

Indian National Junior Science Olympiad 2018

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QUESTION PAPER

INJSO 2018
Duration: **3 Hours**

Date: 27th January 2018
Maximum marks: **90**

INSTRUCTIONS

- Write your roll number on top of this page in the space provided.
- Use only black or blue pen to write your answers in the Answer Sheet provided. **Do not use a pencil.**
- Before starting, please ensure that you have received a copy of this Question paper containing a total of 20 pages (20 sides on 10 sheets including the first 2 cover pages for instructions and values of physical constants).
- In section A, there are 30 multiple choice questions with 4 alternatives, out of which only 1 is correct. You get 1 mark for every correct answer and – 0.25 mark for every wrong answer.
- In Section B there are 12 questions of total 60 marks.
- For Section A, you have to indicate the answers on page 3 of the Answer sheet by putting a “x” in the appropriate box against the relevant question number, like this:

Q. No.	(a)	(b)	(c)	(d)
22	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Marking a cross means affirmative response (making your particular choice). **Do not use tick mark or any other signs to mark the correct answers.**

- For each of the 12 questions in Section B, a separate page has been provided in the Answer sheet, with the particular question number indicated in the top left hand corner. One additional page for answering those questions has also been appended, in case of necessity.
- A blank page has been provided in the Answer sheet, for rough work.
- **Write the answers in the answer sheet only.**
- **Calculator(s) and mobile phone(s) are not allowed.**
- The Answer Sheet must be returned to the invigilator. You may take this Question paper with you.

Useful Physical constants and Definitions (Many constants have been adjusted to make calculations simple in this examination)

Gravitational Constant (G)	=	$6.7 \times 10^{-11} \text{ m}^3 \text{ kg}^{-1} \text{ s}^{-2}$
Acceleration due to gravity (g)	=	10 m/s^2
Avogadro's number (N)	=	$6.0 \times 10^{23} / \text{mol}$
Gas constant (R)	=	$8.3 \text{ J mol}^{-1} \text{ K}^{-1}, 0.082 \text{ L atm K}^{-1} \text{ mol}^{-1}$
Charge on each proton (+e)	=	$1.6 \times 10^{-19} \text{ C}$
Mass of proton (M_p)	=	$1.7 \times 10^{-27} \text{ kg}$
$1/4\pi\epsilon_0$	=	$9.0 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$
Velocity of sound in air	=	350 m/s
Velocity of sound in water	=	1500 m/s
Density of ice	=	910 kg/m^3
Density of water	=	1000 kg/m^3
$\sqrt{2} = 1.41$	$1/\sqrt{3} = 0.58$	
$1/\sqrt{2} = 0.71$	$\sqrt{3} = 1.73$	
$\sqrt{3/2} = 0.87$		

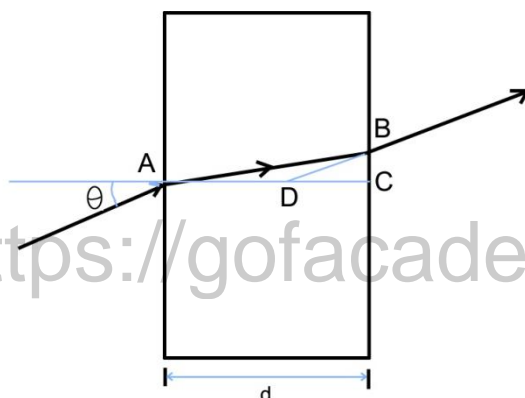
Element	Atomic Mass	Atomic Number	Element	Atomic Mass	Atomic Number
H	1	1	Li	6	3
C	12	6	Be	9	4
N	14	7	F	18	9
O	16	8	Cl	35.5	17
Na	23	11	Ca	40	20
Mg	24	12	Ba	137	56
Al	27	13	Fe	56	26
S	32	16	Zn	65	30
Cu	63.5	29	Ar	40	18
K	39	19	Ti	48	22
Sc	45	21	V	51	23
Cr	52	24	Mn	55	25
Co	59	27	Ni	59	28
Ga	70	31	Ge	73	32
Se	79	34	As	75	33
Br	80	35	Kr	84	36
Rb	85.5	37	Sr	88	38

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.

- Natural water contains about 0.02% D₂O (heavy water). When it is enriched to 20% (by volume), calculate the fraction of weight due to neutrons in 1 mole of water sample.
a) 0.355 b) 0.444 c) 0.455 d) 0.500
- A piece of alloy of Al and Zn weighing 1.67 g was completely dissolved in acid and evolved 1.69 litre of hydrogen at NTP. What is the percentage of Al in the piece of alloy?
a) 26.5% b) 48.5% c) 51.5% d) 73.5%
- The DNA sequence of the genome of a virus is known and contains equal number of A, T G and C. The genome is composed of double stranded DNA molecule. It is 10Kb in length. If one searches the genome for the presence of the following sequence 5'-AAAAA-3'/3'-TTTTT-5', predict the number of such stretches that are likely to occur. (1Kb = 1000 base pairs).
a) Two b) Eight c) Sixteen d) Thirty two
- An astronaut has to burn 40g of glucose in his body per hour to get the required energy. Find the amount of oxygen that would need to be carried in space to meet his energy requirement for thirty days.
a) 10.2 kg b) 28.8 kg c) 30.7 kg d) 96.1 kg
- A particle moves along positive X-axis with a velocity (in a suitable unit) varying as $(4 - 3t - t^2)$ where t is time in seconds. Students draw following four conclusions.
(I) Initially the particle is at the origin.
(II) Initial speed of the particle is zero.
(III) The particle decelerates till $t = 1$ s.
(IV) The speed of the particle goes on increasing after $t = 1$ s.
Therefore, conclusions
a) (i) & (ii) are sometimes correct, (iii) & (iv) are always correct,
b) (i), (iii) & (iv) are always correct and (ii) is sometimes correct
c) (i), (iii) & (iv) always correct, (ii) is never correct
d) (i) is sometimes correct, (ii) is never correct, (iii) & (iv) are always correct

6. Titration is carried out for 3 moles of a mixture of ferrous and ferric sulphate, which required 100 mL of 2 M potassium permanganate in acidic medium. Hence the mole fraction of ferrous sulphate in the mixture is _____.
- a) $1/3$ b) $2/3$ c) $2/5$ d) $3/5$
7. Many proteins of the chloroplast are encoded by genes in the nucleus. In these cases the RNA is transcribed in the nucleus, translated by the cytoplasmic ribosomes and the protein transported to the chloroplast. For such a protein how many membrane(s) does the protein cross to reach the thylakoid space (lumen) of the chloroplast?
- a) One b) Two c) Three d) Four
8. A ray of light passes through a thick glass sheet with some angle of incidence θ as shown. The refractive index of glass is _____.



- a) Exactly d/DC .
b) Approximately d/DC .
c) Approximately d/AD .
d) Approximately AD/AC .
9. A sample of clay was partially dried and then found to contain 60% silica and 8% water. The original sample of clay contained 15% water. Find the percentage of silica in the original sample.
- a) 52.3% b) 47.8% c) 55.5% d) 51.7%
10. A plant has pink flowers. When this plant was self pollinated, there were three types of progeny obtained; progeny with red flowers, pink flowers and white flowers that appeared in the ratio of 1:2:1. From the given information how many alleles are involved in the formation of these flower colours?
- a) One b) Two c) Three d) Four

11. A beaker of mass 50 g, with 262 g of water in it, is kept on a weighing machine. A uniform hollow brass ball of total volume 36π cc is inserted into the water in the beaker. It is observed that the ball floats on water. The weighing machine now reads 400 g. Density of brass is 8 g/cc, while that of the air inside the brass ball can be neglected. Thickness of the brass used to prepare the ball must be nearest to _____.

- a) 0.5 mm b) 0.8 mm c) 1 mm d) 1.2 mm

12. If a body exerts a force on a surface, the surface exerts a reaction force on the body. This reaction force is always along normal to the surface at that point and is popularly known as the normal force N . When the body slides on a surface, the surface exerts a force of friction on the body in the direction opposite to the direction of slipping. The magnitude of this frictional force is given by μN , where μ is a constant (called coefficient of friction) for the given pair of surfaces in contact and N is the normal force.

Consider a block of mass 100 kg placed on a level surface. If one person tries to push it with a force F , he is unable to do so. He receives help from two of his friends and each one applies the same force F . Now the block moves with a uniform acceleration of 0.5 m/s^2 . After sometime, one of them happens to leave the exercise of pushing the block. This time the block moves with a uniform speed. The magnitude of force F and the coefficient of kinetic friction μ are respectively _____.

- a) 50 N, 0.05 b) 100 N, 0.1 c) 50 N, 0.1 d) 100 N, 0.2

13. The elements A, B, C, and D belong to the groups 1, 2, 14, and 17 respectively of the periodic table. Which of the following pairs of elements would produce a covalent bond?

- a) A and D b) B and C c) A and B d) C and D

14. How many molecules of water of hydration are present in 252 mg of oxalic acid ($\text{C}_2\text{H}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$)?

- a) 1.2×10^{21} b) 1.7×10^{21} c) 2.4×10^{21} d) 3.4×10^{21}

15. Which of the following is NOT a component of the theory of natural selection when Darwin proposed his theory?

- a) Heritable variations allow some individuals to compete more successfully for resources.
b) Selective pressure allows some individuals in a population to reproduce more than others.
c) All new variations in a given population arise from spontaneous mutation in genes.
d) Some new variations are passed on to the next generation.

16. Some people face problems seeing distant objects clearly. They, however, have no problem seeing nearby objects. A person wears a spectacle with concave lenses to see distant objects. He is able to see nearby object clearly without using lenses. When this person is reading without using the spectacles the image will be formed _____.

- a) On the blind spot b) Behind the retina
c) In front of the retina d) In the fovea region on the retina.

17. A magnet is in the form of a bar. Initially, the axis of the bar magnet is along X-axis. At some distance from the magnet, a coil is kept in the Y – Z plane with its centre along X-axis. Which of the following motions of the bar magnet will **NOT** induce electric current in the coil?

a) Translational vibrations perpendicular to X-axis.



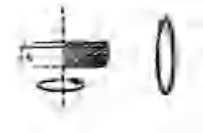
b) The bar magnet axis is turned to make an acute angle with the X-axis and the magnet is rotated about X-axis with the south pole fixed on X-axis.



c) The bar magnet axis is swinging back and forth about the X-axis with the south pole fixed on the X-axis.



d) The bar magnet spins about a perpendicular bisector as its axis of rotation, with its center on the X-axis.



18. A falcon and its trainer are exactly midway between two vertical & parallel hills. As the trainer fires the gun, the falcon starts flying directly towards one of the hills. The falcon hears first and second echoes of the gun-shot at 2 s and 3 s respectively. Ignore reflection of sound from the falcon and from the trainer. The air is practically still. *Among the following options*, respective speeds of the falcon and the sound (in m/s) could be _____.

a) 85 & 340

b) 68 & 340

c) 50 & 350

d) 40 & 360

19. At time $t = 0$, an object is dropped from point A that rebounds inelastically (losing some of its kinetic energy) with a speed of 10 m/s after making a collision with the ground. It finally attains the maximum possible height at $t = 4$ s. What is the difference of heights at $t = 0$ and at $t = 4$ s? (Ignore air resistance as well as the time of impact)

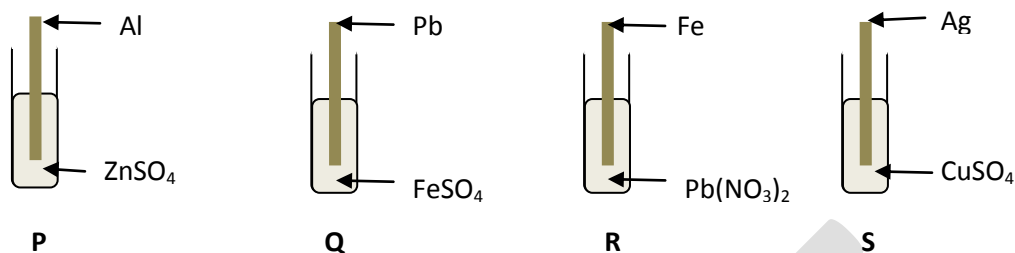
a) 35 m

b) 40 m

c) 45 m

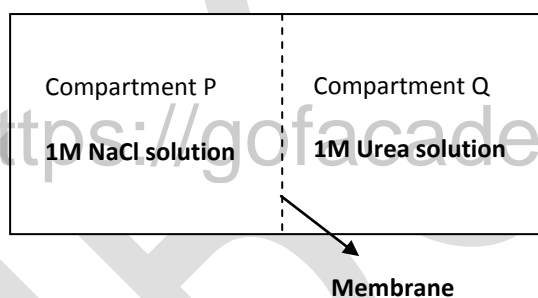
d) zero

20. Observe the following diagram carefully. Concentration of solution in each test tube is 0.1M. The test tube in which a chemical reaction occurs is



- a) P & R b) P & Q c) Q & R d) P & S

21. When two equimolar salt solutions are separated by a selectively permeable membrane, the movement of water molecule across the membrane depends on the water potential of the respective solutions. Water moves from higher water potential to lower water potential. Higher the concentration of ions in a solution; lower is its water potential. In an experiment, two compartments are separated by a specifically designed synthetic membrane that is permeable to water and urea and not to sodium chloride molecules.



Hint: MW of NaCl: 58.4g/mol MW of Urea: 60 g/mol.

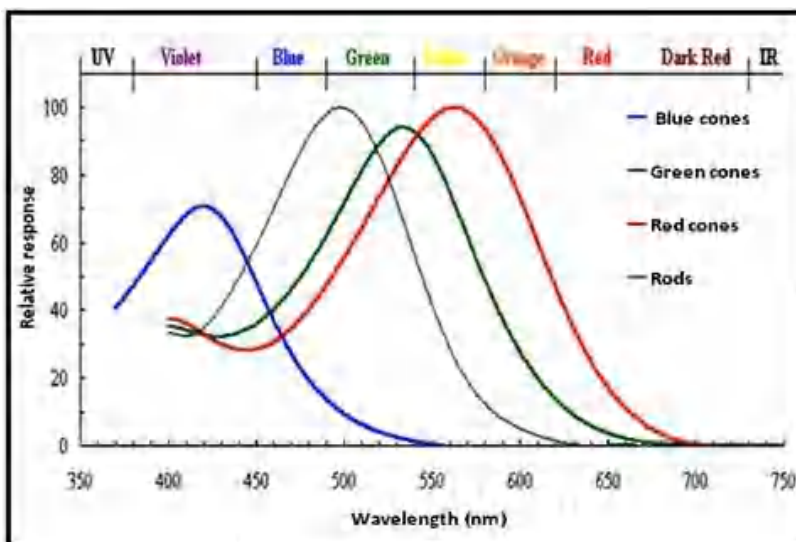
In the above condition, which one of the following options best represents the movement of water and its reason?

- a) Water moves into P, because P has higher concentration of non-penetrating solutes.
 b) Water moves into P, because P has higher concentration of penetrating solutes.
 c) Water moves into Q, because Q has higher concentration of non-penetrating solutes.
 d) Water moves into Q, because Q has lower concentration of non-penetrating solutes.

22. When 0.7 L of Hydrogen at 0.8 bar and 1.5 L of Oxygen at 0.6 bar are introduced in a 1 L vessel at $25^\circ C$, the total pressure of the gas mixture is _____.

- a) 0.8 bar b) 1.24 bar c) 1.46 bar d) 1.62 bar

23. Cone cells in human eye are responsible for color vision. The cone cells are of three types: Red (R), Green (G) and Blue (B) cells. Each type of cone cell responds to a range of wavelengths, with a particular wavelength showing the maximum response. Given below is a graph showing relative response of rods and cone cells in different wavelengths of light.



Which of the cone cell(s) will respond to wavelengths in the orange region?

- a) Blue and red b) Red and green c) Blue and green d) only red

<https://gofacademy.in>

24. Five polyester balls labeled P, Q, R, S & T are suspended from insulating threads. Several experiments are performed on the balls and the following observations are made.

- I. Ball P repels R and attracts Q
- II. Ball S attracts Q and has no effect on T
- III. A negatively charged rod attracts both P and T

Which one of the following options correctly describes the nature of charges on the respective balls (0 refers to uncharged)?

	P	Q	R	S	T
a	+	-	+	0	+
b	+	-	+	+	0
c	-	+	-	0	0
d	+	-	+	0	0

25. Plant tissues where carbon fixation occurs are known as 'source'. The product(s) formed is/are then transported to different parts of the plant body for its further utilization or storage, which is known as 'sink'.

Which of the following can be categorized as 'source (P)' and 'Sink (Q)'?

- a) (P) endodermis of root; (Q) phloem cells of root
- b) (P) epidermal region of assimilatory root; (Q) meristematic region of assimilatory root
- c) (P) parenchyma of beet tuber; (Q) phloem cells of root
- d) (P) xylem tissue of a green leaf; (Q) phloem tissue of the adjacent green leaf

26. Immunity is the state of protection against foreign agents. It can be conferred either actively by activating a person's immune system or passively without activating his own immune system. Following are different examples of how immunity can be attained.

I. Antibodies passed from mother to the child through breast feeding.

II. Treatment of humans bitten by venomous snakes with antivenin, a serum from sheep or horses that have been immunized against the venom.

III. Infection with hepatitis A virus and subsequent recovery from it.

IV. Administration of hepatitis A vaccines.

Which of the above are examples of passive immunity?

- a) I & II only
- b) II & III only
- c) I only
- d) I & IV only

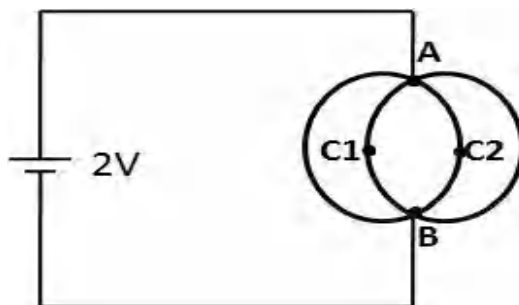
27. A student titrated a mixture of NaHCO_3 and Na_2CO_3 against a standard solution of HCl. He pipetted out a certain volume of mixture and added phenolphthalein indicator. The pink solution changed to colourless after addition of x mL of HCl. To the same solution he added methyl orange indicator and continued the titration. The end point with methyl orange indicator was obtained after addition of y mL HCl. The volume of HCl required for complete neutralization of Na_2CO_3 is _____.

- a) $2x$
- b) $x/2$
- c) y
- d) $y - x$

28. The organism whose body develops from two germ layers are called diploblastic, whereas the organism developed from three germ layers are called triploblastic. In some triploblastic organism the body cavity or coelom is formed from mesoderm and endoderm. Such an organism is called as ___[P]___ and an example for it is ___[Q]___. Choose the correct option to fill in the blanks in the above statement.

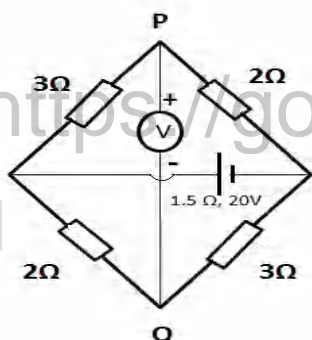
- a) [P] – Coelomate; [Q]-Hydra
- b) [P] – Coelomate; [Q]-*Planaria*
- c) [P] – Pseudocoelomate; [Q]- Pila
- d) [P] – Pseudocoelomate; [Q]- *Ascaris*

29. Two identical circular rings are placed in a plane such a way that they pass through each other's centres C_1 and C_2 as shown in figure. Resistance of the wire forming *each* ring is 36Ω . Conducting joints are made at intersection points A and B of the rings. An ideal cell of e.m.f 2 volt is connected across A and B. The power delivered by the cell will be _____.



- a) $1/18 \text{ W}$ b) $2/9 \text{ W}$ c) 1 W d) $8/9 \text{ W}$

30. In the circuit shown below, the internal resistance of the battery is 1.5Ω and its e.m.f. is 20 V. A multimeter in its voltage mode is connected between P and Q. Internal resistance of the multimeter can be taken to be infinite. The multimeter reading is _____.



- a) -2.5 V b) -4 V c) 4 V d) 2.5 V

SECTION B

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

Question 31

A) An ion with mass number 79 when placed between two electrically charged plates with potential difference 1 V gains energy of 2 eV and moves towards the positive plate. If the ion contains 25 % more neutrons than the electrons, identify the ion. **[Total=3 marks]**

B) Trisha was given a silvery white metal (A) and she was asked to heat it in air. Trisha did that and observed that a white ash (X) is formed. Out of curiosity she dissolved the ash (X) in water and obtained a solution (Y). Trisha tested the solution (Y) using pH paper and found that it turned blue. (Y) is commonly used in dental work as an antimicrobial, and is the substance of choice of dentists for forming a protective layer known as an apical barrier. (Y) when reacts with chlorine gas gives (B), which is used as a toilet cleaner. To this solution (Y), she added dil sulphuric acid and obtained a white precipitate (Z). Help Trisha to identify A, B, Y, Z. Write balanced equations for all the reactions involved. **[Total=2 marks]**

Question 32

A point object is moved away from 5 cm to 90 cm along the principal axis of a concave mirror of radius of curvature 60 cm. (Distances are from centre of the mirror).

Using Cartesian sign convention, calculate image distances (v) for at least ten *suitable* object distances (u) and tabulate the values.

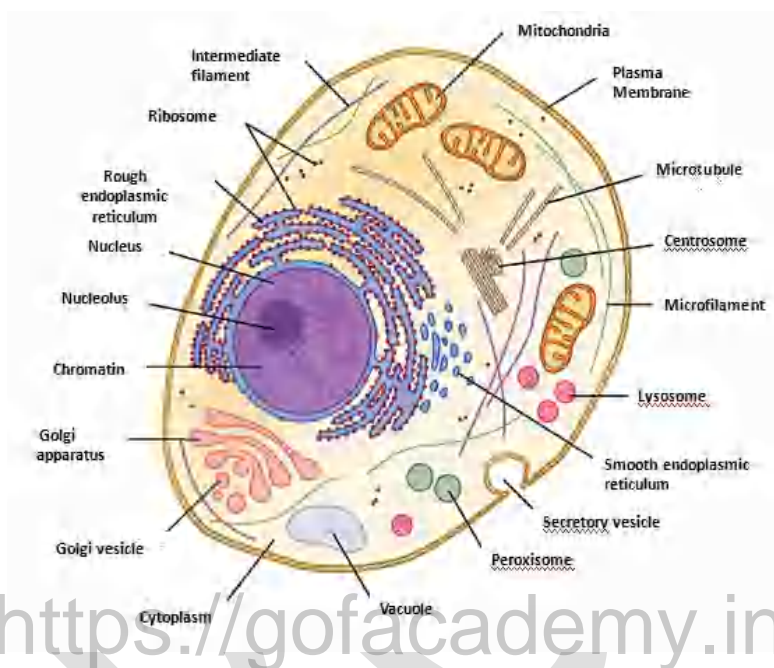
Plot a graph of v against u using the tabulated values with a proper choice of scales. **[Total= 5 marks]**

Question 33

A sprint runner was running a 100 meter race. 10 min before starting his run in the race, he was given 200 ml of 5% glucose solution. [Assume M.W. of glucose = 180.0]. **[Total=5 marks]**

- I) Calculate how many moles of glucose was given to the sprinter. **[1.5]**
- II) If 100% of the glucose molecules was absorbed into his body and were used for production of pyruvic acid, calculate the moles of pyruvic acid that will be produced from these glucose molecules. **[0.5]**

- III) 25% of the total pyruvic acids generated from these glucose molecules are in muscle tissues and they subsequently form lactic acid. Calculate the total moles of lactic acid produced from these pyruvic acids. **[0.5]**
- IV) If all the pyruvic acid generated (including the muscles and other parts of body) undergo aerobic oxidation to produce CO_2 and water, calculate the total moles of CO_2 produced from these pyruvic acid. **[1.0]**



- V) The figure above represents a pictorial representation of components of a cell. Based on the information above predict the sites where these products are formed when glucose is metabolized by aerobic or anaerobic oxidation. **[1.5]**
- The site of formation of pyruvic acid is _____ in the cell.
 - The site of lactic acid formation is _____ in the cell.
 - The site of oxidation of pyruvic acid for generation of end products such as CO_2 and H_2O is _____.

Question 34

A stable carbon nucleus has 6 protons and 6 neutrons and a radius of 2.7×10^{-15} m. The six protons repel each other so that each proton experiences equal resultant force from the others which is also the minimum resultant repulsive force.

For the purpose of calculations, assume that the protons and neutrons are point particles and protons are point charges. Also assume that protons and neutrons get distributed inside or on the surface of sphere of radius given above. The nuclear force which gives nucleus its stability is *NOT* discussed in this question.

Note: A force F has its component at an angle θ given by $F \cos \theta$ and in a direction perpendicular to the first (in the same plane), it is $F \sin \theta$.

Note: while expressing a number in scientific notation, decimal point should be placed one digit after first non-zero digit and then multiplied by appropriate power of 10, **as given in the constants** on the front page. **[Total=5 marks]**

- i) Draw a simple sketch **or** explain in few words the orientation of the protons in the nucleus when the above mentioned condition is satisfied. **[1.0]**
- ii) Obtain the expression for the resultant repulsive force on one proton due to the remaining protons. **[1.0]**
- iii) Calculate the magnitude of this resultant repulsive force. **[1.0]**
- iv) Calculate the attractive gravitational force on this proton due to the remaining protons under the condition stated above. **[1.0]**
- v) Calculate the approximate ratio of the repulsive electrostatic force to the attractive gravitational force. **[0.5]**
- vi) What is the direction of the resultant electrostatic repulsive force on this proton? **[0.5]**

Question 35

A) Veeni thermally decomposed 90g of potassium chlorate of 60% purity. The total gas produced was allowed to react with hydrogen that was prepared by passing steam over hot magnesium metal. Calculate the amount of magnesium required to produce just sufficient hydrogen for completion of the reaction. **[Total=2 marks]**

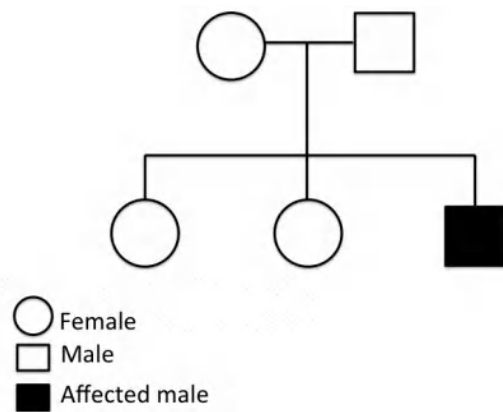
B) When a silvery grey powder of a solid (A) is mixed with a powder of solid (B) no reaction occurs. But if the mixture is ignited and lighted using magnesium ribbon a reaction occurs with evolution of large amount of heat forming product (C) which settles down as liquid metal and the solid product (D) formed floats on the liquid (C). (C) in solid form reacts with moisture to form rust. The amount of heat generated during the reaction is so high that the reaction is used in welding of electric conductors, joints in railway tracks. Based on this information, answer the following questions.

- I) Identify (A), (B), (C) and (D).
- II) Write the balanced chemical equation for the reaction. Name the type of reaction.
- III) If (A) reacts with air on heating what will be the nature of oxide formed?
- IV) Does oxide of (A) react with aqueous NaOH and/or HCl . Give balance chemical equation/s.

[Total=3 marks]

Question 36

Inheritance of traits in humans is studied by analyzing the presence or absence of a trait in a family. This is then depicted as a chart showing different generations and indicating individuals who show the trait. The following is a pedigree for a rare genetic disorder representing parents (top row) and their three children. **[Total=5 marks]**



The pedigree suggests that the genetic disorder could be either autosomal recessive or X-linked recessive.

The following statements were made about the genotypes (with respect to the gene responsible for the disorder) of the 5 individuals in this pedigree:

- The mother is heterozygous.
 - The daughters could be either homozygous or heterozygous.
 - The daughters are only homozygous.
- I) Which of the above statement(s) is/ are correct if the genetic disorder is
[No marks will be given for partially correct answers]

- Autosomal recessive? **[2.0]**
- X-linked recessive?

II) Assuming that both the parents carry the allele responsible for the disorder, what is the probability that the first daughter would carry the same allele?

- a) 1/4 b) 2/4 c) 1/3 d) 2/3 **[1.0]**

III) Assume that the trait is X-linked recessive. The affected son marries a woman who does not carry the allele for the disorder. When they have a child, what is the probability that child will carry the allele, if the child is a

- Son
- Daughter **[2.0]**

Question 37

A tank measuring 3 m (l) \times 3 m (b) \times 2 m (h) contains water to 80% of its capacity. The tank is moving with a uniform velocity along a smooth horizontal surface.

i) Will the free surface of water be horizontal? If not, sketch the nature of the free surface. **[0.5]**

ii) From $t = 5$ s the tank is accelerated along its length at a m/s². Will the free surface of water be horizontal? If not, sketch the nature of the free surface. **[0.5]**

iii) Determine the maximum value of acceleration a such that water does not spill over the tank. **[3.0]**

iv) Complete the following statement by choosing the correct option. **[1.0]**

During accelerated motion of the water tank an air bubble trapped inside will move_____.

- a) Parallel to the direction of acceleration a .
- b) In a direction opposite to the direction of a .
- c) Vertically upward.
- d) In a direction perpendicular to the free surface of the water.

Question 38

A) Deepa has 100 ml of 10.7 % ammonium chloride solution. Vikram added some amount of slaked lime in it. The gas produced in the reaction is allowed to react with 23.85 g of copper (II) oxide to give solid copper. **[Total=3 marks]**

Calculate:

- i) Write balanced chemical equations for all the reactions involved.
- ii) The amount of slaked lime required to produce sufficient amount of the gas for complete reaction with copper oxide
- iii) The mass of copper after the reaction.

B)

a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r
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a to r are elements of the fourth period in the periodic table. Answer the questions given below based on the above information. **[Total=2 marks]**

- i) Write the formula of the compound formed when o reacts with q.

- ii) Which element forms maximum number of oxidation states?
- iii) Which element forms a purple salt which is also used as disinfectant and for sterilizing well water.
- iv) Identify the coinage elements in the above period.
- v) Which element is a metalloid?
- vi) Which of the above elements has the lowest percentage in the common variety of brass?

Question 39

Some experiments were carried out using *Croton* sp. plants to understand the process of photosynthesis. It was observed that the leaves of the plant exposed to light for longer duration accumulated more starch. However, due to presence of pre-formed starch in the leaves, it was difficult to find the net productivity on a fixed exposure to light source. Therefore, it was necessary to obtain starch free leaves in the plant before starting the experiment. **[Total=5 marks]**

1. Which of the following would help obtain starch free leaves in the plant? **[0.5]**

- a) Expose the leaves to blue light for 48 hours before starting the experiment.
- b) Keep the plant in dark for about 48 hours before starting the experiment.
- c) Remove starch from the leaves by exosmosis, 48 hours before starting the experiment.
- d) Keep the leaves to red light for 48 hours before starting the experiment.

2. After a period of illumination, the leaves were boiled in alcohol to make them colourless. Which of the following could be used to test the end product stored in the leaves? **[0.5]**

- a) Cobalt chloride paper
- b) Litmus paper
- c) Iodine solution
- d) Copper sulfate solution

3. During the experiment it was also noted that the end product starch got accumulated only in the cells containing green plastid and upon their illumination to specific wavelengths of light. What is the immediate purpose of the specific wavelength of light used? **[1.0]**

- a) In reducing carbon dioxide
- b) For synthesis of glucose
- c) Excitation of chlorophyll
- d) Splitting water into oxygen and hydrogen ion.

4. Some of the starch free leaves were coated with wax on both the surfaces. The plant was maintained under normal environmental conditions. At the end of the experiment, the wax coated leaves are likely to show _____. [1.0]

- a) Accumulation of more water.
- b) Wilting of the wax coated leaves.
- c) Increase in sucrose accumulation.
- d) Decrease in number of chloroplasts

5. During the morning hours, using a fine blade, an incision was made to the leaves such that the phloem tissue was cut open. Analysis of the liquid oozing out was found to contain high amount of [1.0]

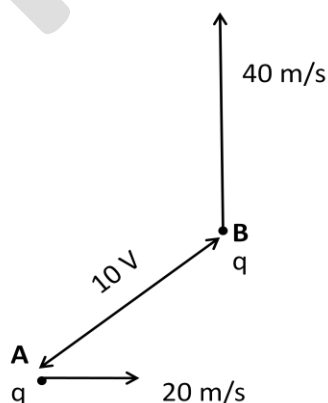
- a) Xylose
- b) Ribose
- c) Sucrose
- d) Galactose

6. Leaves of the plant were homogenized in an appropriate buffer environment under appropriate temperature conditions in a test tube. In which of the following conditions is photosynthesis likely to happen in the homogenate? [1.0]

- a) As long as the test tube is illuminated by white light and oxygen concentration is high.
- b) As long as the test tube is illuminated by white light and sodium bicarbonate is present in it.
- c) As long as oxygen concentration is high and sodium carbonate is present in the test tube.
- d) As long as the test tube is illuminated by white light and potassium phosphate is present in it.

Question 40

- A) The electrostatic potential difference $V_B - V_A$ between two points A & B , corresponding to electrostatic forces, is defined as the change in electrostatic potential energy per unit charge as it moves from A to B . A charged particle of mass 0.02 kg moves under electrostatic forces only, from A to B having potential difference of 10 volts as shown. Velocity of the particle at A is 20 m/s and at B is 40 m/s and their directions are perpendicular. Calculate the charge q on the particle. [Total=2 marks]



B) Two helicopters X and Y are stationary at a distance of 80 m from each other and 10 m above the surface of sea (near the Antarctic). The two helicopters have sound detectors. Helicopter X is stationary, vertically above a 50 m thick block of ice. (For the purpose of calculation, the vertical section of the block can be considered as rectangle). A Blue whale (W) is stationary vertically below X and 50 m below the water surface in such a way that there is no ice in the line of sight between Whale W and helicopter Y. This line of sight intersects water surface at point M.

Whale W gives out a call (sound) which is detected by X. Y received the same sound 0.07 seconds after X received it. (For practical purpose, helicopters are considered to be point objects).

[Total=3 marks]

- i) How much height of ice is floating above the surface of sea? [1.0]
- ii) What is the distance YM and YW? [0.25 + 0.25]
- iii) What is the time taken for the sound to travel from W to Y after W makes the sound? [0.5]
- iv) What is the time taken for the sound to travel from W to X? [0.5]
- v) What is the velocity of sound in the ice? [0.5]

Question 41

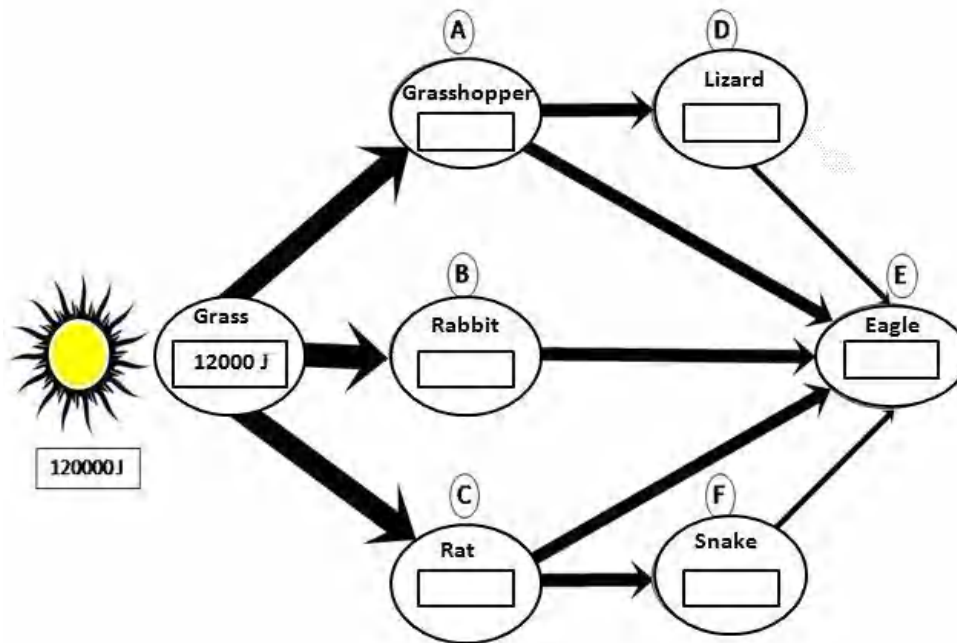
A) A mixture of a 5 mL sample solution of HCl and 2 drops of phenolphthalein turns pink on the addition of 2 drops of 1 M NaOH solution to it. Find the concentration and grams of HCl in the given sample solution. (100 drops of 1 M NaOH is found to be equivalent to 6 mL) [Total=2 marks]

B) Reshma and Shubha were working together in the chemistry laboratory. They wanted to find out the exact molarity of a solution of sodium hydroxide (NaOH), prepared by dissolving exactly one gram of sodium hydroxide pellets in water and diluting the resultant solution to 250 mL in a volumetric flask. Reshma weighed exactly one gram of solid sodium hydroxide using a chemical balance; but while transferring it to a beaker, she spilled some amount of the weighed solid on the floor but she still went ahead with the preparation. Shubha was unaware of this spillage. She titrated the sodium hydroxide solution prepared by Reshma with 10 mL solution of 0.05 M dibasic acid having formula $(C_2H_3O_2)_2$. The constant titre reading for the titration obtained by Shubha was 11.3 mL.

- (i) Calculate the amount of sodium hydroxide spilled on the floor.
- (ii) How many molecules of each of the reactants were present in the titration performed by Shubha? [Total=3 marks]

Question 42

- A) An analysis of food chains and the energy flow within an ecosystem provides important understanding of contingencies and mutual dependencies of organisms. The following visual depicts the energy flow within some members of a grassland ecosystem.



The grass in the above ecosystem transducer 120,000 J of sunlight and fixes it into 12,000 J of energy. It is established that 90% of the energy of one trophic level is not passed to the next trophic level. Further assume that the energy transferred from one trophic level to the next is equally shared among the different organisms at that trophic level. [Total=5 marks]

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- I) How many food chains are present in the food web depicted above? [0.5]
- II) Based on the above information, indicate the amount of energy that an organism (A to F) may have received from an organism from the previous trophic level. [0.5]
- III) In the food web depicted above, identify the most energy efficient link for tertiary consumer? [1.5]
- B) Assume that an insect eats plant seeds containing 100 J of energy. A part of this energy is lost or is unassimilated in the form of faeces; while the rest is assimilated through respiration and biomass production. It uses 36 J of that energy for respiration and excretes 52 J in its faeces. [1.0]
- i) How much is the insect's net secondary production?
- (a) 12 J
- (b) 48 J
- (c) 24 J
- (d) 36 J

- (ii) Production efficiency is the percentage of energy stored in assimilated food that is not used for respiration. In the case of the insect described above, what will be its production efficiency? **[1.0]**
- (a) 5.8 %
 - (b) 25 %
 - (c) 75 %
 - (d) 92 %
- C) Which of the following represents the correct sequence representing an increasing order of biomass production efficiencies? **[0.5]**
- (a) Birds → Mammals → Fishes → Microorganisms
 - (b) Microorganisms → Birds → Fishes → Mammals
 - (c) Fishes → Birds → Mammals → Microorganisms
 - (d) Mammals → Fishes → Birds → Microorganisms

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ANY ALTERNATIVE METHOD OF SOLUTION TO ANY QUESTION THAT IS SCIENTIFICALLY AND MATHEMATICALLY CORRECT, AND LEADS TO THE SAME ANSWER WILL BE ACCEPTED WITH FULL CREDIT. PARTIALLY CORRECT ANSWERS WILL GAIN PARTIAL CREDIT.

SECTION A

Q. No.	(a)	(b)	(c)	(d)	Q. No.	(a)	(b)	(c)	(d)
1	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	16	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	17	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	18	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	19	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	20	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	21	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	22	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
8	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	23	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	24	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
10	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	25	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	26	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	27	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	28	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
14	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	29	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
15	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	30	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

SECTION B**Question 31****A)**

PD of 1 V, gains 2 eV therefore charge of ion is -2 C

The number of electrons in the ion = X

Then the number of neutrons will be $X + 25 X/100 = 1.25X$

The number of electrons in the neutral atom = X-2

The number of protons in the neutral atom = X - 2

Mass number = No. of Protons + No. of neutrons

$$79 = X - 2 + 1.25X$$

$$2.25 X = 81$$

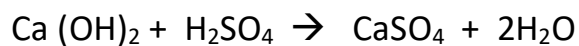
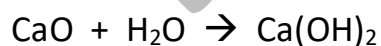
$$X = 81 / 2.25 = 36$$

Number of protons = $36 - 2 = 34$ Hence the element is Se Symbol of Ion is Se^{-2}

B)

A = Ca B = CaOCl_2 Y = Ca(OH)_2 Z = CaSO_4

Reactions: $2\text{Ca} + \text{O}_2 \rightarrow 2\text{CaO}$



OR $2\text{Ca(OH)}_2 + 2\text{Cl}_2 \rightarrow \text{Ca(ClO)}_2 + \text{CaCl}_2 + 2\text{H}_2\text{O}$

II. 1 molecule of glucose forms 2 molecules of pyruvic acid

All the glucose thus will produce $0.0555 \times 2 = 0.111$ moles of pyruvic acid

III. One molecule of pyruvic acid forms 1 molecule of lactic acid

Hence all lactic produced from the 25% of the pyruvic acid will be: $0.111/4 = 0.02775$ moles

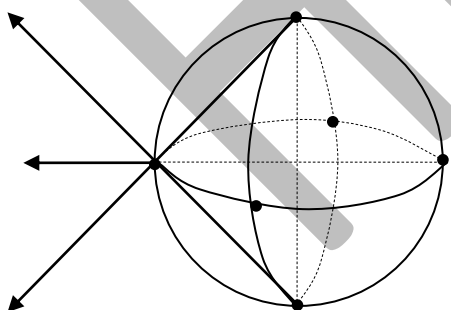
IV. 1 molecule of pyruvic acid gives 3 molecules of CO_2

Hence moles of CO_2 produced from this pyruvic acid will be: $0.111 \times 3 = 0.333$ moles

V. i) cytoplasm, ii) cytoplasm, iii) mitochondria

Question 34

i)



ii) $F_e = \frac{1}{4\pi\epsilon_0} q^2 \left(4 \times \frac{1}{\sqrt{2}} \times \frac{1}{2r^2} + \frac{1}{(2r)^2} \right) = \frac{1}{4\pi\epsilon_0} \left(\sqrt{2} + \frac{1}{4} \right) \left(\frac{e^2}{r^2} \right)$ r = radius of carbon atom

iii) $F_e = (9 \times 10^9) \times (1.66) \times \frac{(1.6 \times 10^{-19})^2}{(2.7 \times 10^{-15})^2} = 52 \text{ N}$

iv) $F_g = 6.7 \times 10^{-11} \times 1.66 \times \frac{(1.7 \times 10^{-27})^2}{(2.7 \times 10^{-15})^2} = 4.4 \times 10^{-35} \text{ N}$

v) $\frac{F_e}{F_g} = \frac{52}{4.4 \times 10^{-35}} \approx 1.2 \times 10^{36}$

vi) Along the diameter, radially outwards.

Question 35

A)

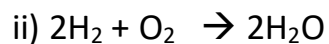


$$2(39 + 35.5 + 48) = 245\text{g} \qquad 3 \times 32 = 96\text{g}$$

Amt. of pure KClO_3 in 90g of 60% purity $(90 \times 0.6) = 54\text{g}$

According to eq(i) 245g of $\text{KClO}_3 = 96\text{g}$ of O_2

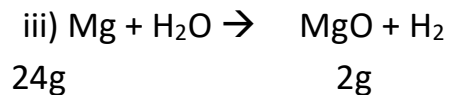
$$\therefore 54\text{g of } \text{KClO}_3 = (96 \times 54) / 245 = 21.2\text{g of } \text{O}_2$$



$$4\text{g} \quad 32\text{g}$$

According to eq (ii) 32 g of $\text{O}_2 = 4\text{g}$ of H_2

$$21.2 \text{ g of O}_2 = (21.2 \times 4)/32 = 2.65 \cong 2.7 \text{ g of H}_2$$



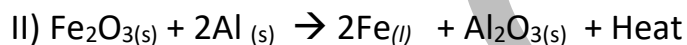
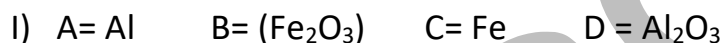
According to eq (iii) 2 g of H₂ = 24g of Mg

$$2.7 \text{ g of H}_2 = (24 \times 2.7)/2 = 32.4 \text{ g of Mg}$$

$$\text{OR } 2.65 \text{ g of H}_2 = (24 \times 2.65)/2 = 31.8 \text{ g of Mg}$$

B)

This is a thermite reaction.



Displacement reaction/ thermite reaction/ redox reaction

III) Amphoteric



Question 36

I) i) Autosomal recessive: **a. and b.**

ii) X-linked recessive: **a. and b.**

II) Option **d** is correct. **2/3**

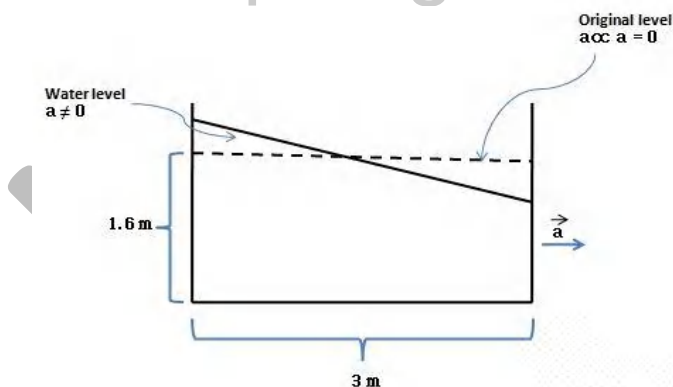
III)

- i. Son answer: 0
ii. Daughter answer : 1

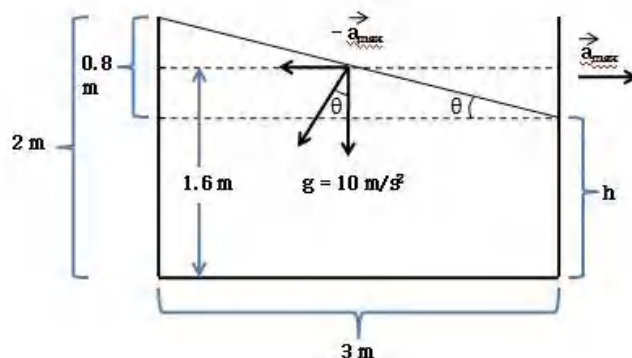
Question 37

i) Since the tank is moving with uniform velocity, the free surface of water will remain horizontal (No need to sketch the free surface)

ii) After $t = 5$ s, since the tank is accelerated uniformly, the free surface will not remain horizontal. In fact a pseudo force (or pseudo acceleration) will act in the tank frame in the opposite direction. This makes the free surface inclined to the horizontal with water rising along the backside. The situation will be as shown.



iii) To find the maximum acceleration a_{\max} for the water not to spill over, the situation is as shown below.



To find h , we equate the volumes in the two situations with changed geometry.

The surface tilts uniformly and it is plane even in the tilted position (as shown in the figure).

The free surface of water will remain perpendicular to the net acceleration which is the vector sum of g (downwards) and $-a_{\max}$ (pseudo acceleration) as shown.

From simple geometry,

$$\tan \theta = \frac{0.8}{3} = \frac{a_{\max}}{10}$$

$$\therefore a_{\max} = \frac{10 \times 0.8}{3} = \frac{8}{3} = 2.66 \text{ m/s}^2$$

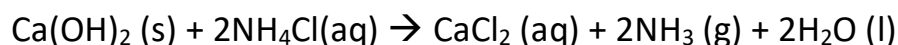
iv) The correct option is (d). The air bubble always travels perpendicular to the free surface.

Question 38

A)

Molecular mass of ammonium chloride (NH_4Cl) = $14+4+35.5= 53.7$

10.7 % of ammonium chloride = 2 molar ammonium chloride solution



74g

34 g

Ammonia gas produced in the above reactions now reacts with 23.85 g CuO



2 mole 3 moles 3 moles

2 x 17 3 x 79.5 3 x 63.5

34 238.5g 190.5g

3.4 23.85g 19.05g

Amount of slaked lime required is 7.4 g

Amount of Copper obtained is 19.05 g



74 34 190.5

B)

- i) O_3 or AsBr_3
- ii) g or Mn (+2 to +7)
- iii) g or KMnO_4
- iv) Coinage elements: h, j, k or Fe, Ni, C
- v) As and/or Ge
- vi) I or Zn

Question 39

1. The correct option is (b) i.e Keep the plant in dark for about 48 hours before starting the experiment.

2. The correct option is (c) i.e Iodine solution

3. The correct option is (c) i.e Excitation of chlorophyll
4. The correct option is (a) i.e Accumulation of more water
5. The correct option is (c) i.e Sucrose
6. The correct option is (b) i.e As long as the test tube is illuminated by white light and sodium bicarbonate is present in it.

Question 40

A)

$$qV = \text{Change in kinetic energy} = \frac{1}{2}m(v^2 - u^2)$$

$$q \cdot 10 = (1/2)(0.02)(40^2 - 20^2) = 12$$

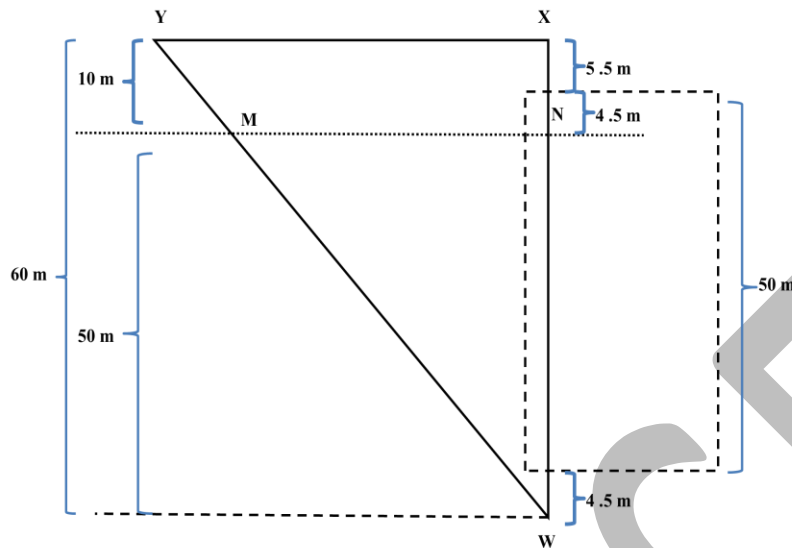
$$|q| = 1.2 \text{ C}$$

While moving from A to B, Kinetic energy increases

∴ Charge must be negative

$$\therefore q = -1.2 \text{ C}$$

B)



i) Mass of ice = $V/910 \text{ kg} = A \times 50 \times 910 \text{ kg}$

So mass of water displaced = $A \times h \times 1000 \text{ kg}$.

$$50 \times 910 = h \times 1000$$

$$h = 50 \times .91 = 45.5 \text{ m}$$

So 4.5 m of ice projects out of water (is above the surface of water). Hence there is 5.5 m of air between X and ice surface.

Also whale is 4.5 m below the sheet of ice.

$$\text{ii) } YW = (6400 + 3600)^{1/2} = 100 \text{ m}$$

Taking ratio of 10/60 in 100m gives $YM = 16.6 \text{ m}$ and $MW = 83.4 \text{ m}$.

iii) Time taken for the sound to reach Y is $(16.6/350 + 83.4/1500) = 0.103 \text{ s}$ iv)

Time taken to travel to x = 0.033 s

v) Travel time in air is $5.5/350 = 0.016 \text{ s}$ and in water below the sheet of ice it is $4.5/1500 = 0.003 \text{ s}$ with total time 0.019 sec. Travel time of sound in ice is thus $0.033 - 0.019 = 0.014 \text{ s}$ for 50 m hence its speed in ice is 3571 m/s.

Question 41**A)**

Vol of 2 drops of 1 M NaOH = $(6 \times 2) / 100 = 0.12$ mL

Conc of HCl = $(\text{conc NaOH} \times \text{vol NaOH}) / \text{vol HCl} = (0.12 / 5) = 0.024$ M

Grams of HCl = $(0.024 \times 5 \times 36.5) / 1000 = 0.00438$ g

B)

(i) Molarity of sodium hydroxide,
 $M = 0.05 \times 10 \times 2 / 11.3 = 0.0885$ M

Amount of NaOH in the solution
gm/ 250 mL. of NaOH,
 $= 40 \times 0.0885 \times 250 / 1000 = 0.885$ g

Amount of NaOH spilled = $1 - 0.885 = 0.115$ g

(ii) 1000 mL 1 Molar any solution contain 6.02×10^{23} molecules

Number of NaOH molecules in 0.0885 M 11.3 mL

$$\begin{aligned} &= (0.0885 \times 11.3 \times 6.02 \times 10^{23}) \div 10^3 \\ &= 6.02 \times 10^{20} \text{ molecules of NaOH} \end{aligned}$$

Number of dibasic acid molecules in 0.05 M 10 mL

$$= (0.05 \times 10 \times 6.02 \times 10^{23}) \div 10^3$$

$$= 3.01 \times 10^{20} \text{ molecules of dibasic acid}$$

Question 42

A) I) 5.

II) A= 400J, B= 400J, C=400J, D=20J, E=84J, F=20J

III) Grass -> Rabbit -> Eagle

B) I) The correct option is (a) i.e 12 J

II) The correct option is (b) i.e 25 %

C) The correct option is (a) i.e (a) Birds → Mammals → Fishes → Microorganisms.

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