2}{R_s} = \frac{v^2}{NR}$$

For parallel combination

$$R_p = \frac{R}{N}$$

$$P_p = \frac{v^2}{R_p} = \frac{v^2}{R/N} = \frac{v^2 N}{R}$$

So $\frac{P_p}{P_s} = N^2$

29. White light from a distant extended source is incident on a convex lens. Its image is seen on a screen kept at the focal plane of the lens. The top half of the lens is covered with a green filter and bottom half with a red filter. Choose the correct statement.

(A) The top half of the image will be green and the bottom half will be red.

(B) The top half of the image will be red and bottom half will be green.

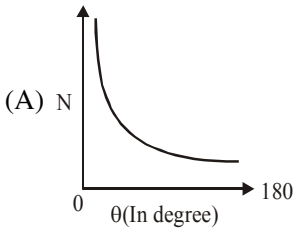
(C) The image will be white.

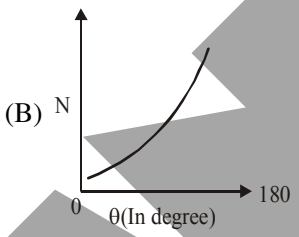
(D) The image will be yellow.

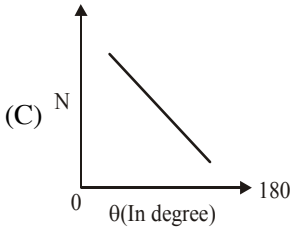
Ans. Option (D) is correct.

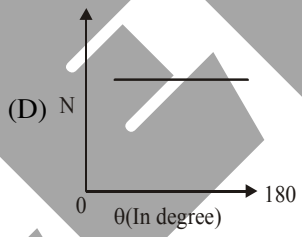
Sol. After refraction the green and red colour will combine and results in the yellow image

30. In Rutherford's experiment the correct plot for the number (N) of alpha particles scattered against scattering angle θ is





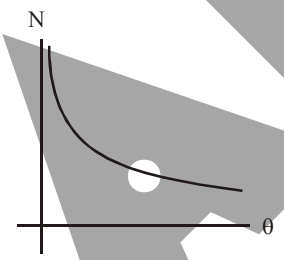




Ans. Option (A) is correct.

Sol. By rutherford experiment

$$N(\theta) \propto \frac{1}{\sin^4(\theta/2)}$$



SECTION B

Question 31 to 42 are long questions. Mark are indicated in the brackets. Answer the questions only in the answer sheet provided.

31. In an experiment, a student exposed seedlings of a plant species to two different light conditions:

(i) Full sun

(ii) Shade (50% of full sun).

Assume that all the remaining conditions are same for both the groups. Plants from both the groups were collected at the end of 6 weeks and various parameters were measured. The mean value for each parameter is given in the table. **[Total = 9 marks]**

Parameter	Condition	
	Sun	Shade
Leaf area (cm2)	42	24
Leaf weight (g)	0.126	0.061
Stem weight (g)	0.283	0.138
Root weight (g)	0.239	0.089
Total weight (g)	0.648	0.288

A student made the following hypotheses (statements about the possible effect of different conditions on plants). You have to say whether these hypotheses are supported by the data given in the table or not.

Hypothesis 1:

Plants grown in sun will show more shoot growth than root growth as compared to plants grown in shade.

(A) Which of the following ratios can help to test hypothesis I ? 0 '5 MARKS)

a. Leaf weight/root weight
b. Leaf area/leaf weight
c. (Leaf weight + stem weight) /root weight
d. Stem weight /Root weight.

Put a cross (X) in the appropriate box.

(B) Calculate the values of the ratios for sun and shade plants based on the option selected by you in (A).

(i) Value of the ratio obtained for plants in the sun : _____ **(1.5 Marks)**

(ii) Value of the ratio obtained for plants in shade condition : _____ **(1.5 Marks)**

(C) Put a cross (X) against the correct statement. (1.5 Marks)

(i) The values obtained in (B) support Hypothesis 1 : _____

(ii) The values obtained in (B) do not support Hypothesis 1: _____

(Questions (B) and (C) will he given marks only if the answer to (A) is correct)

Hypothesis 2:

Leaves produced by plants in shade condition will be thicker than those produced in sunny conditions. **(1.5 Marks)**

(D) Which of the following ratios can help to test hypothesis 2?

a Leaf weight/leaf area
b. Leaf area/shoot weight
c. Leaf weight/total plant weight
d. Shoot weight/total plant weight

Put a cross (X) in the appropriate box.

(E) In another experiment the growth of plants was studied under two conditions as given below, (under sufficient light in both): **(1.5 Marks)**

(I) Condition X: water is supplied in sufficient quantity required for normal growth.

(II) Condition Y: 50% of the required quantity of water is supplied.

What w ould be the expected results?

a. Increase in leaf weight to stem weight ratio in Y as compared to X.

b. Decrease in leaf thickness in Y as compared to X.

c. Decrease in shoot weight to root weight ratio in Y as compared to X .

d. Increase in leaf weight to Stem weight ratio in X as compared to Y.

Put a cross (X) in the impropriate box.

Sol. (A)-c (leaf weight + stem weight)/ Root weight

According to Hypothesis I shoot weight and root weight ratio will be considered.

(B) (i) The shoot weight and root weight ratio of sun plant = 1.26 + 0.283/0.239 = 1.71

(ii) The shoot weight and root weight ratio of shad plant = 0.061 + 0.138/0.089 = 2.2359

(C) The value obtained in (B) do not support hypothesis I because the shoot weight and root weight ratio of shad plant is more than sun plant. Which is against of Hypothesis I.

(D)-a Leaf weight/Leaf area

Support to Hypothesis-2 because according to Hypothesis-2. We considered leaf weight and leaf are ratio of both plant

Sun plant $\frac{126}{42} = 0.03$

Shad plant $\frac{0.061}{24} = 0.025$

If we taken leaf weight and leaf area ratio of both plants the ratio and sunny plant will be more.

(E) -d

In 'X' condition we provide sufficient light and sufficient water which is required normal growth. In this case the chance of leaf weight to stem weight ratio is increased compare to Y. Due to the high rate of photosynthesis.

But not chance to decreasing shoot weight to root weight ratio in Y as compared to X.

32. Rajcsh went to a doctor to check his blood glucose level. Doctor used a reagent which is colourless and turns pink in presence of glucose. More the concentration of glucose, greater the intensity of color. This color intensity can be quantitated using an instrument 'colorimeter'. Following table gives colorimeter readings for four standard glucose concentrations. **(12 Marks)**

mg%	Reading
20	0.15
40	0.29
80	0.61
120	0.91

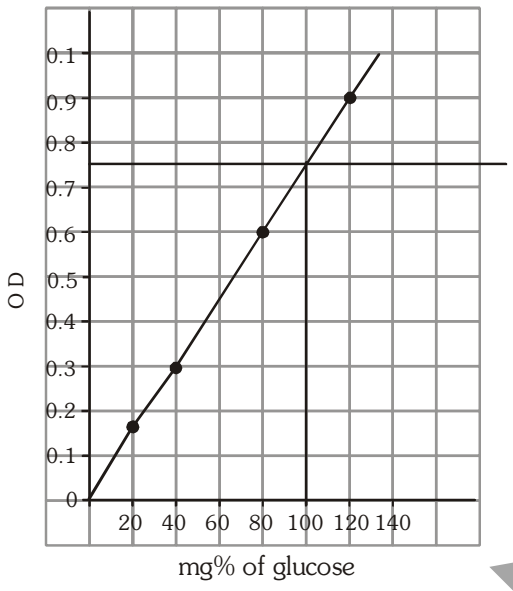
Note that all colorimeter reading values above 0.05 are considered positive.

Rajesh's blood sample showed a reading 0.75.

A standard graph of OD values against the concentration of glucose is given.

(A) What is the molar concentration of glucose in Rajesh's blood? 100 mg%

Show extrapolation in the graph and calculations in the box. **(3 Marks)**



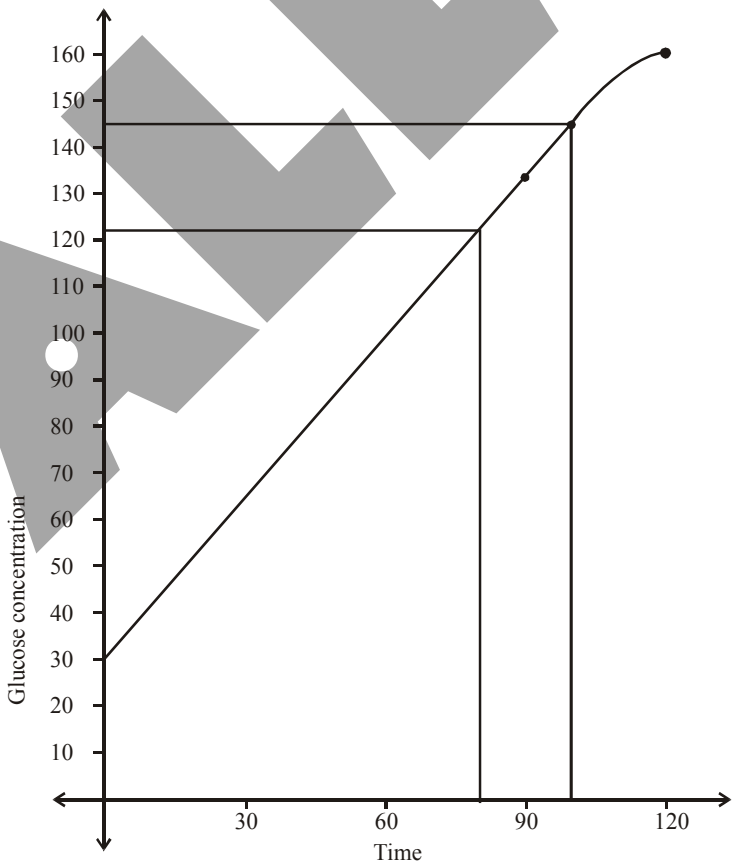
Scale :
x-axis 1 cm = 20mg%
y-axis 1 cm = 0.100

Doctor then gave Rajesh 100 g glucose to eat and tested his urine and blood samples at the intervals of 30, 60, 90 and 120 min. The readings in the colorimeter were as follows :

Min	Reading for blood sample	Reading for urine sample
30	0.55	0.03
60	0.75	0.15
90	1.0	0.25
120	1.2	0.35

(B) Plot graphs of glucose concentration in blood and urine against time in the given graph paper in the answer sheet. **(3 Marks)**

Answer :



(C) What is the concentration of glucose (in mg%) in the blood leaching nephron at 80 min?

(2 Marks)

Answer : According to above graph answer is 122 mg% glucose concentration.

(D) What is the conceniration of glucose above which the kidneys start removing it in urine?

Answer : According to above graph answer is 145 mg% glucose concentration.

33. Consider a self-sustaining ecosystem Consisting of three components X, Y and Z set up in a laboratory for several weeks. During a 26-days observation period, it was disturbed by human intervention on a particular day. The population size of the three components during this period is tabulated below.

Day	Population size		
	Component X	Component Y	Component Z
1	10	40	200
4	11	42	220
7	15	54	210
10	14	53	190
13	14	43	220
17	0	120	100
20	0	130	30
23	0	30	30
26	0	15	150

(A) Assign the correct component alphabet to each of the following:

i. Primary producer _____ **(1.5 Marks)**

ii. Herbivore _____ **(1.5 Marks)**

iii. Carnivore _____ **(1.5 Marks)**

Answer : _____

(B) The average biomass of a producer is 0.0060 g and that of a herbivore is 0.0025 g. Usiing the population sizes on day 1, calculate the transfer of energy in the form of biomass (in %) from producers to herbivores occurring in the ecosystem. **(3 Marks)**

Show your calculations in the box.

Answer : _____

(C) Indicate the day and the most likely activity that has disturbed the balance of the ecosystem.

Answer : _____ **(0.5 Mark)**

Activity: _____ **(1 Mark)**

Options for activity:

a) Removal of component X.

b) Addition of component Y.

c) Partial removal of component Z.

Sol. (A)(i) Primary producer - Z

(ii) Herbivore - Y

(iii)Carnivolre - X

(B) Calculate the transfer of energy in the form of biomass = $\frac{\text{Biomass of Herbivores}}{\text{Biomass of producer} + \text{Herbivores}}$

PNCF Head Office: "SAMANVAYA" C-210/2 Talwandi, Kota (Rajasthan) INDIA-324005
Ph: 0744-2752600 | Email: prenurture@allen.ac.in

For population size on day 1

Biomass of herbivores in day 1 = 0.0025 × 40 = 0.1

Biomass of producer in day 1 = 0.0060 × 200 = 1.2

Percentage energy $= \frac{0.1}{1.2+0.1} \times 100 = \frac{0.1}{1.3} \times 100 \approx 7.7\ \%$

(C) According to the given data at **day 17** the herbivores (component-Y) is increasing compare to producer (component-Z).

Activity - a

34. Acid rain is a term referring to rain having a pH lower than that of natural rain. Historic monuments built with various materials such as iron coated with layers of $CaCO_3$ and Na_2SO_4 can get damaged by acid rain. Acid rain can lead to flaking of this coat. One such sample of coating was brought to the lab to be analysed. The weight of sample was 0.626 g.

The analyst added the sample to aqueous oxalic acid and completely precipitated the calcium as calcium oxalate (CaC_2O_4). The calcium oxalate precipitate obtained was then dissolved in sulphuric acid and the resulting oxalic acid ($H_2C_2O_4$) formed was titrated with a standard $KMnO_4$ solution. The titration of the oxalic acid required 17.8 mL of 0.1 M $KMnO_4$ solution.

(A) Balaced the equation for the titration reaction between $KMnO_4$ and $H_2C_2O_4$. (Only entirely correct answer will be given marks.) (3.5 Marks)

__ $KMnO_4$ + __ $H_2C_2O_4$ + ___ $H_2SO_4 \rightarrow K_2SO_4 + MnSO_4 + H_2O + CO_2$

(B) Identify the oxidizing agent and the reducing agent in the reaction.

(i) _____ is an oxidising agent. (1.5 Marks)

(ii) _____ is a reducing agent. (1.5 Marks)

(C) Calculate the number of mole of oxalic acid reacted with the $KMnO_4$. (3 Marks)

Show your calculations in the box.

Answer : _____ moles of oxalic acid

(D) Calculate the mass (in g) of $CaCO_3$ in the original sample (2 Marks)

Show your calculations in the box.

Answer : _____ g of $CaCO_3$

(E) find the percent (%) of Na_2SO_4 present in the original sample. (2 Marks)

Show your calculations in the box.

Answer : _____

Sol. (A) $2KMnO_4 + 5\ H_2C_2O_4 + 3H_2SO_4 \longrightarrow K_2SO_4 + 2MnSO_4 + 8H_2O + 10CO_2$

(B) (i) $KMnO_4$ (O.A)

(ii) $H_2C_2O_4$ (R.A.)

(C) Equivalence of $H_2C_2O_4$ = equivalence of $KMnO_4$

(mole × v.f.) of $H_2C_2O_4 = \frac{17.8}{1000} \times 0.1 \times 5$

mole of $H_2C_2O_4 = \frac{0.0089}{2} = 0.00445 = 4.45 \times 10^{-3}$

(D) Equivalence of $H_2C_2O_4$ = Equivalence of $CaCO_3$ = mole of $CaCO_3 \times$ v.f.

$0.0089 = \text{mole} \times 2$

$\text{mole} = 0.00445 = \frac{\text{wt}}{100}$

wt = 0.445g

35. The following acid base reaction is performed in a thermos flask

$H^+(aq) + OH^-(aq) \rightarrow H_2O(\ell)$

The termperature of 90g of water rises from 29°C to 30.5 °C when 0.010 mole of H^+ is reacted with 0.010 mole of OH^-.

Calculate :

(A) The heat absorbed by the water (4 Marks)

Show your calculations in the box.

Answer : q_{water} = _____

(B) Heat evolved during the reaction of 17 g OH^- with 1 g H^+. (2 Marks)

Show your calculations in the box.

Answer : _____

Sol. (A) $H^+(aq) + OH^-(aq) \longrightarrow H_2O(\ell)$

$\Delta t = 5°C$ charge in temperature

heat $q = ms\Delta t$

$= 90 \times 1 \times 1.5 \times 4.18$

$= 564.3$ J

(B) $\because$ for 0.01 mole of H^+ (aq) and OH^- (aq)

heat radiated = 564.3 J

$\therefore$ for 1 mole of H^+(aq) and OH^- (aq)

$$\text{heat radiated} = \frac{564.3 \times 1}{0.01} = 56430 \text{ J}$$

36. The molecular formula of a gaseous compound is to be determined. This compound is found to be composed of 85.7% by mass carbon and 14.3% by mass hydrogen. Its density is 2.28 gL^{-1} at 300 K and 1 atm pressure. From the given data. **[Total = 10.5 marks]**

(A) Calculate the number of moles of carbon atoms present in 100 g of compound

Show your calculations in the box. **[2 marks]**

(B) Calculate the number of moles of hydrogen atom present in 100g of compound. **[2 marks]**

Show your calculations in the box.

(C) The empirical formula of the compound is : _____ **[1 marks]**

(D) Moles/ Litre of the compound at NTP = _____ **[2 marks]**

Show your calculations in the box.

(E) Empirical formula units = _____ **[2 marks]**

(F) Molecular formula = _____ **[1.5 marks]**

Sol.

C	:	H
85.7%	:	14.3%
$\frac{85.7}{12}$	:	$\frac{14.3}{1}$
7.14	:	14.3
1	:	2

Empirical formula = CH_2

Empirical formula mass = 12 + 2 = 14

$$P = \frac{dRT}{M}$$

$$\Rightarrow 1 = \frac{2.28 \times 0.0821 \times 300}{M}$$

M = 56.1564 g = 56g (taken approx)

$$n = \frac{56.1564}{14} = 4 \text{ (approx)}$$

Molecular formula = $(CH_2)_4 = C_4H_8$

(A) $\because$ 56 g compound contains = 4 mole $_6C$

$\therefore$ 100 g compound contains = $\frac{4}{56} \times 100 = 7.14$ moles of $_6C$

(B) $\because$ 56 g compound contains = 8 mole $_1H$

$\therefore$ 100 g compound contains = $\frac{8}{56} \times 100 = 14.28$ moles of $_1H$

(C) Empirical formula : CH_2

(D) $\frac{n}{v} = \frac{1}{0.0821 \times 273} = 0.04395$ mole/L

= 0.044 Mole/L (approx)

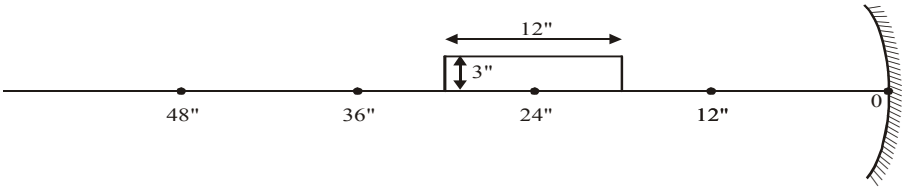
(E) Empirical formula mass = 14 u

(F) Molecular formula = C_4H_8

37. As shown in the grid figure given below, there is a foot rule of dimensions 12" × 3" kept on and above the principal axis of a small concave mirror of radius of curvature 24". Distance from the pole of the mirror along the principal axis are marked.

The 6" mark of the foot rule is at the center of curvature of the mirror.

Draw the image of the foot rule on the grid in the answer sheet using the same scale to which the foot rule is drawn. Show the calculations required for drawing the image in the box provide in the answer sheet.



Note that marks will be given if justified by calculations in the box.

Sol. Using mirror formula $\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$

For Point C

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

$$\Rightarrow \frac{1}{v}-\frac{1}{18}=\frac{1}{-12}$$

$v = -36"$

$$m = \frac{-v}{u}=\frac{h_i}{h_0}$$

$$\therefore \quad m = -\frac{v}{u}=-\frac{36}{18} = -2$$

$$\therefore \quad h_i = -2 \times 3 = -6"$$

Image is real, inverted and magnified.

For point B

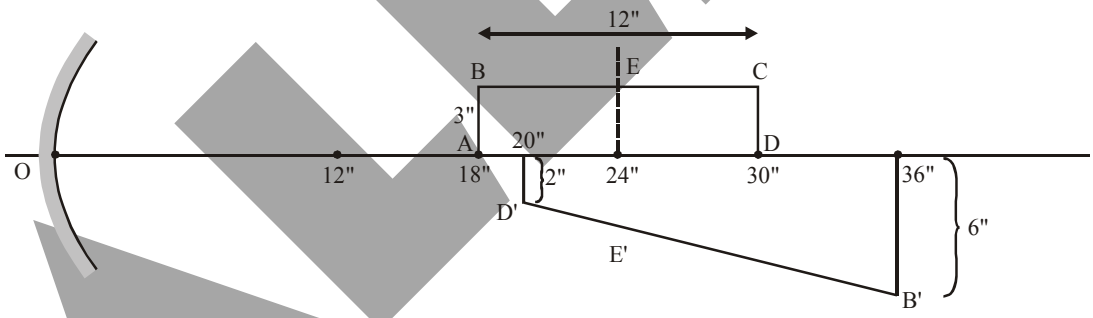
$$\frac{1}{v}-\frac{1}{30}=\frac{1}{-12}$$

$v = -20$ cm

$$\therefore \quad m = -\frac{20}{30}=-\frac{2}{3}$$

$$\therefore \quad h_i = -\frac{2}{3}\times 3 = -2"$$

Image is real, inverted and diminished

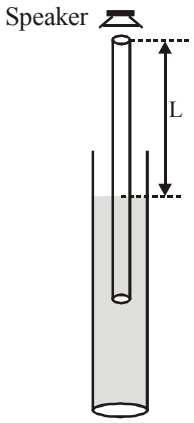


38. The experiement of the Resonance Tube is commonly performed to determine speed of sound. The experimentalk setup is as follows. A hollow tube open at both ends can be suitable lowered into water inside a jar as shown in the figure. A speaker of variable frequency is held just above the top end of the tube.

Sound waves from the speaker are allowed to enter into the tube from the top. On gradually raising or lowering the tube in the water, it is observed that when a certain length is above the water level, a loud sound is audible due to resonance. The length of the tube above the water at this position is recorded as L. According to the theory if λ is the wavelength of the sound then

$$\left(\frac{\lambda}{4}=L+e\right)$$

where e is end correction given by e = 0.3 d (d = inner diameter of the tube).



A given setup of this experiment uses a tube of inner diameter 5.0 cm. Values of L recorded for different frequencies are as given below.

No.	Frequency f (Hz)	L(cm)
1	400	19.9
2	500	16.0
3	750	10.0
4	1000	7.5
5	1250	5.1

(A) Choose proper variable X and Y to produce a suitable linear graph which can be used to determine the speed of sound. Indicate these variable in the answersheet. **[4 marks]**

(i) Variable on the x axis (X) : _____

(ii) Variable on the y axis (Y) : _____

(B) Fill the data table used to plot the graph. **[2 marks]**

(C) Use the graph sheet to produce a suitable linear graph. **[9 marks]**

(D) Determine the speed of sound using the graph plotted **[3 marks]**

Show you calculation in the box.

Speed of sound in air : _____

Sol. Given $\lambda = 4(L + e)$

$\because \quad v = \lambda f = \dfrac{f}{(1/\lambda)} = \dfrac{\text{frequency}}{\text{wave number}}$

(A) (i) X-axis : wave number $(1/\lambda)$

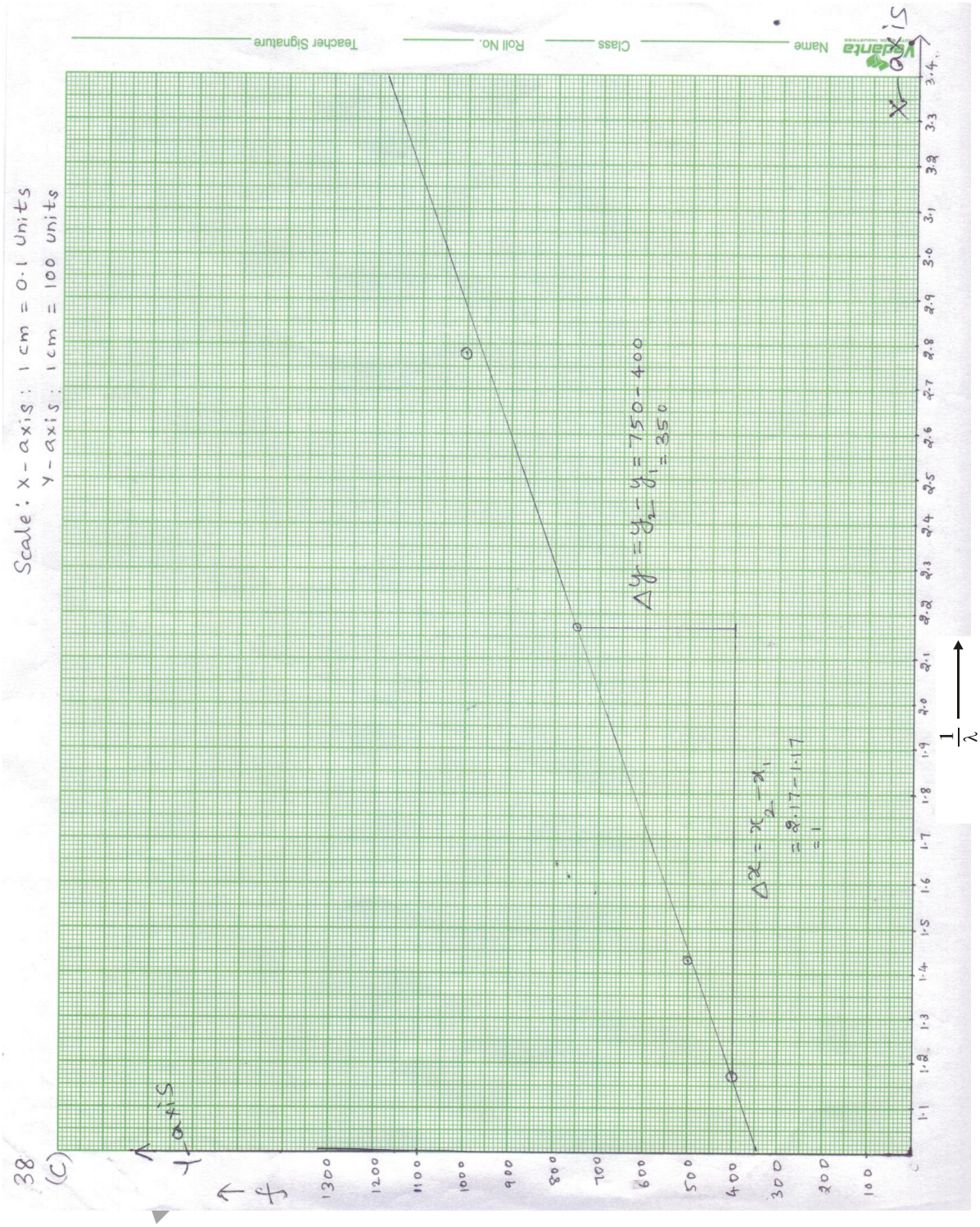
(ii) Y-axis : frequency (f)

(B) Tabular form

S.No.	f(Hz)	L(m)	$e = 0.3d$ (m)	$\lambda = 4(L + e)$ (m)	$\frac{1}{\lambda}(m^{-1})$
1	400	0.199	0.015	0.856	1.17
2	500	0.160	0.015	0.700	1.43
3	750	0.100	0.015	0.460	2.17
4	1000	0.075	0.015	0.360	2.78
5	1250	0.051	0.015	0.264	3.79

$e = 0.3\ d = 0.3 \times 0.05 = 0.015$

(C) Taking f is on Y-axis and $\left[\frac{1}{\lambda}\right]$ on Y-axis we get linear graph



(D) Using the graph speed of the sound will be equal to the slope of the graph

$$\text{Slope} = \frac{\Delta y}{\Delta x} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{750 - 400}{2.17 - 1.17} = 350 \text{ m/s}$$

$\therefore$ velocity of sound = 350 m/s

PNCF Head Office: "SAMANVAYA" C-210/2 Talwandi, Kota (Rajasthan) INDIA-324005
Ph: 0744-2752600 | Email: prenurture@allen.ac.in