INDIAN NATIONAL JUNIOR SCIENCE OLYMPIAD 2019

Duration: 3 Hours **Date: 2nd February, 2019**
Maximum Marks: 180

INSTRUCTIONS

- The question paper is divided into Sections A and B. All answers should be **written in the answer sheet booklet only** which will be collected at the end of the examination. The question paper need not be submitted to the examiner.
- Use only black or blue pen to write your answers in the Answer Sheet. Do not use a pencil.
- Before starting, please ensure that you have received a copy of Question Paper containing a total of 23 (23 sides on 12 sheets) pages.

Section A

- Section A consists of 30 questions each with 4 alternatives, out of which only one is correct. You get 3 marks for every correct answer and -1 for every wrong answer.
- For Section A, you have to indicate the answers by putting a '**X**' in the appropriate box against the relevant question number, as indicated below:

Q. No.	(A)	(B)	(C)	(D)
22	☐	☒	☐	☐

Marking a cross ☒ means affirmative response (selecting the particular choice).

Do not use ticks or any other signs to mark the correct answers.

- Once marked, the answer should not be changed as far as possible. However in an extreme case, if you want to change the answer you can do so as shown below:

Q. No.	(A)	(B)	(C)	(D)
22	☐	☒	☐	☒

Section B

- Section B consists of 8 questions with a total of 90 points.
- The points for the questions in Section B vary depending on the number of answers and the complexity of the question. These points have been indicated along with the question.
- Contradictory answers will not be considered for marking.

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Useful information:

Refractive index of water = 4/3

Acceleration due to gravity $(g) = 9.8\ \mathrm{m/s^2}$

Density of water = $1000\ \mathrm{kg/m^3}$

Specific heat of water = $4200\ \mathrm{J/(kg\,°C)}$, $4.18\ \mathrm{J\ g^{-1}\ °C}$

Avogadro's number (N) $= 6.02 \times 10^{23}$ / mol

Gas constant (R) = $8.314\ \mathrm{J\ mol^{-1}\ K^{-1}}$, $0.082\ \mathrm{L\ atm\ K^{-1}\ mol^{-1}}$

Charge on each proton (+e) = 1.6×10^{-19} C

Mass of proton (Mp) = 1.7×10^{-27} kg

Density of water = $1000\ \mathrm{kg/m^3}$

Pressure = 1 atm, 101.325 kPa, 760 mm Hg

Faraday constant (F) = $96485\ \mathrm{C\ mol^{-1}}$

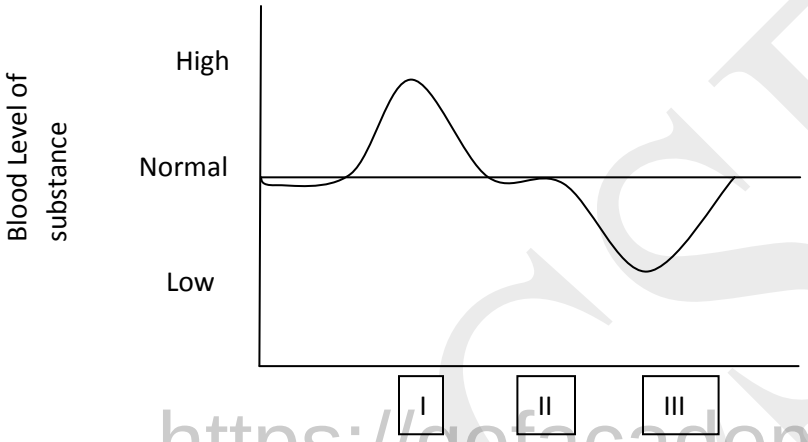
Temperature 0°C = 273.15 K

Element	Atomic Mass	Atomic Number	Element	Atomic Mass	Atomic Number
H	1	1	Li	6	3
C	12	6	Be	9	4
N	14	7	F	18	9
O	16	8	Cl	35.5	17
Na	23	11	Ca	40	20
Mg	24	12	Ba	137	56
Al	27	13	Fe	56	26
S	32	16	Zn	65	30
Cu	63.5	29	Ar	40	18
K	39	19	I	127	53
Sc	45	21	V	51	23
Cr	52	24	Mn	55	25
Co	59	27	Ni	59	28
Ga	70	31	Ge	73	32
Se	79	34	As	75	33
Br	80	35	Kr	84	36
Rb	85.5	37	Sr	88	38

INDIAN NATIONAL JUNIOR SCIENCE OLYMPIAD – 2019

SECTION A

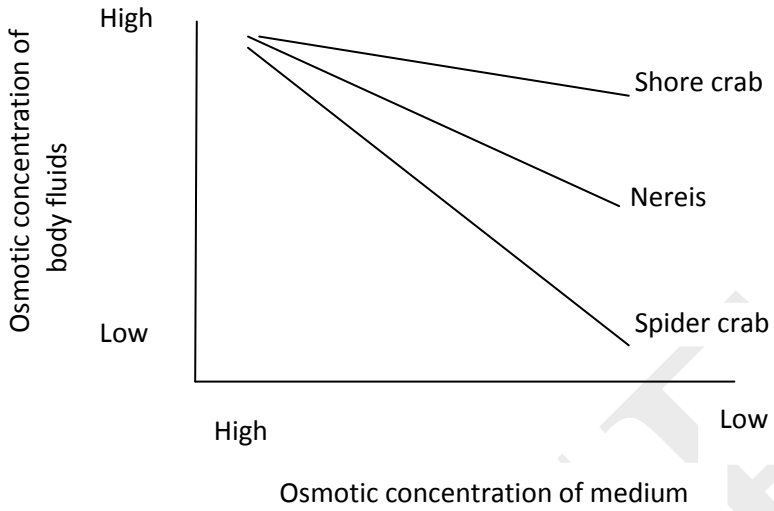
1. Liver is an organ that maintains constant levels of different substances in the blood. Levels of one such substance entering the liver during three types of body activities (I – III) are shown.



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

	Substance	Activity		
		I	II	III
(A)	Glucose	Exercise	Resting	Sleep
(B)	CO_2	Exercise	Sleep	After meals
(C)	Glucose	After meals	Resting	Exercise
(D)	O_2	Exercise	Sleep	Resting

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.

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:

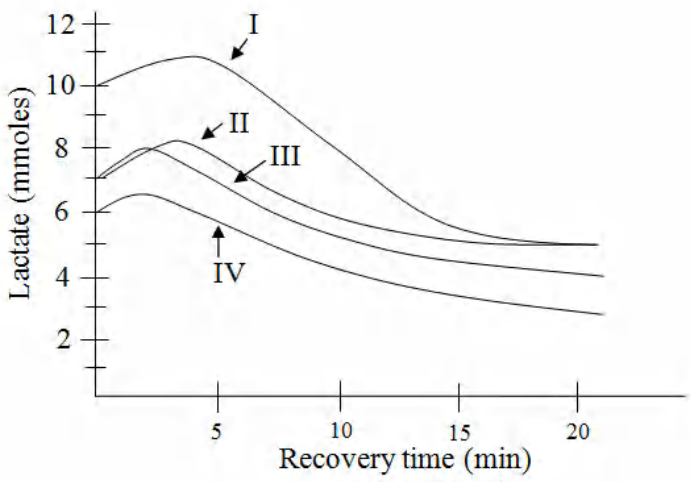
(A) Myopia

(B) Hypermetropia

(C) Astigmatism

(D) Colour blindness

4. During extensive activity, there is accumulation of lactic acid in muscles. This could lead to 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

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 represent/s autotrophic nutrition?

(A) (iii) only

(B) (i) and (iii) only

(C) (ii) and (iii) only

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

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

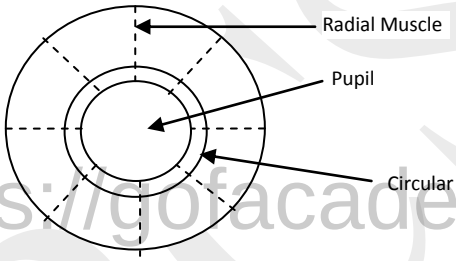
Animal	Oxygen consumption per kg body mass per hour (Litre O_2 kg^{-1} h^{-1})
I	0.68
II	0.21
III	1.65
IV	0.07

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

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.

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?

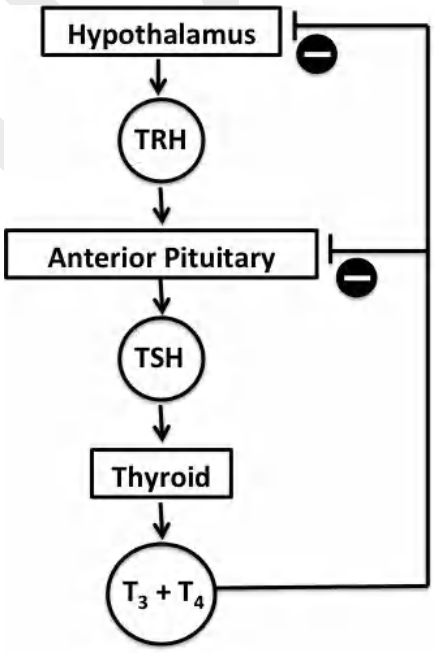
(A) Reabsorption of water
(B) Filtration of urea
(C) Retaining of plasma salts and clotting factors in the blood
(D) Retaining of platelets in the blood

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.

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 swollen neck goes to a doctor. The person also feels tired and mentally dull. Clinical analysis shows 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.

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%

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}

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

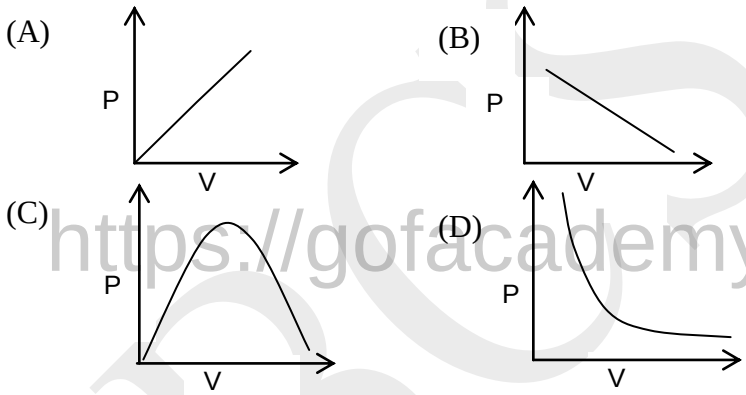
14. In a chemistry laboratory, a student found a bottle labeled ‘Acid’. As it was a solid, she was curious to find out what it is. She weighed 0.42g of this and made a solution of it and

titrated it with 0.17M 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 1mole of the alkali.

(A) 1 proton and 73g (B) 2 protons and 146g

(C) 1 proton and 46g (D) 2 protons and 73g

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



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.

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 as a germicide. P, Q and R respectively, are

(A) NaCl, Cl_2 , $Ca(OH)_2$
(B) Na_2SO_4 , SO_2 , $Al(OH)_3$
(C) $NaHCO_3$, CO_2 , Na_2CO_3
(D) $AlCl_3$, Cl_2 , $Al(OH)_3$

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.

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

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

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) $2NO_2 + H_2O \rightarrow HNO_3 + HNO_2$ (B) $3S + 2H_2O \rightarrow SO_2 + 2H_2S$
(C) $NH_4NO_3 \rightarrow N_2O + 2H_2O$ (D) $3Cl_2 + 6OH^- \rightarrow 5Cl^- + ClO_3^- + 3H_2O$

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

21. A particle is travelling with uniform acceleration of magnitude a. During successive time intervals $\Delta t_1, \Delta t_2,$ andΔt_3 its average velocities are $v_1, v_2,$ and v_3 respectively. Then

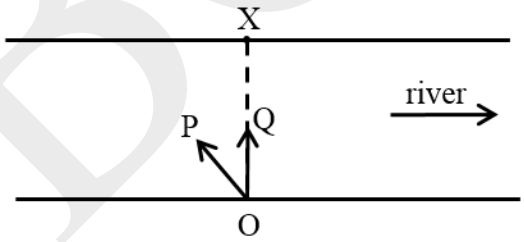
(A) $\frac{v_2-v_1}{\Delta t_2-\Delta t_1} = \frac{v_3-v_2}{\Delta t_3-\Delta t_2}$

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

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

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

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 $t_{\min}$.

(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 $t_{\min}$.

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

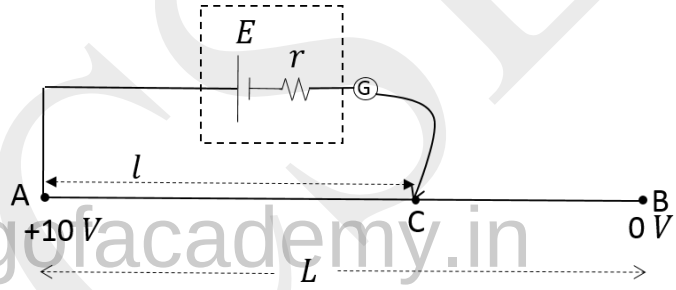
(A) $2mg$

(B) $mg/2$

(C) $3mg$

(D) mg

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

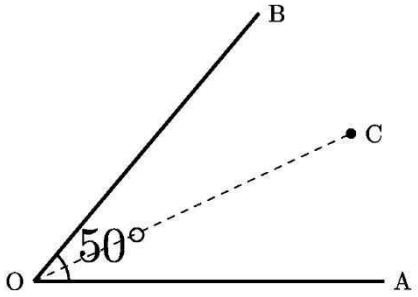
(C) E and r only

(D) $E, r,$ and L only

25. A concave mirror of focal length f and diameter $d(d \ll f)$ 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) $0.75f$

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

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

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

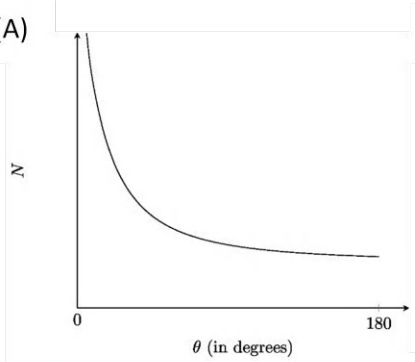
(A) N (B) 1/N (C) N^2 (D) $1/N^2$

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.

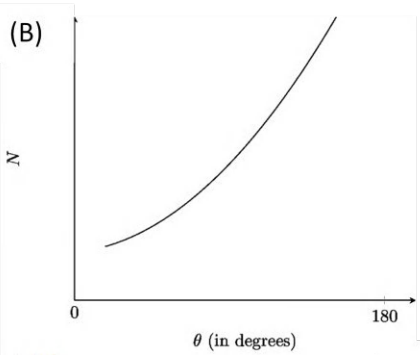
(A) The top half of the image will be green and the bottom half will be red.
(B) The top half of the image will be red and bottom half will be green.
(C) The image will be white.
(D) The image will be yellow.

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

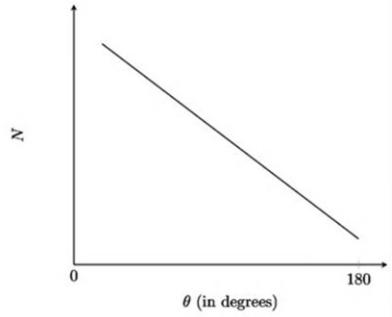
(A)



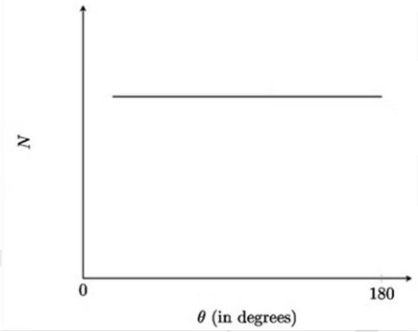
(B)



(C)



(D)



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SECTION B

Questions31-38 are long questions. Marks are indicated in the brackets. Answer the questions **only in the Answer Sheet** provided.

31. (9 MARKS) 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.

Parameter	Condition	
	Sun	Shade
Leaf area (cm^2)	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 1? (1.5 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 be 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 would 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 appropriate box.

32. (12 MARKS) Rajesh 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.

mg%	Reading
20	0.15
40	0.29
80	0.61
120	0.91

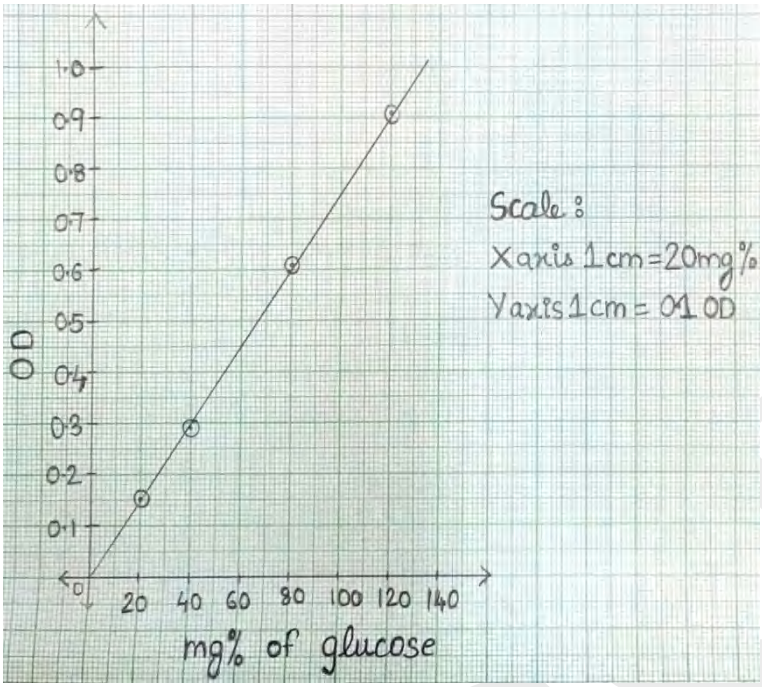
Note that all colorimeter reading values above 0.05 are considered positive.

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 <u>molar concentration</u> of glucose in Rajesh's blood? _____

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



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)

(C) What is the concentration of glucose (in mg%) in the blood reaching nephron at 80 min? (2 MARKS)

Answer: _____

(D) What is the concentration of glucose above which the kidneys start removing it in urine? (4 MARKS)

Answer: _____

33. (9 MARKS) Consider a self-sustaining ecosystem consisting of three components X, Y and Z set up in a laboratory for several weeks. During a 26-day 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)

(B) The average biomass of a producer is 0.0060 g and that of a herbivore is 0.0025 g. Using 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: Day: ____ (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.

34. (13.5 MARKS) 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 0.1M $KMnO_4$ solution.

(A) Balance 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 → __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 moles 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: _____

35. (6 MARKS) The following acid-base reaction is performed in a thermos flask

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

The temperature of 90 g 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: _____

36. (10.5 MARKS) 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 300K and 1 atm. pressure. From the given data,

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

(2 MARKS)

Show your calculations in the box.

Answer: _____

(B) Calculate the number of moles of hydrogen atoms present in 100g of compound.
(2 MARKS)

Show your calculations in the box.

Answer: _____

(C) The empirical formula of the compound is : _____ (1 MARK)

(D) Moles /Litre of the compound at NTP = _____ (2 MARKS)

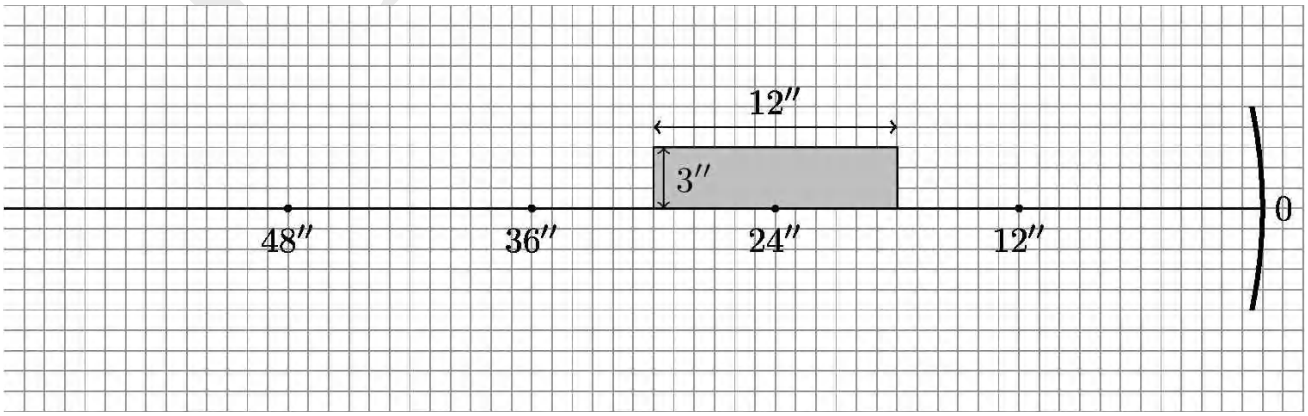
Show your calculations in the box.

(E) Empirical formula units = _____ (2 MARKS)

(F) Molecular formula : _____ (1.5 MARKS)

37. (12 MARKS) 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". Distances 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 <u>in the answer sheet</u> using the same scale to which the foot rule is drawn. Show the calculations required for drawing the image in the box provided in the answer sheet.



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

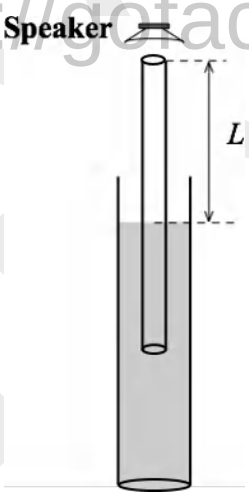
38. (18 MARKS) The experiment of the Resonance Tube is commonly performed to determine the speed of sound. The experimental setup is as follows. A hollow tube open at both ends can be suitably lowered into water inside a jar as shown in the figure. A speaker of variable frequency is held just above the 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 the end correction given by $e = 0.3d$ (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 variables X and Y to produce a suitable linear graph which can be used to determine the speed of sound. Indicate these variables 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 your calculations in the box.

Speed of sound in air: _____

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INJSO - 2019

ROLL NO. | | | | | – | | | | | – | | | | |

Indian National Junior Science Olympiad 2019

ANSWER KEY

Date: 02/02/2019

Duration: Three Hours | Maximum Marks: 180

Centre:_____

(Please do NOT write anything below)

Sec A [MCQ]	**Correct (X)**	**Wrong (Y)**	**Not attempted**	**Marks(3X-Y)**

Sec B [Theory]		**Q 31**	**Q 32**	**Q 33**	**Q 34**	**Q 35**	**Total**
	Marks						
	Marks						
	Marks						
		Q 36	**Q 37**	**Q 38**			
	Marks						
	Marks						
	Marks						

Total A + B _____

HOMI BHABHA CENTRE FOR SCIENCE EDUCATION
Tata Institute of Fundamental Research
V.N. Purav Marg, Mankhurd, Mumbai, 400 088

Instructions overleaf

Instructions

- **x** Use only black or blue pen in this answer sheet. **Do not use a pencil.**
- x Graphs/Diagrams may be drawn with pencil or pen.
- x Write your roll number on top of every page in the space provided.
- x Before starting, ensure that you have received a copy of this Answer Sheet containing a total of 16 pages (16 sides on 8 sheets).
- ~~x~~ Answers for Section A have to be marked in the boxes provided in page 3 of this Answer Sheet.
- x For Section A, you have to indicate the answers by putting a '**X**' in the appropriate box against the relevant question number, as indicated below:

Q. No.	(A)	(B)	(C)	(D)
22	☐	☒	☐	☐

Marking a cross ☒ means affirmative response (selecting the particular choice).

Do not use ticks or any other signs to mark the correct answers.

- x Once marked, the answer should not be changed as far as possible. However in an extreme case, if you want to change the answer you can do so as shown below:

Q. No.	(A)	(B)	(C)	(D)
22	☐	☒	☐	☒

- x For Section B, boxes are provided where you can show the calculations. Additional blank page is provided for rough work.
- x In case you need extra space for rough work, you may request for additional blank sheets from the invigilator. Remember to write your roll number on the extra sheets and get them attached to your answer sheets.
- x **This Answer Sheet must be returned to the invigilator.**

ROLL NO. | | | | | – | | | | | – | | | | |

SECTION A: ANSWER KEY

Q. No.	(A)	(B)	(C)	(D)	Q. No.	(A)	(B)	(C)	(D)
1.			X		16.				X
2.			X		17.	X			
3.	X				18.				X
4.	X				19.			X	
5.				X	20.			X	
6.				X	21.		X		
7.		X			22.				X
8.	X				23.			X	
9.			X		24.		X		
10.		X			25.				X
11.				X	26.				X
12.		X			27.		X		
13.		X			28.			X	
14.				X	29.				X
15.				X	30.	X			

	X	Y	Not attempted	
SECTION A				3X – Y =

ROLL NO. | | | | | – | | | | | – | | | | |

SECTION B: ANSWER KEY

QUESTION 31 (9 MARKS)

(A) (1.5 MARKS)

a.	b.	c.	d.
		X	

(B)

(i) Value of the ratio obtained for plants in the sun: 1.71 (1.5 MARKS)

(ii) Value of the ratio obtained for plants in shade condition: 2.236 or 2.24

(1.5 MARKS)

(C) (1.5 MARKS)

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

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

(D)

a.	b.	c.	d.
X			

(1.5 MARKS)

(E)

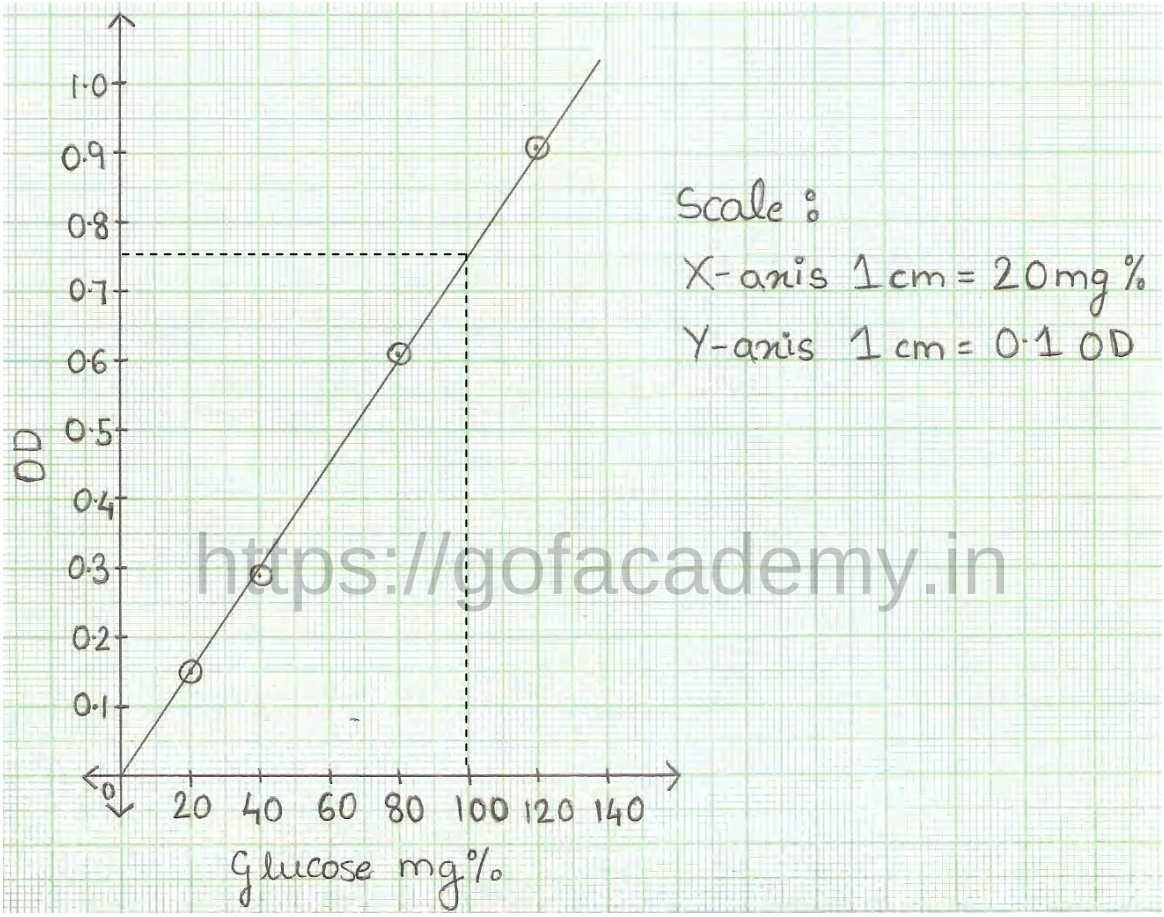
a.	b.	c.	d.
		X	

(1.5 MARKS)

QUESTION 32 (12 MARKS)

(A) Molar concentration of glucose in Rajesh's blood: 0.0055 or 0.0056

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



Calculations:

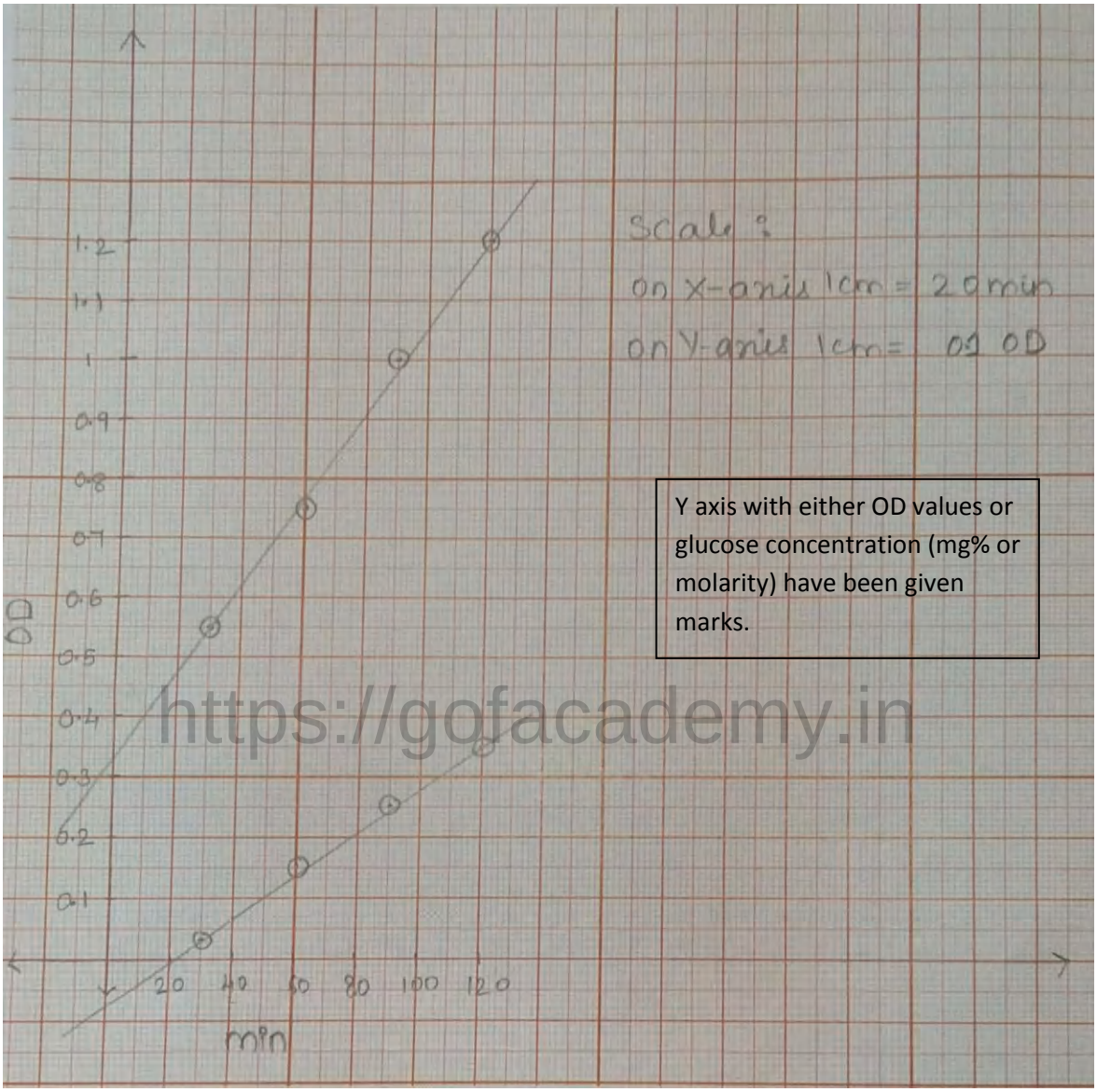
MW of glucose = 180

180 gm in 1 litre = 1M

0.1 gm in 100 ml = 0.0055M

Alternate representations of the answer have been given marks.

(B) Graph: (3 MARKS)



(C) Answer: 120 mg% (118 – 122 mg% will be awarded full marks) (2 MARKS)

(D) Answer: 78 mg% or 4.3×10^{-4}M (4 MARKS)

QUESTION 33 (9 MARKS)

(A)

i. Primary producer __Z___ (1.5 MARKS)

ii. Herbivore __Y___ (1.5 MARKS)

iii. Carnivore __X___ (1.5 MARKS)

(B)

(3 MARKS)

Calculations:

0.006 X 200 = 1.2 g

0.0025 X 40 = 0.1 g

Hence 0.1/1.2 X100 = 8.33 %

Answer: 8.33%

(C) Answer: Day: 13-17 (0.5 MARK)

Activity: a (1 MARK)

QUESTION 34 (13.5 MARKS)

(A) $2\mathbf{KMnO_4} + 5\mathbf{H_2C_2O_4} + 3\mathbf{H_2SO_4} \rightarrow \mathbf{K_2SO_4} + 2\mathbf{MnSO_4} + 8\mathbf{H_2O} + 10\mathbf{CO_2}$ (3.5 MARKS)

(B) (i) $\underline{KMnO_4}$ is an oxidising agent. (1.5 MARKS)

(ii) $\underline{H_2C_2O_4}$ is a reducing agent. (1.5 MARKS)

(C) Calculate the number of moles of oxalic acid reacted with the $KMnO_4$. (3 MARKS)

Calculations:

$17.8 \times 10^{-3} \times 0.1 \times 5/2 = 4.45 \times 10^{-3}$ Moles of Oxalic acid

Answer: 4.45×10^{-3} moles of oxalic acid

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

Calculations:

$100 \times 4.45 \times 10^{-3}$

Answer: 0.445 g of $CaCO_3$

(E) Find the percent (%) of Na_2SO_4 present in the original sample. (2 MARKS)

Calculations:

(0.626 – 0.445) = 0.181 g
(100X 0.181) / 0.626 = 28.9% or 29%

Answer: <u>28.9 or 29%</u>

QUESTION 35 (6 MARKS)

(A)The heat absorbed by the water. (4 MARKS)

Calculations:

q = (specific heat) x m x Δt

Where q is heat absorbed by the water,

m is mass of water in grams= 90 g

Δt is the temperature change = 30.5 -29 = 1.5˚C

q_{water} = [4.18 (J/g·C) 4200 J] x 90 g x 1.5°C

Answer: q_{water} = 564.3 J OR 135 cal OR 567 J

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

Calculations:

17 g OH ≡ 1mole OH

and 1 g H^+ ≡ 1 mole H^+.

when 0.010 mol of H^+ and OH reacts, heat evolved is –564.3 J

Hence 1 mole of H^+ and 1 mole OH on reacting may evolve

– 564.3 / 0.01 = 56430 J = – 56.43 kJ

Answer: – or + 56.43 kJ OR 56.7 kJ OR 13500 cal

QUESTION 36 (10.5 MARKS)

(A) Calculate the number of moles of carbon atoms present in 100g of compound. (2 MARKS)

Calculations:

$$\frac{(85.7\text{ g C})(1\text{mol of C})}{(12.0\text{ g C})} = 7.14\text{ mol C}$$

Answer: 7.14 mol C

(B) Calculate the number of moles of hydrogen atoms present in 100g of compound. (2 MARKS)

Calculations:

$$\frac{(14.3\text{ g H})(1\text{mol of H})}{(1.008\text{ g H})} = 14.2\text{ -}14.3\text{ mol H}$$

Answer: 14.2mol

(C) The empirical formula of the compound is : $\underline{CH_2}$ (1 MARK)

(D) Moles /Litre of the compound at NTP = $\underline{0.04065}$ OR 0.0409 …….. (2 MARKS)

Calculations:

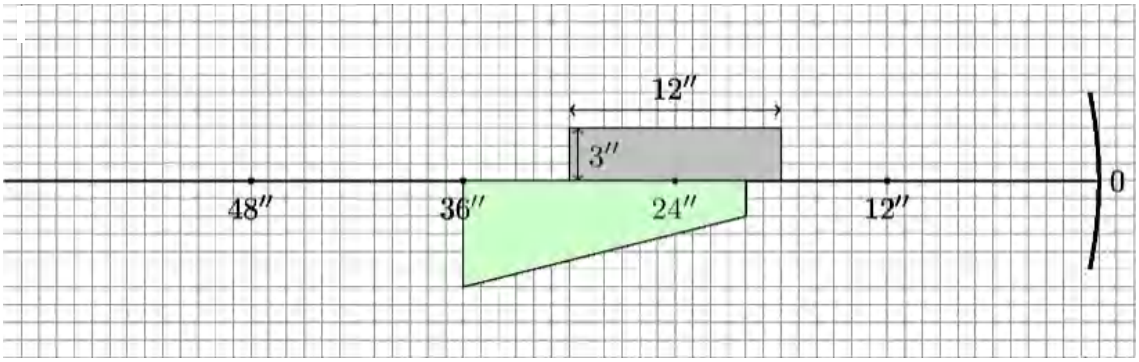
$$n = PV/RT = \frac{(1.00\text{ atm})\,(1.00\text{ L})}{(0.0820\text{ L atm K}^{-1}\text{ mol}^{-1})(300\text{ K})} = 0.04065\text{ mol}$$

Temperature of 273K will be considered for partial marks.

(E) Empirical formula units = 4 (2 MARKS)

(F) Molecular formula : C_4H_8 (1.5 MARKS)

QUESTION 37 (12 MARKS)



Calculations: Image distances and the magnifications at the various points are shown below.

Object distance, *u*”	18	20	21	24	27	30
Image distance, *v*”	36	30	28	24	$\frac{108}{5}$	20
Linear magnification, $m = \frac{v}{u}$	2	1.5	$\frac{4}{3}$	1	0.8	$\frac{2}{3}$
Size of image, I = (*m*.3)”	6	4.5	4	3	2.4	2

This shows that magnification increases linearly as object distance decreases from the mirror.

Alternate solutions may exist. Correct methods to draw the image on the grid will be credited accordingly.

QUESTION 38 (18 MARKS)

(A) (4 MARKS)

(i) Variable on x axis (X) : $L + e$

(ii)Variable on y axis (Y) : $\frac{1}{f}$

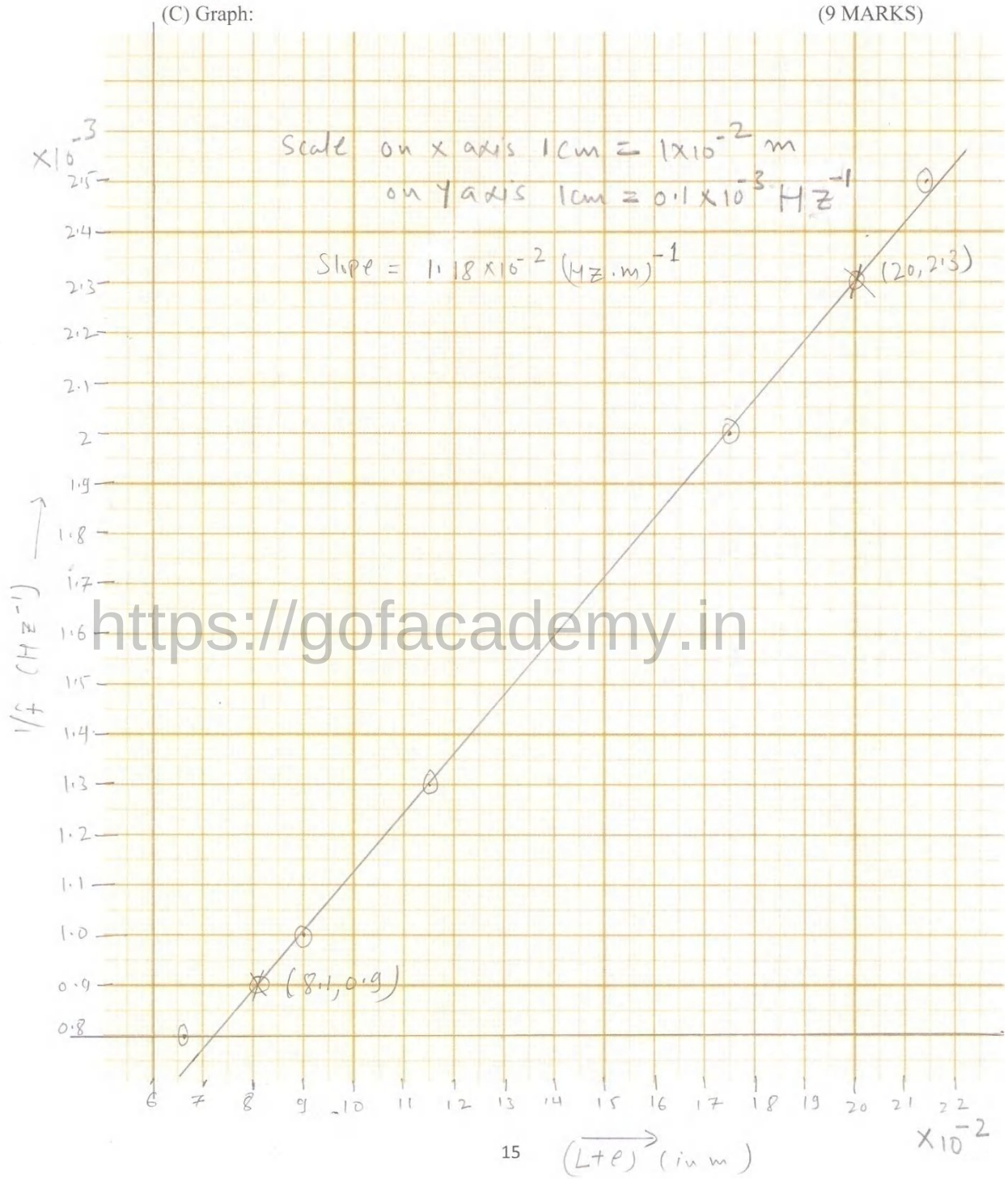
Any correct set of variables which produces linear graph will be equally credited (for example $4(L + e)$ vs $1/f$ etc.).

(B) Table: (2 MARKS)

No.	Frequency f (Hz)	L(cm)	X $(\boldsymbol{L + e})$ $(\times \mathbf{10^{-2}}$ **m)**	Y $\left(\frac{\mathbf{1}}{\boldsymbol{f}}\right)$ $(\times \mathbf{10^{-3}Hz^{-1}})$
1	400	19.9	21.4	2.50
2	500	16.0	17.5	2.00
3	750	10.0	11.5	1.33
4	1000	7.5	9.00	1.00
5	1250	5.1	6.60	0.80

(C) Graph:

(C) Graph: (9 MARKS)



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Calculations:

$$\frac{1}{f} = \frac{4}{c}(L + e)$$

Where c is the speed of sound. For the plotted graph:

Slope of the graph $= \frac{4}{c} = 1.18 \times 10^{-2}$ (Hz · m)$^{-1}$

Speed of sound in air $c = 3.39 \times 10^{2}$m/s

Range of slope = $0.0124 - 0.0108$ (Hz · m)$^{-1}$

(D) Speed of sound in air = $3.23 \times 10^{2} - 3.70 \times 10^{2}$ m/s (3 MARKS)

********* END OF SECTION B ********