Indian National Junior Science Olympiad 2017

Roll Number: | | | | | | | | | | | | |

QUESTION PAPER

INJSO 2017 Date: 28th January 2017
Duration: **3 Hours** Maximum marks: **90**

INSTRUCTIONS

- Please write your roll number on top of this page in the space provided.
- Please use only black or blue pen to write your answers in the Answer Sheet provided. **Please 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 "**×**" in the appropriate box against the relevant question number, like this:

Q. No.	(a)	(b)	(c)	(d)
22	☐	☐	☒	☐

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 have also been appended, in case of necessity.
- A blank page have been provided in the Answer sheet, for rough work.
- **Please write the answers in the answer sheet only.**
- C**alculator(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) = 6.67×10^{-11} $m^3kg^{-1}s^{-2}$
Avogadro's number (N) = 6.0×10^{23} / mol
Gas constant (R) = 8.314 J mol^{-1} K^{-1}, 0.082 L atm K^{-1} mol^{-1}
Mechanical equivalent of heat (Conversion factor for calorie) = 4.2 J/cal
Specific heat capacity of liquid water = 1 cal/g° C, 4.15 kJ kg^{-1} K^{-1}
Specific heat capacity of liquid heavy water = 4.25 kJ kg^{-1} K^{-1}
Specific heat capacity of frozen water = 2.1 kJ kg^{-1} K^{-1}
Latent heat for melting of water = 330 kJ kg^{-1}
Latent heat for melting of heavy water = 340 kJ kg^{-1}
Specific latent heat for fusion of ice = 80 cal/g
Specific latent heat for boiling of water = 540 cal/g; Heat of vaporization of water at 25°C = 42000 J/mol
Density of liquid water = 1.0 g/cc; Standard pressure = 1 atm
Density of liquid heavy water = 1.1 g/cc; Standard temperature = 273 K
Melting point of heavy water = 4°C; Volume of 1 mole of an ideal gas at S.T.P. = 22.4 L

Element	Relative Atomic Mass	Atomic Weight	Element	Relative Atomic Mass	Atomic Weight
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
S	32	16	Fe	56	26
B	10	5	K	39	19

Ore	Chemical name
Chalcocite	Copper(I) sulphide
Chalcopyrite	Cupric ferrous sulphide
Cinnabar	Mercuric sulphide
Covellite	Copper(II) sulphide
Galena	Lead sulphide
Goethite	Ferric hydroxide oxide
Hematite	Iron(III) oxide
Magnetite	Iron(II,III) oxide
Sphalerite	Zinc sulphide
Zincblende	Zinc sulphide

1 femtogram = 10^{-9} microgram, 1 microgram = 10^{-3} mg.

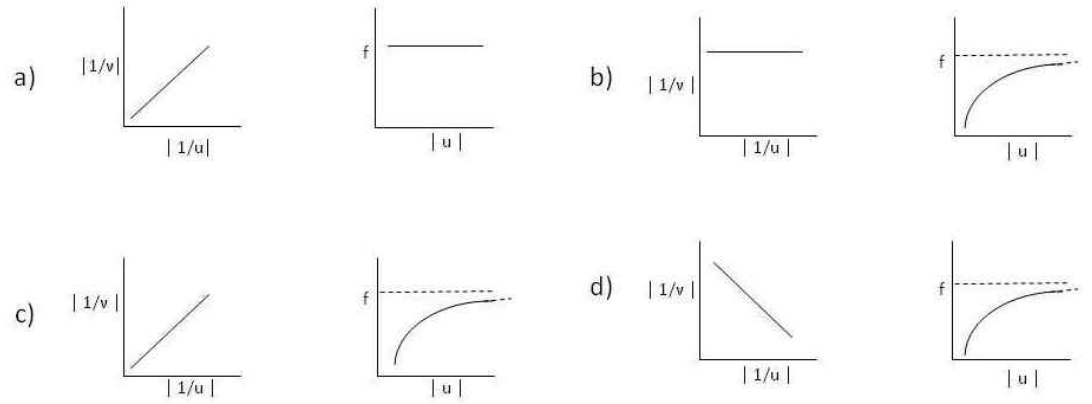
SECTION A

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

1. In an old *Sherlock Holmes* movie, a criminal kept a 12.5 cm long knife (mass 1 kg), in a 15 cm thick book (excluding thickness of the covers) with a spring trap. The spring has 25 turns each of 1 mm thickness. The spring is fixed at the back cover and the knife presses the spring to its maximum when the front cover is closed so that the turns touch each other. The design is such that if the book is held in front of the body and opened, the knife gets detached from the spring and hits the reader (*Sherlock Holmes* in this case). Unstretched length of the spring is equal to thickness of the book. However, *Sherlock Holmes* was too smart and hence he opened the book in such a way that the knife flew vertically upwards. All the energy of the spring is given to the knife, which just reached the ceiling, at a height of 5 m from the tip of the knife and got stuck there. Calculate the spring constant which satisfies the equation $F = -kx$.

   a) 160/9 N/mm b) 40/9 N/mm c) 40 N/mm d) 6.4 N/mm

2. The focal length of a biconvex lens made of a soft material ***can*** be changed by changing its shape. An object was brought from far away to near the biconvex lens. For each option given below, the first (left side) graph gives dependence of $\left|\frac{1}{v}\right|$ on $\left|\frac{1}{u}\right|$ as the shape of the lens is changed, and the second graph gives corresponding dependence of f on $|u|$. Here u, v and f have standard meanings and all images are real. Which of the following options is the correct representation of that lens?



Diagrams drawn are not to scale.

3. A black dot has a mass of about one femto gram. Assuming that the dot is made up of carbon only, calculate the approximate number of carbon atoms present in the dot.

   a) 1×10^8 b) 5×10^{10} c) 5×10^7 d) 1×10^{11}

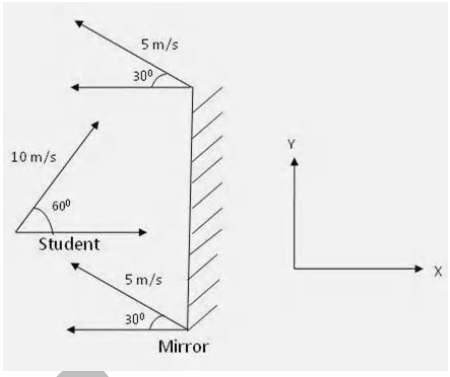
4. Among the following, the third ionisation energy is highest for which one of the following elements?

   a) Boron b) Magnesium c) Aluminium d) Beryllium

5. In a hypothetical situation, a cell was found to lack rough endoplasmic reticulum. Which one of the following activities was all likely absent in this cell?

a) Transcription
b) Translation
c) Synthesis of secretory proteins
d) Manufacture of fat molecules or lipids

6. In a laboratory, a plane mirror and a student move with velocities as shown in the figure. X and Y components of the velocity (in m/s) of the image (of the student), as seen by the student, are respectively



a) $-2.5(2+\sqrt{3})$, Zero
b) $-5, (5\sqrt{3} - 2.5)$
c) $-5(2+\sqrt{3})$, Zero
d) $-5(1+\sqrt{3})$, Zero

7. In liver transplantation, the first three months after transplantation is when the patient requires the most care and post-surgery monitoring. Which of the following statement is most suitable up to three months for a patient who has undergone liver-transplantation recently?

a) She will require no drugs but only care and follow ups.
b) She will be treated with immunosuppressive drugs only.
c) She will be treated with antibiotics only.
d) She will be treated with combination of immunosuppressive drugs and antibiotics.

8. While driving on a level road at 72 kmph, Vinayak observes the traffic signal turning red, the (white) stopping line being 52 m away from the front end of his car. Immediately he applies the brakes that decelerate his car at 4 m/s^2. How far from the stopping line will the front end of Vinayak's car be after 6 seconds?

a) Zero
b) 2 m
c) 4 m
d) 6 m

9. When a mixture of 60mL of carbon monoxide and 40mL of oxygen is sparked, mixture A is obtained. Mixture A is passed through aqueous potassium hydroxide to yield mixture B. The volumes of mixtures A and B respectively are

a) 70mL,10mL
b) 40mL,20mL
c) 60mL,20mL
d)80mL,10mL

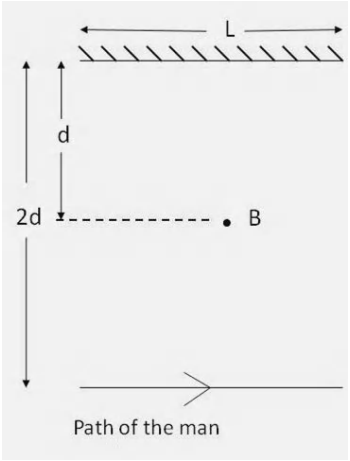
10. A convex mirror of radius of curvature 12 cm has its principal axis horizontal. A simple pendulum with a tiny bob is oscillating in front of the mirror such that centre of mass of the bob is 12 cm away from the mirror along the principal axis. Amplitude of oscillation is 3 cm and there is practically no damping. Length of the pendulum is sufficiently large and the plane of oscillation is such that the bob moves practically along the principal axis of the mirror. Path length of the image of the bob formed by the mirror is …..

a) 4 cm
b) 2 cm
c) 0.7 cm
d) 8 cm

11. Choose the correct sequence of the following ions in increasing order of their ionic radii.

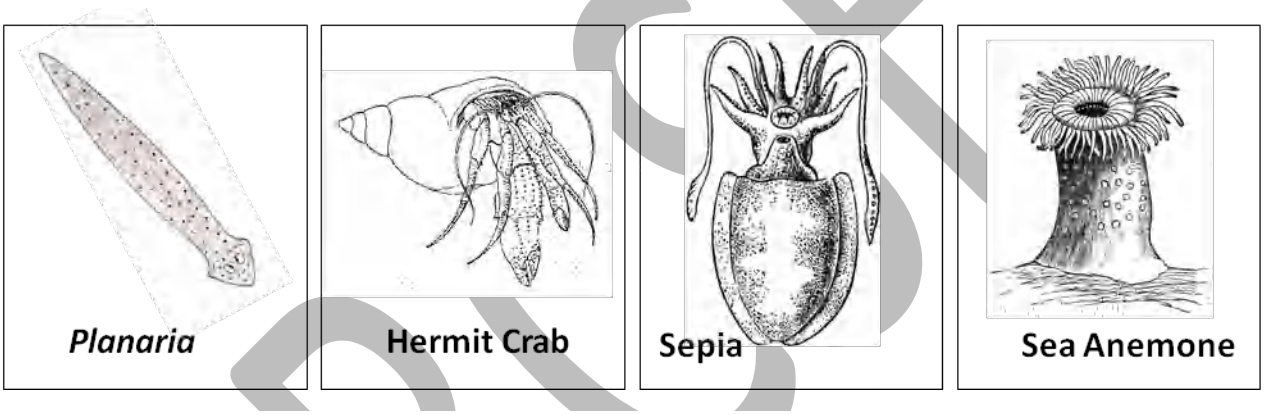
a) $Be^{2+} < Li^{1+} < F^{1-} < O^{2-}$
b) $Li^{1+} < Be^{2+} < O^{2-} < F^{1-}$
c) $O^{2-} < F^{1-} < Li^{1+} < Be^{2+}$
d) $Li^{1+} < Be^{2+} < F^{1-} < O^{2-}$

12. A point source of light B is placed at a distance *d*, in front of the centre of a mirror of horizontal length *L* fixed on a wall. A man walks in front of the mirror and parallel to it at a distance *2d* from it as shown in the figure. The greatest distance over which he can see the image of the light source in the mirror is



a) *L*/2 b) *L* c) 2*L* d) *3L*

13. A group of biology students on excursion to Goa beaches collected the following animal samples.



While they were putting the animals in the jar with sea water, they noticed that one of the animal's 1/3rd body part was missing. The injured animal (with only 2/3rd of its body) was brought to the lab and was allowed to grow in the laboratory in appropriate condition. To their surprise the lost body part of the animal had regenerated. Which of the above animal would have been collected?

a) *Planaria* b) Hermit crab c) Sepia d) Sea anemone

14. A buoy, of height 2 m, is floating in the sea. A wave of amplitude 0.5 m and wavelength λ >> base of the buoy, passes the buoy. The maximum tilt of the buoy (from the vertical) will practically

a) Depend on the amplitude only.
b) Depend on the frequency only.
c) Depend on both frequency and amplitude.
d) be 90˚.

15. A compound exists in the gaseous state both as monomer (A) and dimer (A_2) .The molecular weight of the monomer is 48. In an experiment, 96 g of the compound was confined in a vessel of volume 33.6 litres and heated to 273°C. Calculate the pressure developed, if the compound exists as a dimer to the extent of 50% by weight under this condition, assuming that temperature does not affect the physical state of the dimer.

a) 0.67 atm b)1 atm c)1.33 atm d)2 atm

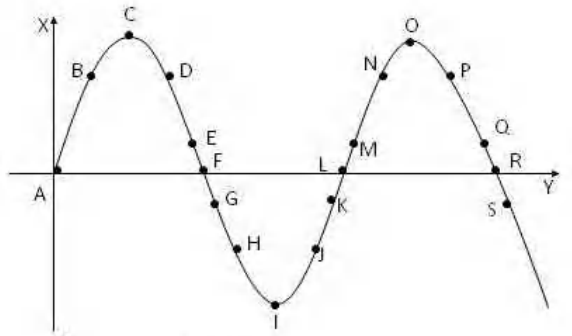
16. A sound wave of fixed frequency is going through a medium in the X direction. Ignore the velocities of the particles due to thermal motion and assume that the layers of the medium perform simple harmonic motions about their mean positions. Graph in the figure represents displacements of the particles from their mean positions (plotted on Y axis) at a particular instant of time. Some of the particles are labeled by alphabets *a* – *s*. Velocity of the particle G is directed negative at that instant. Points C, I and O correspond to maximum displacement at that instant.

I) The sound wave is travelling along the negative X direction.

II) The sound wave is travelling along the positive X direction.

III) Particles C, I and O are possessing maximum kinetic energy at the given instant.

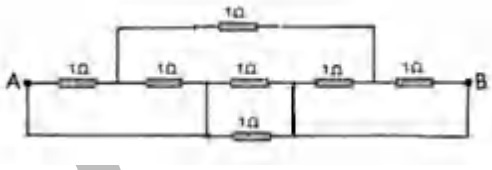
IV) Particles F, L and R are possessing maximum kinetic energy at the given instant.



a) Only I and IV are correct. b) Only II and III are correct.
c) Only I and III are correct. d) Only II and IV are correct.

17. Seven 1 Ω resistances are connected as shown in the figure. Resistance of the conducting wires is negligible. Effective resistance between A and B is

a) (3/5) Ω
b) (3/7) Ω
c) (19/7) Ω
d) 5/7 Ω



18. Following are some statements about mitochondria and chloroplasts:
   I. Mitochondrion has double stranded DNA that replicates independently while chloroplast does not have the same.
   II. Both mitochondria and chloroplast have double stranded DNA that replicates independently.
   III. Both mitochondria and chloroplast have single stranded DNA replicating independently.
   IV. Mitochondria and chloroplast have both RNA and ribosomes.

   Which of the above statements are correct?

   a) Both I and IV b) both III and IV c) both II and III d) both II and IV

19. A solution of pure ferric sulphate containing 0.140g of ferric ions is treated with excess of barium hydroxide solution. Total weight of the precipitate will be.

   a) 0.87g b) 1.14g c) 0.25 g d) 0.56g

20. P, Q, R are different colourless solids, while S is a colourless solution. They are (**in random order**) Sodium chloride (NaCl), Calcium Carbonate ($CaCO_3$), Acetic acid (CH_3COOH) and Phenolphthalein indicator. Small amount of the above substances were added in pairs (e.g. P with Q; Q with R etc.) to a small amount of water in a test tube. They give the following results as shown in the observation table.

Observations table:

	P	**Q**	**R**
Q	No reaction	-	No reaction
R	Dark Pink Colour	No reaction	-
S	No reaction	No reaction	Effervescence

Then the chemicals are

	P	**Q**	**R**	**S**
a)	NaCl	$CaCO_3$	CH_3COOH	Phenophthalein
b)	Phenophthalein	NaCl	$CaCO_3$	CH_3COOH
c)	CH_3COOH	Phenophthalein	NaCl	$CaCO_3$
d)	$CaCO_3$	CH_3COOH	Phenophthalein	NaCl

21. Fishes such as S*almon* are called as anadromous fish. They are born in fresh water. However, then they migrate to the sea and spend most of their life in the sea. They return to fresh water to spawn. On the contrary, catadromous fishes such as *Eels* do the opposite. They live in fresh water for their entire life. They migrate to the sea to spawn.

Salmon

Eel

Which one of the following strategies will Salmon adopt in order to manage the problem of osmoregulation when it is in the sea?

a) Salmon drinks profusely in sea and it drinks feebly in fresh water.
b) It produces large volume of dilute urine in sea water.
c) In sea water, gills filter NaCl which is absorbed selectively into its body.
d) The mode of excretion of *Salmon* is changed from ammonia to uric acid.

22. You are provided with 4 metal ores at different levels of activity series, extraction of these metals from their ores involves oxidation and reductions. Match the metal ores with their extraction processes.

Metal ores	Processes
1. Cinnabar	I. Oxidation and reduction
2. Zincblende	II. Oxidation
3. Hematite	III. Electrolysis
4. Galena	IV. Reduction

a) 1-I, 2-II, 3-IV, 4-II b)1-II, 2-I, 3-IV, 4-I c) 1-I, 2-III, 3-II, 4-IV d)1-IV, 2-II, 3-III, 4-I

23. In a hypothetical experiment the outer tissues of the woody part of the stem of a dicotyledonous plant is removed in the form of a ring, leaving only the xylem and pith intact. Which one of the statements is most likely to be correct?

a) Water transport from the root to leaves will be obstructed but food transport from leaves to stem will be unhindered.
b) Water transport from root to leaves will not be obstructed but food transport from stem to leaves will be hindered.
c) Water transport from root to leaves will not be obstructed but food transport down the leaves stops at the ring.
d) Water transport from leaves to root is obstructed but food transport down from the leaves stops at the ring.

24. In an experiment involving treatments to demonstrate transpiration, six experimental setups were as follows:

I. Woody plant with only leaves coated with Vaseline jelly
II. Woody plant with only stem coated with Vaseline jelly
III. Woody plant without any coating of Vaseline jelly
IV. Herbaceous plant with only stem coated with Vaseline jelly
V. Herbaceous plant with only leaf coated with Vaseline jelly
VI. Herbaceous plant without any coating of Vaseline jelly

Cobalt chloride ($CoCl_2$) paper (changes from blue to pink when wet) was attached to the leaves and stem. The plants were well watered and kept under adequate sunlight. The following were proposed:

	Colour change of $CoCl_2$ paper on	
Plants	**Leaves**	**Stem**
I	Blue	Blue
II	Pink	Pink
III	Pink	Blue
IV	Blue	Blue
V	Blue	Pink
VI	Pink	Blue

Which of the above is/are correct?

a) I ,II and V b)Only II c)III, IV and VI d)Only V

25. Bones, ligaments and muscles are structures that are considered to be lever system in the body for human movement. Classically, the levers are represented as: first, second and third (I, II and III), classes of levers depending on their relative positions of the fulcrum, effort and resistance (or load).
Given below are few body part movements (represented as P = backward bending of neck, Q = walking on toe and R = folding of arm) which can be compared to specific classes of levers. From the options below identify the correct combination of body part to that of a class of lever.

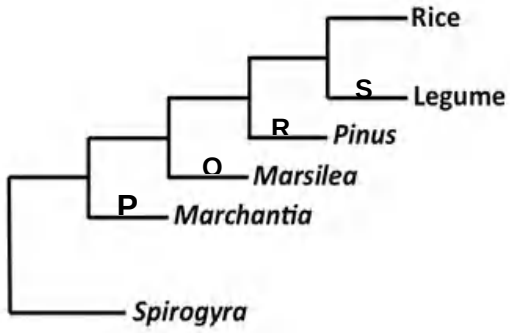

P


Q


R

a) P-I, Q-II, R-III
b) P-II, Q-III, R-I
c) P-III, Q-I, R-II
d) P-II, Q-I, R-III

26. The chart represents the relationships between some plants. In the scheme (P) to (S) represent characters which distinguish one example from the rest.



(i) to (v) below represent some characters related to (P) – (S), but not necessarily in that order:

i. Without vascular tissue
ii. Seeds have two cotyledons
iii. Seeds have one cotyledon
iv. Do not produce seeds
v. Naked seeds

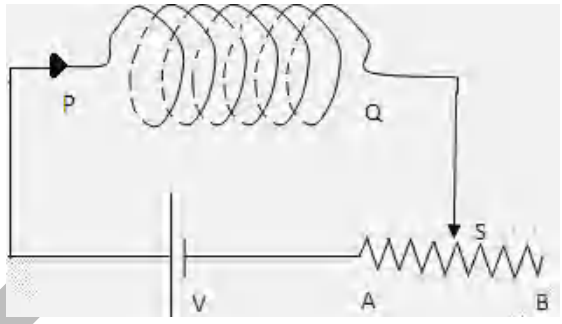
Which one of the following is a correct match between (P to S) with (i to v).

a) (P)-(i); (Q)-(iv); (R)-(v); (S)-(ii) b) (P)-(iv); (Q)-(i); (R)-(v); (S)-(ii)
c) (P)-(i); (Q)-(v); (R)-(iv); (S)-(iii) d) (P)-(i); (Q)-(iv); (R)-(v); (S)-(iii)

27. If 22 g of nitrogen gas, 44 g of oxygen gas and 38 g of carbon dioxide gas are kept in separate containers at the same temperature and volume, then what will be the order of their pressure?

a) $P_{O_2} < P_{N_2} < P_{CO_2}$ b) $P_{N_2} < P_{CO_2} < P_{O_2}$ c) $P_{N_2} = P_{O_2} = P_{CO_2}$ d) $P_{CO_2} < P_{O_2} < P_{N_2}$

28. In the figure given, PQ is a long uniform coil of metal wire, V is a constant voltage source and ASB is a rheostat. Consider the following statements and choose the correct option.



I) The (equivalent) pole at the end P if slider S of rheostat is moved from A to B is North.

II) The (equivalent) pole at the end P if slider S of rheostat is moved from A to B is South.

III) The (equivalent) pole at the end P if slider S of rheostat is moved from B to A is North

IV) The (equivalent) pole at the end P if slider S of rheostat is moved from B to A is South.

a) Only III and IV are correct
b) Only I and II are correct
c) Only II and IV are correct
d) Only I and III are correct

29. Which one of the following statements is true about the fate of glucose, following oxidation in the presence and in the absence of oxygen?

a) In absence of oxygen, glucose undergoes only up to glycolysis and pyruvate is converted to lactate, while in the presence of oxygen glucose undergoes only up to glycolysis and pyruvate is converted to acetyl-CoA in the cytosol.
b) In absence of oxygen, glucose undergoes only up to glycolysis and pyruvate is converted to ethanol, while in the presence of oxygen glucose undergoes only up to glycolysis and pyruvate is converted to acetyl-CoA in the mitochondria.
c) In absence of oxygen glucose undergoes only up to glycolysis and pyruvate is converted to acetyl-CoA, while in the presence of oxygen glucose undergoes only up to glycolysis and pyruvate is converted to lactate in the muscle.
d) In absence of oxygen glucose undergoes only up to glycolysis and pyruvate is converted to lactate, while in the presence of oxygen glucose undergoes only up to glycolysis and pyruvate is converted to ethanol in bacterial cell.

30. Following experiments were carried out separately in chemistry laboratory in different test tubes, labelled as (I), (II), (III), and (IV).

(I) Mg + dil. HCl

(II) Al + dil. H_2SO_4

(III) Cu + dil. HCl

(IV) Mn + dil. HNO_3

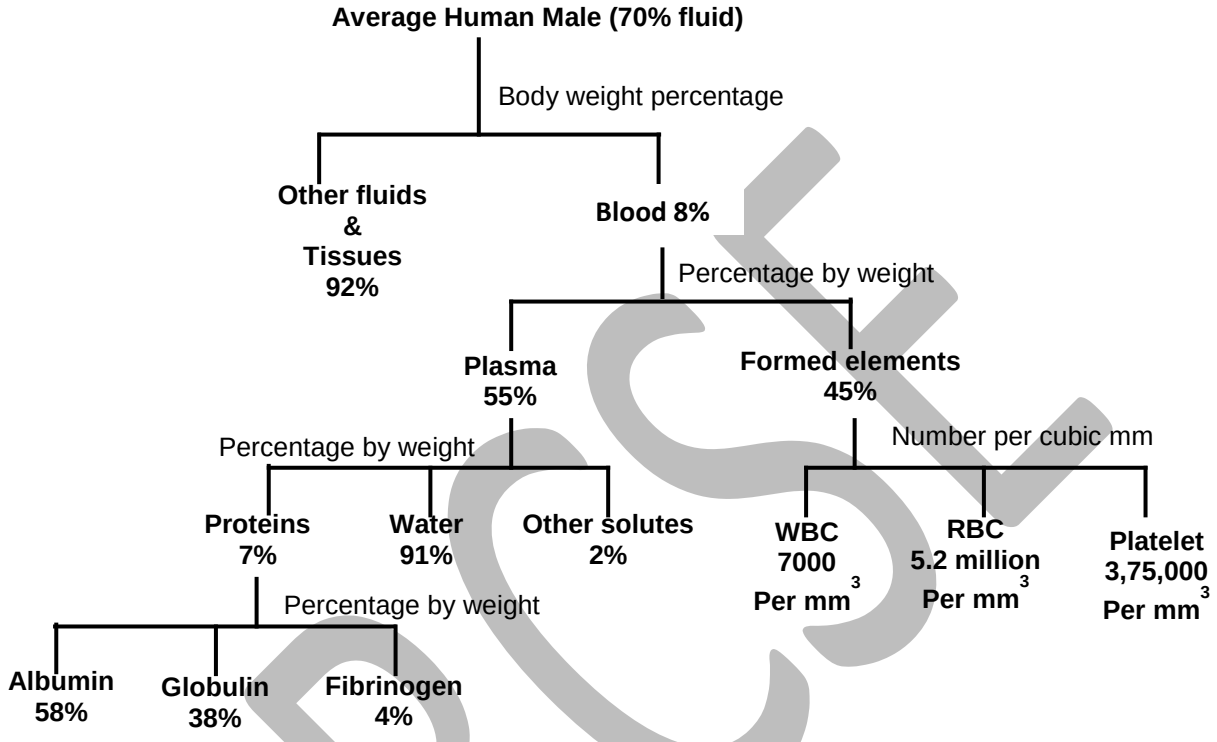
She observed hydrogen gas is not produced in:

a) Only Test tube (IV)
b) Both test tubes (III) and (IV)
c) Only test tube (III)
d) Both test tubes (II) and (III)

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



Composition of blood of an Indian male

[WBC: 7000/mm^3, RBC: 5.2 million/mm^3, Platelets: 3,75,000/mm^3 of blood]

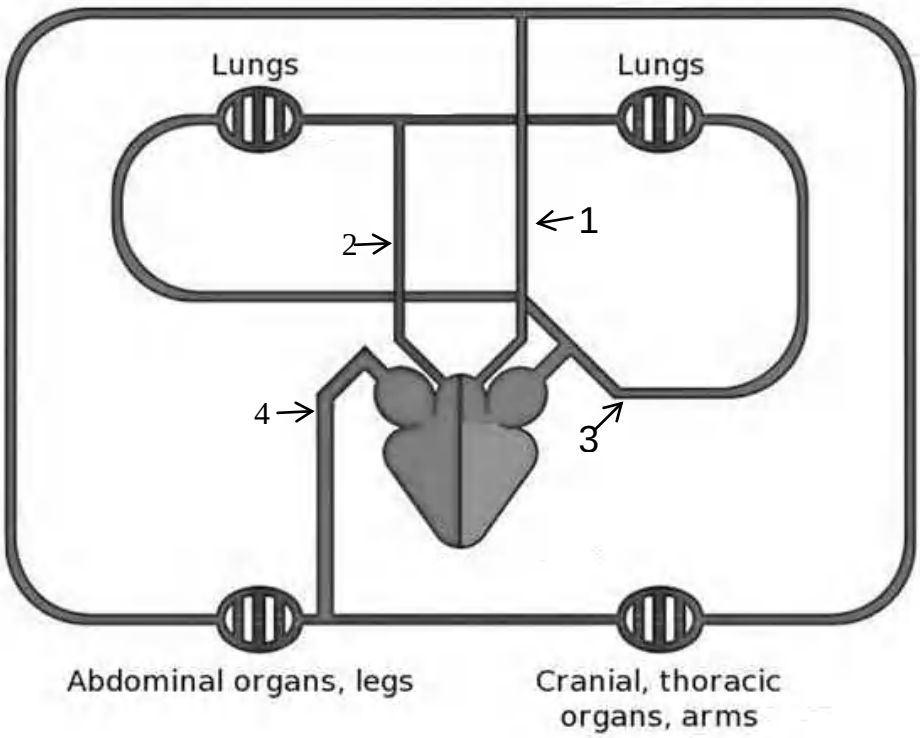
31.A. The figure above represents the composition of human blood for an Indian individual weighing 70 kg. Assume the total fluid to be 70% of the total body weight and average density of whole blood = 1060g/l. With these considerations now calculate the following.

I) Calculate the volume of blood present in a person weighing 70 kg. **[1.0]**

II) Calculate the total number of nuclear DNA molecules that will be present in the blood cells of the human. Consider that the human is genetically normal. **[1.0]**

III) Calculate the total number of moles of albumin present in the total human blood as shown in the above figure. (M.W. of albumin is 66kDa and assume that 1 a.m.u = 1g) **[2.0]**

31.B. The following is a schematic representation of the circulatory system of humans.



Fill the table below by selecting the correct option regarding composition of blood and direction of blood flow in regions labeled 1, 2, 3 and 4 **[2.0]**

Label	Composition of blood (choose between oxygenated or deoxygenated)	Direction of flow (choose between away from or towards the heart)
1		
2		
3		
4		

[Total = 6 marks]

QUESTION 32

32.A.I) Alumina in nature occurs as a colourless mineral corundum .Being amphoteric it reacts with acids as well as alkalis. It is used to prepare anhydrous aluminium chloride by passing chlorine gas over heated mixture of alumina and carbon. Write the balanced chemical equation for the same. **[1.0]**

II) Double salts of the type M_2SO_4, $M'_2(SO_4)_3.24H_2O$ are called alums.Here M is univalent ion such as Na^+,K^+ etc. Whereas M' is a trivalent ion like Al^{3+}, Fe^{3+} etc. Potash alum [K_2SO_4,$Al_2(SO_4)_3.24H_2O$] the common alum is manufactured from alum shale which contains iron disulphide and aluminium silicate ($Al_2O_3.xSiO_2$)and that is roasted in excess air to yield aluminium sulphate and ferrous

sulphate.Ferrous sulphate is removed by fractional crystallisation and calculated quantity of K_2SO_4 is added to the mother liquor which is concentrated to give crystals of alum. Write balanced chemical equation for roasting of alum shale. **[2.0]**

32.B. For quantitative analysis 3 g of mixture of sodium carbonate, sodium bicarbonate and sodium chloride was supplied to students. They found out on gentle heating, the mixture liberates 56 mL of CO_2 at NTP and another 3g of the same mixture requires 30.5mL of 1N hydrochloric acid for complete neutralization. Calculate the percentage of sodium chloride. **[2.0]**

[Total = 5 marks]

QUESTION 33

33. A sample of water which gives lather with soap with difficulty is known as hard water, while a sample of water which gives lather with soap easily is known as soft water.

Hardness of water is due to the presence of bicarbonates, sulphates and chlorides of calcium and magnesium. Hardness of water is of two types, temporary and permanent hardness. When hardness of water is due to the presence of bicarbonates of magnesium and calcium, it is called temporary hardness.When hardness of water is due to the presence of sulphates and chlorides of magnesium and calcium, it is called permanent hardness.

The amount of hardness causing substances in a certain volume of water measures the extent of hardness or degree of hardness. Hardness of water is always calculated in terms of calcium carbonate although it is never responsible for causing hardness of water because of its insoluble nature.

The reason for choosing calcium carbonate as the standard for calculating hardness of water is the ease in calculation as its molecular weight is exactly 100.

Degree of hardness is usually expressed as parts per million (ppm) and thus may be defined as the number of parts by weight of calcium carbonate (equivalent to calcium and magnesium salt) present in a million (10^6) parts by weight of water.

1ppm=1 part of $CaCO_3$ in (10^6) parts of water.

I) Vishal has two samples of hard water, one contains 2mg of calcium sulphate and 0.5mg of magnesium chloride per litre of water and another contains 3mg magnesium sulphate per kg of water. Calculate the degree of hardness of both the samples. **[3.5]**

II) Permanent hardness of water can be removed by adding washing soda, if both temporary and permanent hardness are present together, then water is softened by addition of caustic soda. Give balanced chemical equations for softening of hard water. **[1.5]**

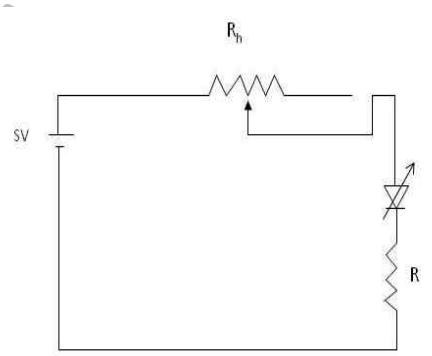
[Total = 5 marks]

QUESTION 34

34.A. An earthen pot was filled with 20 litres of water at room temperature of 25˚ C and left closed. After some time it was found that the temperature of the water has dropped by 5˚ C while the temperature of the surrounding and the pot remained the same. How much is the amount of water remaining in the pot? **[2.0]**

34.B. To get a significant amount of photons of wavelength λ from an LED, the minimum voltage across the LED should be able to increase the energy of the electrons by an amount equal to the energy of the photons, $E = hc/\lambda$. The value of hc can be taken as 1250 eV-nm. Here eV denotes electron volt and nm denotes nanometer. A voltage V applied across an LED raises the energy of electron by V eV.

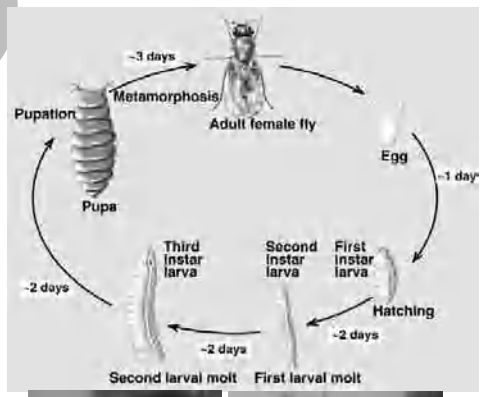
Light Emitting Diode (LED) of a particular brand glows with significant brightness if 20 mA current passes through it. While conducting, its resistance is practically negligible once proper voltage exists across it. A circuit is made as shown in the figure. There is a fixed series resistance of R = 40 Ω for the purpose of limiting the current and a 5 V battery is used. Assume that the voltage across the LED is the minimum required to raise the energy of the electrons equal to the energy of light photon needed. Estimate the resistance range of the rheostat if light from wavelength 625 nm (orange-red) to 500 nm (green-cyan) is to be emitted by the LED. **[3.0]**



[Total = 5 marks]

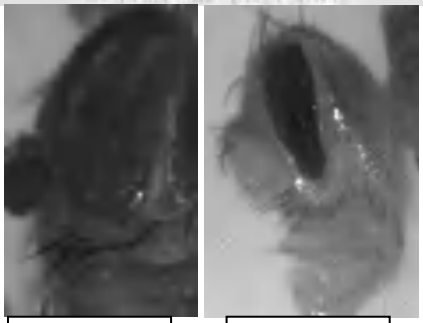
QUESTION 35 (For question I – IV, provide only the correct option number in your answer sheet.)

35. *Drosophila melanogaster* (fruit fly) is a favorite among geneticists to study inheritance of characters. Like other insects the life cycle of *Drosophila* consists of larvae, pupae and adults (see below).



It can be easily maintained in the laboratory, has a short lifecycle, produces large number of progeny and has only four pairs of chromosomes. The inheritance of eye color and shape, have been studied by many geneticists. The eye shape could be round or slit-like (called Bar eyed).

The allele that controls the Bar-eyed phenotype (B) is dominant over that which controls round shape (b). Although found in the laboratories, the occurrence of Bar-eyed fruit fly in nature is extremely rare.



Round eye

Bar eye

I) A geneticist wanted to study the inheritance of eye shape in *Drosophila*. Which one of the following is the necessary pre-requisite to study inheritance of any character? **[1.0]**

a) Life cycle should be short.

b) A homozygous line for the character should be available.

c) Variation in character should be available in the population.

II) From the information given in the write-up which of the following statement(s) is/are correct? **[0.5]**

a) Bar eye is a mutant character because it is dominant over round.
b) Bar eye is a mutant character because it is found rarely in the nature.
c) Round eye is a mutant type character because it is recessive to Bar.

III) A bar-eyed *Drosophila* could be homozygous (*BB*) or heterozygous (*Bb*) for the gene controlling the bar-eye shape. In order to differentiate between the two genotypes a geneticist should cross it to a fly with the genotype **[0.5]**

a) BB b)Bb c)bb

IV) Variations in phenotypes in *Drosophila* can be generated in the laboratory by mutagenesis. X-ray is a known mutagen. In order to generate mutants in *Drosophila* which one of the following stages in its life cycle should be treated with X-ray? **[0.5]**

a) Egg b)Larvae c)Pupae d)Adult

V) The following is a hypothetical situation. A geneticist studies the inheritance of eye shape and color in a newly identified insect. Like *Drosophila* there are two eye shapes in this insect: round and bar. Round is dominant in this case. There are two eye colors: red and white, where red is dominant over white. Genes for eye-color and eye shape are present on the autosomes.

a) A cross is made between a red, round-eyed and bar, white-eyed insect. What will be the phenotype of the F_1 progeny? **[0.5]**

b) When the F_1 progeny were crossed, the following F_2 progeny (phenotype: numbers) was obtained:

Red, round eyed : 899
Red, bar eyed : 301
White, round eyed : 293
White, bar eyed : 107

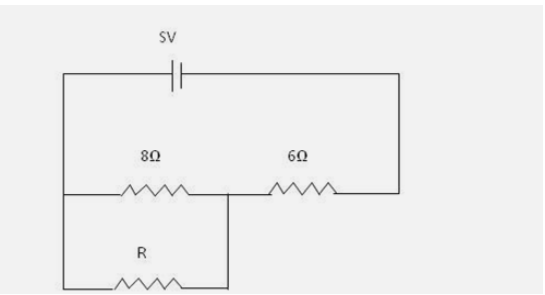
Based on the above data do the genes for eye color and shape show independent assortment? Yes/No. **[1.0]**

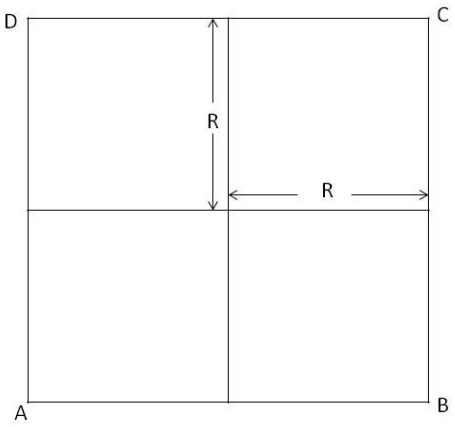
c) Calculate the ratio obtained from the given F2 progenies provided as above to prove your choice in (ii). **[1.0]**

[Total = 5 marks]

QUESTION 36

36.A. In the circuit diagram given, on removing the resistor *R*, it is necessary to have an additional 6Ω resistance in series with the 6Ω resistance, so that the current through 8Ω resistor is unchanged. Determine *R*. **[2.0]**



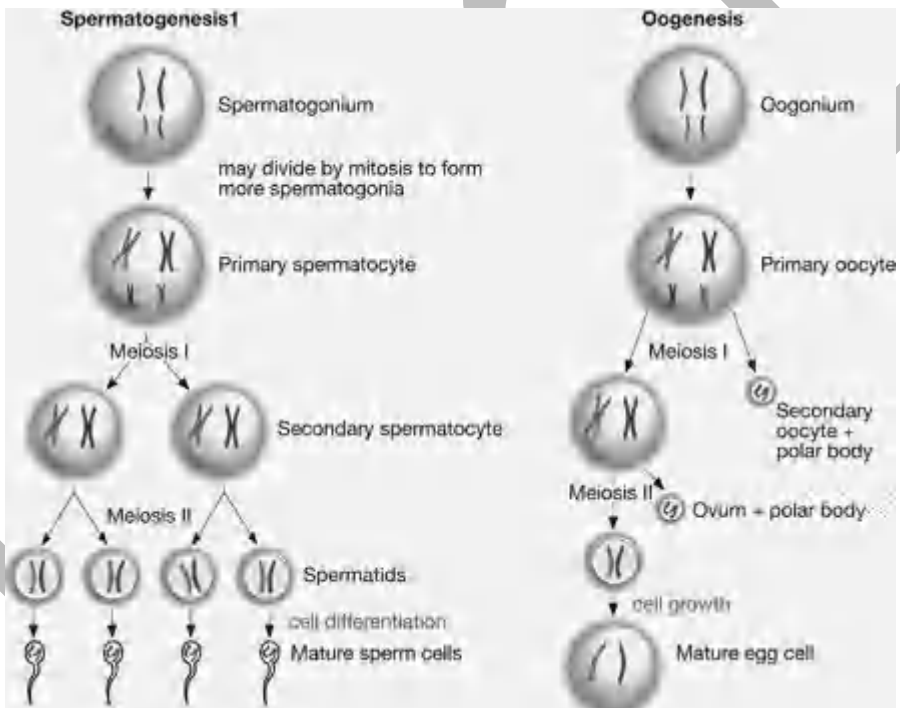


36.B. A battery of mobile phone of rating 3.6 V, 3600 mAh (practically) loses its complete charge in 24 hrs when connected to a mesh on the largest diagonal points (between A & C or between D & B) shown below. What is the value of resistance R of individual arm? (All arms have same resistance). How long will the battery last if it is connected across one of the outer arms, say DC (or CB or AB or BC)? Assume that the battery voltage remains constant throughout its discharge. **[3.0]**

[Total = 5 marks]

QUESTION 37 (Provide only the correct option number in your answer sheet.)

37.A. Spermatogenesis and oogenesis are processes of formation of the male and the female gametes as shown below.



http://moodle2.rockyview.ab.ca/pluginfile.php/64201/mod_book/chapter/25797/biology_30/images/m5/b30_m5_036_I.jpg

Answer the following questions, related to gamete formation.

I) If accidentally the primary oocyte is fertilized with a sperm, the resulting zygote will have how many sets of chromosomes: **[0.5]**

a) n b)2n c)3n d)4n

II) The middle piece of the sperm contains: **[0.5]**

a) Mitochondrial DNA only
b)No DNA at all
c) Nuclear DNA only
d) Nuclear and mitochondrial DNA both

III) The most plausible reason for the formation of polar bodies during oocyte development is **[0.5]**

a) to retain large quantity of cytoplasm in the oocyte**.**
b) to retain chromosomes in the oocyte.
c) to retain both chromosomes and cytoplasm in the oocyte.
d) to retain the egg membrane which is essential for fertilization.

IV) Which one of the following statements is true regarding normal oocyte development? **[0.5]**

a) Primary oocytes are produced after a female attains puberty (post puberty).
b) Primary oocytes are already produced in the ovary when a girl is born.
c) Primary oocytes are produced in the ovary just before the female attains puberty (pre puberty).

37.B. 'Triple parent' is a novel concept of creating embryos using DNA from three people. This technique can prevent passing of genetic diseases due to defects in mitochondria from a mother to her babies. This technique involves removing the nuclear DNA from a healthy female donor's eggs and replacing it with the nuclear DNA of the prospective mother. After fertilization, the resulting child would inherit the mother's nuclear DNA and the donor's healthy mitochondrial DNA. If approved for use, the technique would allow a woman to give birth to a baby who would inherit the normal nuclear DNA but not the defective mitochondrial DNA.

I) The concept of a triple parent involves:

a) Three females and no requirement of male
b) One male and two females in which the other parent (female donor) is not genetically involved
c) One male and two females all contributing genetically
d) One female and two males all contributing genetically

[0.5]

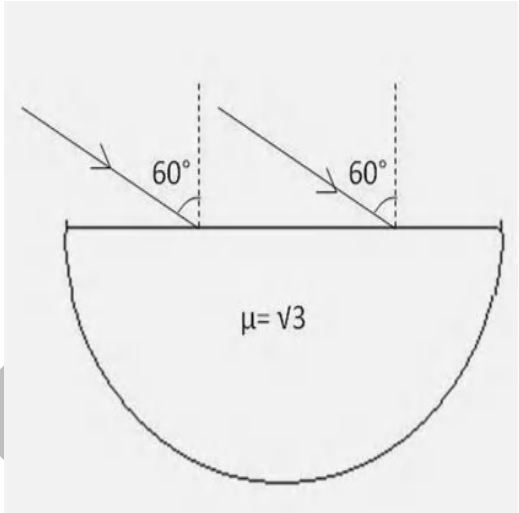
II) Given below are few statements regarding triple parent technique. Mark them as true (T) or false (F), by identifying them as either correct or incorrect statements. **[2.5]**

a) This technique can also be useful for father with defective mitochondrial genes.
b) This technique will not work for mother or father with defective nuclear genes.
c) The child produced by the technique will contain some foreign genes from a third parent.
d) The chance of transmission of foreign gene to the next generation (by normal reproduction involving two parents) will be almost zero if the triple parent technique generates a male.
e) The offspring produced by the triple parent technique will be affected if the third parent has a genetic defect in the nuclear genes.

[Total = 5 marks]

QUESTION 38

38.A. An artificially prepared dense glass is used to prepare imitation jewelry. Consider a hemisphere of such a glass placed with its flat surface horizontal. The figure shows a vertical cross section of the hemisphere passing through its centre C. A wide, parallel beam of monochromatic light (for which, the refractive index of this glass is $\sqrt{3}$) falls on the flat surface, in the plane of drawing, at an angle of incidence 60^0.



Is it possible that all the rays of this beam emerge from the spherical surface? (You may use $\frac{1}{\sqrt{3}} \cong \sin 35^0$)

If your answer is YES, give the range of corresponding angles of emergence.

If your answer is NO, determine the part of the spherical surface (shown in the figure) through which the emergence is possible. You may state your answer in terms of the angles made by the extreme points of the spherical surface at the centre. Diagram given, may not be to the scale. **[3.0]**

38.B. A 7 m long uniform rope of mass 140 g is hanging freely from a ceiling. A transverse pulse is generated at the free end, which travels up to the top. Speed of wave (or pulse) along a string is given by $v = \sqrt{\frac{T}{\lambda}}$ where *T* is tension along the string and λ is the linear density. Using g = 10 m/s^2, calculate the speed of the pulse at 5 different distances at every 1 m from free end.

Plot variation in the speed against the distance from the bottom. Using your graph determine the speed of the pulse at the midpoint of the string (indicate it on the graph provided in the answer sheet). **[2.0]**

[Total = 5 marks]

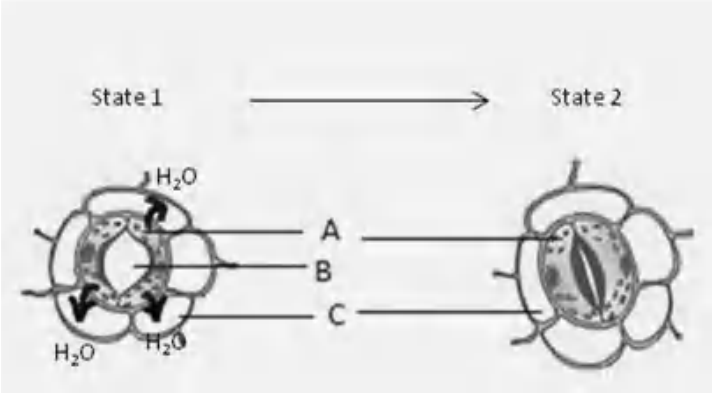
QUESTION 39

39.A. A hydrocarbon contained 10.5g of carbon per gm of hydrogen. One litre of the hydrocarbon vapours at 127 °C and 1 atm pressure weighed 2.8g. Help Sakshi to find the molecular formula of the hydrocarbon. **[3.0]**

39.B. 40 mL of mixture of hydrogen and oxygen gases was placed in a gas burette at 48°C and 1 atm pressure. A spark was applied so that the formation of water is complete. The volume of the remaining hydrogen gas was 10 ml at 48°C and 1 atm pressure. Find the initial mole percentage of hydrogen in the mixture. **[2.0]**

[Total = 5 marks]

QUESTION 40 (For question III – VI, provide only the correct option number in your answer sheet.)



I. Which of the following statements is TRUE or FALSE for state 1 and state 2? **[0.75]**

a) State 1 is observed specifically on the adaxial surface of mesophytic leaf during day time.

b) State 2 is obtained when guard cells absorb moisture from sub-stomatal space.

c) Uneven thickness of guard cell wall favours the stomatal movement.

II. Consider the above figures and fill in the blanks. **[1.75]**

The labeled region designated as 'A' in the figure above is/are the epidermal cell(s) with **(i)** _____ (chloroplast/rhodoplast/leucoplast). In daylight (the region labeled as '**A')** makes carbohydrates by the process of **(ii)**_____ (chemosynthesis/photosynthesis/ respiration). This **(iii)** _____ (increases/decreases) the water potential of **(the region 'A')**. Water enters cell by **(iv)** _____ (endosmosis/diffusion/pinocytosis) whereby water moves from **(v)** _____ (higher/lower) water potential to **(vi)** _____ (higher/lower) water potential. Now, **the region 'B'** reaches **state 1** due to **(vii)** _____ (increase/decrease) in turgidity.

III. Closing of stomata is likely to cause the following physiological changes EXCEPT **[0.25]**

a) Decrease in the rate of photosynthesis.
b) Decrease in the rate of transpiration.
c) Decrease in the rate of nitrogen fixation.
d) Decrease in the rate of water uptake.

IV. Which one of the following represents the correct statement about the tonicity of environment around cell A in state 1? **[0.25]**

a) The environment is hypertonic with respect to cell A.
b) The environment is hypotonic with respect to cell A.
c) The environment is isotonic with respect to cell A.

V. Water Potential is the difference in the free energy or chemical potential per unit molar volume of water in a system compared to that of pure water at the same temperature and pressure. Water potential of pure water at normal temperature and pressure is zero. This value is considered to be the highest. The presence of solid particles reduces the free energy of water and decreases the water potential. Therefore, water potential of a solution is always less than zero or it has negative value. If

the water potential (Ψ) of guard cell placed in distilled water is measured as 0.0 MPa and the water potential (Ψ) of 0.1M glucose solution is – 0.23 MPa, what will be result if guard cells are placed in 0.1M glucose solution. **[0.25]**

a) Glucose will flow into guard cells
b) Water will flow into the guard cell
c) Water will flow out from the guard cell
d) Nothing will happen as the process will also depend on energy input.

VI. When chemical "X" is sprayed on plants, it results in wilting. The probable explanation for this is: **[0.75]**

a) Stoma remains in state 1 for an extended period of time.
b) Stoma remains in state 2 for an extended period of time.
c) The stomatal pore gets blocked by the chemical.

[Total = 4 marks]

QUESTION 41

41. During respiration, glucose combines with oxygen in the cells of our body to form carbon dioxide, water and production of energy. Atmospheric air consists of 20 % oxygen by volume, only 5% of that oxygen is consumed by the body in each breath of an average person at STP. According to the study an average person at rest inhales 8 litres of air per minute. In 3.5 hrs, how much glucose is used up by an average person at rest? Find the amount of carbon dioxide exhaled during the process. **[5.0]**

[Total = 5 marks]

QUESTION 42

42. Hydrogen has two isotopes: Hydrogen (H), whose nucleus has one proton only and deuteron (D) which has one proton and one neutron in the nucleus. Heavy water is formed when one or both hydrogen nuclei are replaced by Deuterons i. e. making it HDO or D_2O.
A scientist takes 40 percent (volume) of heavy water D_2O and 60 percent (volume) H_2O and thoroughly mixes it to make a total of 1000 L. D_2O and H_2O have nearly similar physical and chemical properties. The data given below is adjusted close to the realistic values so that the calculations become simple. Hence the data is valid for this question only. Also assume that HDO, the other form of heavy water, does not get formed.

The scientist is conducting an experiment to calculate the specific heat capacity of D_2O in its frozen stage. As a first step he freezes it to exactly 0^0C and then heats it slowly in a chamber which is thermally insulated from atmosphere. After providing 387160 kJ of energy the combination reaches 10^0C.

Given the data, calculate the specific heat of ice formed from D_2O and give the graphical representation (qualitative, with appropriate values marked) of the entire process on the axes drawn on the graph paper provided in the answer sheet.

[5.0]

[Total = 5 marks]

SECTION A

Q. No.	(a)	(b)	(c)	(d)	Q. No.	(a)	(b)	(c)	(d)
1	☐	☐	☐	☒	16	☒	☐	☐	☐
2	☐	☒	☐	☐	17	Question dropped			
3	☐	☐	☒	☐	18	☐	☐	☐	☒
4	☐	☐	☐	☒	19	☐	☒	☐	☐
5	☐	☐	☒	☐	20	☐	☒	☐	☐
6	☐	☐	☒	☐	21	☒	☐	☐	☐
7	☐	☐	☐	☒	22	☐	☒	☐	☐
8	☐	☒	☐	☐	23	☐	☐	☒	☐
9	☒	☐	☐	☐	24	☐	☐	☐	☒
10	☐	☐	☒	☐	25	☒	☐	☐	☐
11	☒	☐	☐	☐	26	☒	☐	☐	☐
12	☐	☐	☐	☒	27	☐	☒	☐	☐
13	☒	☐	☐	☐	28	☐	☐	☒	☐
14	☒	☐	☐	☐	29	☐	☒	☐	☐
15	☐	☐	☐	☒	30	☐	☐	☒	☐

All alternative solutions have been given due consideration

SECTION B

QUESTION 31

A.

I. Total fluid if 70 % of body weight i.e. 70% of 70Kg = 49 Kg
Blood is 8% of the total fluid i.e. 8% of 49 kg = 3.92 kg
Converting kg into volume- 3920/1060 = **3.698 litres**

II. DNA in White blood cells: 7000 x 1000 x1000x 3.69 x 46

III. Weight of albumin = 7% of 3.92= 0.2744 x58%= .159kg
66000 g =1 mole
159g = 159/66000 moles

B.

Label	Composition of blood (choose between oxygenated or deoxygenated)	Direction of flow (choose between away from or towards the heart)
1	Oxygenated	Away from
2	Deoxygenated	Away from
3	Oxygenated	towards
4	Deoxygenated	towards

QUESTION 32

A.I) $Al_2O_3 + 3C + 3Cl_2\,(g) \rightarrow 2AlCl_3 + 3CO\,(g)$

II) $6FeS_2 + 6H_2O + 21O_2 \rightarrow 6FeSO_4 + 6H_2SO_4$

$2Al_2O_3.2XSiO_2 + 6H_2SO_4 \rightarrow 2Al_2(SO_4)_3 + 2xSiO_2 + 6H_2O$

…… Or

$6FeS_2 + 21O_2 + 2Al_2O_3.2XSiO_2 \rightarrow 2Al_2(SO_4)_3 + 2xSiO_2 + 6FeSO_4$

B. $2NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_{2(g)}$

2x84 22.4 L

Amt of $NaHCO_3$ equivalent to 56 mL of CO_2 at NTP = (56x168)/22400= 0.42g

Equivalent of $NaHCO_3$ present = 0.42/84= 0.005 or 5 milli eq.

The amt. of HCl consumed by $NaHCO_3$ and Na_2CO_3 in the mixture= 30.5mL of 1N HCl= 0.0305 equivalents or 30.5 milli eq.

The amt. of HCl consumed by Na_2CO_3 =30.5-5=25.5 m.e.

Hence the amt. of Na_2CO_3 present = $25.5x53x10^{-3}$g = 1.35 g

Thus amt. of NaCl in 3g of the mixture= 3-0.42-1.35= 1.23

% 0f NaCl= 41%= (1.23x100)/3

QUESTION 33

I) Sample 1) 2mg of $CaSO_4$ =$2x10^{-3}$ of $CaSO_4$= $2x10^{-3}/136$ =$1.5x10^{-5}$mol of $CaSO_4$1mol of $CaSO_4$ = 1mol of $CaCO_3$ =100g of $CaCO_3$

Therefore $1.5x10^{-5}$mol of $CaSO_4$ =$1.5x10^{-5}$ x100 = $1.5x10^{-3}$ g of $CaCO_3$

Thus, 1000g of water contains $CaSO_4$ equivalent to $1.5x10^{-3}$ g of $CaCO_3$

10^6 g (one million) of water contains =$[(1.5x10^{-3})/1000]x10^6$ = 1.5g of $CaCO_3$

Or [(2x100)/136]= 1.5g of $CaCO_3$ **(direct method)**

0.5mg of $MgCl_2$= $5x10^{-4}$ g of $MgCl_2$ = $5x10^{-4}/95$=$0.053x10^{-4}$mol of$MgCl_2$

1mol of $MgCl_2$ = 1mol of $CaCO_3$ =100g of $CaCO_3$

$0.053x10^{-4}$mol of$MgCl_2$=$0.053x10^{-4}$x 100 = $0.053x10^{-2}$ g of $CaCO_3$

10^6 g (one million) of water contains = $[(0.053x10^{-2})/1000]x10^6$ = 0.53g of $CaCO_3$

Or [(0.5x100)/95]= 0.53g of $CaCO_3$ **(direct method)**

Hence degree of hardness of sample 1 is 1.5+ 0.53= 2.03ppm

Sample 2) 3mg of $MgSO_4$ =$3x10^{-3}$ of $MgSO_4$ = $3x10^{-3}/120$ =$2.5x10^{-5}$mol of $MgSO_4$

1mol of $MgSO_4$ = 1mol of $CaCO_3$ =100g of $CaCO_3$

Therefore $2.5x10^{-5}$mol of $MgSO_4$ =$2.5x10^{-5}$ x100 = $2.5x10^{-3}$ g of $CaCO_3$

Thus, 1000g of water contains $MgSO_4$ equivalent to $2.5x10^{-3}$ g of $CaCO_3$

10^6 g (one million) of water contains = $[(2.5x10^{-3})/1000]x10^6$ = 2.5g of $CaCO_3$

Hence degree of hardness of sample 2= 2.5ppm

Or [(3x100)/120]= 2.5g of $CaCO_3$ **(direct method)**

II) $Ca(HCO_3)_2 + 2NaOH \rightarrow CaCO_3 + Na_2CO_3 + 2H_2O$

(Any one reaction either with Calcium or Magnesium)

$CaSO_4 + Na_2CO_3 \rightarrow CaCO_3 + Na_2SO_4$

$2MgCl_2 + 2Na_2CO_3 \rightarrow 2MgCO_3 + 4NaCl$

(Any two reactions either with sulphate or chloride of Calcium or Magnesium)

QUESTION 34

A. The evaporation of water through the pores causes decrease in the temperature. Let *m* kg be the mass of the water evaporated.

Heat of vaporization = 42000 J/mol = 7000/3 J/g = (7/3) x 10^6 J/kg

(20 - *m*)*4200* 5 = *m*(7 x 10^6 /3) ∴ $(20 - m)21 = 7000m/3$

∴ 420 – 21*m* = 7000*m*/3 ∴ 1260 – 63*m* = 7000*m* ∴ 1260 = 7063*m* ∴ $m \cong 0.18$ kg (or, 0.17 kg)

B. Voltage across LED for 625 nm (red) light = 1250/625 = 2 V.

Remaining voltage (from 5 V) will be across the resistance.

∴ $V_{res_{red}} = 5 - 2 = 3\,V$. Current through LED, i. e. through circuit is 20 mA (for significant brightness).

∴ $R_{red} = \frac{3}{20 \times 10^{-3}} = 150\,\Omega$

Out of this 40 Ω is a fixed resistance. Thus maximum additional resistance of 110 Ω will be 625 nm light.

Voltage across LED for 500 nm (green) light = 1250/500 = 2.5 V.

Remaining voltage (from 5 V) will be across the resistance.

∴ $V_{res_{green}} = 5 - 2.5 = 2.5\,V$. Current through LED, i. e. through circuit is 20 mA (for significant brightness).

∴ $R_{red} = \frac{2.5}{20 \times 10^{-3}} = 125\,\Omega$

Out of this 40 Ω is a fixed resistance. Thus minimum additional resistance of 85 Ω will be 500 nm light.

Range of rheostat resistance is 85 Ω to 110 Ω.

QUESTION 35

I) c)Variation in character should be available in the population

II) b)Bar eye is a mutant character because it is found rarely in the nature

III) b)Bb OR c)bb

IV) d)Adult

V) a) red, round-eyed
b) Yes
c) It shows a 9:3:3:1 ratio, a hallmark of independent assortment

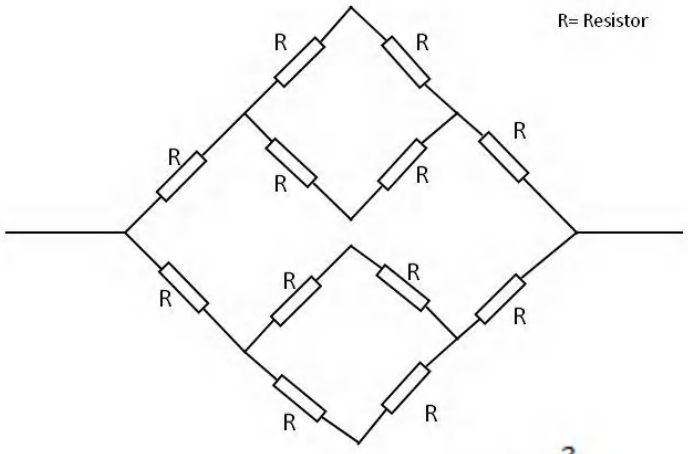
QUESTION 36

A. Current through 8 Ω resistance after removing *R* is 5/20 = ¼ A. ∴ the p. d. across 8 Ω resistance is 2 V. ∴ in the original circuit, the p. d. across 6 Ω resistance is 3 V. ∴ the current through it is ½ A. ∴ the current through *R* is ¼ A and p. d. across it is 2 V ∴ *R* = 8 Ω

B. Current rating 3600 mAh means if we draw a constant current of 3.6 A, the battery will last for 1 hour. In the present case it lasts for 24 hours. ∴ *I* = 3.6/24 = 0.15 A.

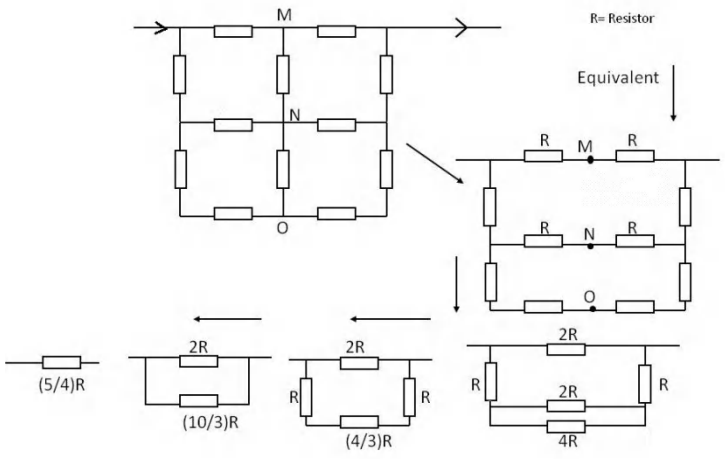
V = 3.6 V and *I* = 0.15 A. Thus equivalent resistance of the circuit in the first case is R_x = 3.6/0.15 = 24 Ω.

The equivalent circuit is given besides. Rx, the resistance between A and C is = 3R/2. Thus, *R* = 16 Ω



$$\therefore X = \frac{3}{2}R$$

Part 2) When used across DC, then the points M, N and O are equipotential due to symmetry, the circuits can be reduced to following and $(R_x)_2$ = 5R/4 = 20 Ω.



Total energy is constant. ∴ V^2t/R_x = constant. Battery voltage 3.6 V is the same. ∴ t is proportional to R_x. ∴ t_2 = 20 hours.

QUESTION 37

A.

I) c)3n
II) a)Mitochondrial DNA only
III) a) To retain large quantity of cytoplasm in the oocyte**.**
IV) b) Primary oocytes are already produced in the ovary when a girl is born.

B.

I) c)One male and two females all contributing genetically
II) a) F
b) T
c) T
d) T
e) F

QUESTION 38

A. The answer is NO. If a student writes answer YES and gives the angles of emergence, it is not correct and no credit will be given. For answer NO, the sector is given in terms of angles α and β.

$\sqrt{3} = \frac{\sin 60^0}{\sin r} = \mu \ \therefore r = 30^0, for\ all\ the\ rays.$
$\frac{1}{\mu} = \frac{1}{\sqrt{3}} = \sin i_c \ \therefore \ i_c = sin^{-1}\left(\frac{1}{\sqrt{3}}\right) \cong 35^0$
As seen from the figure, the rays through glass just emerge (grazing emergence) at A and B.
From $\Delta ACD, \alpha = 180 - 60 - 35 = 85^0$
For $\Delta BCE, \beta = \angle ACB\ is\ exterior\ angle\ for\ \angle CEB\ and\ \angle EBC. \therefore \ \beta = 120 + 35 = 155^0$

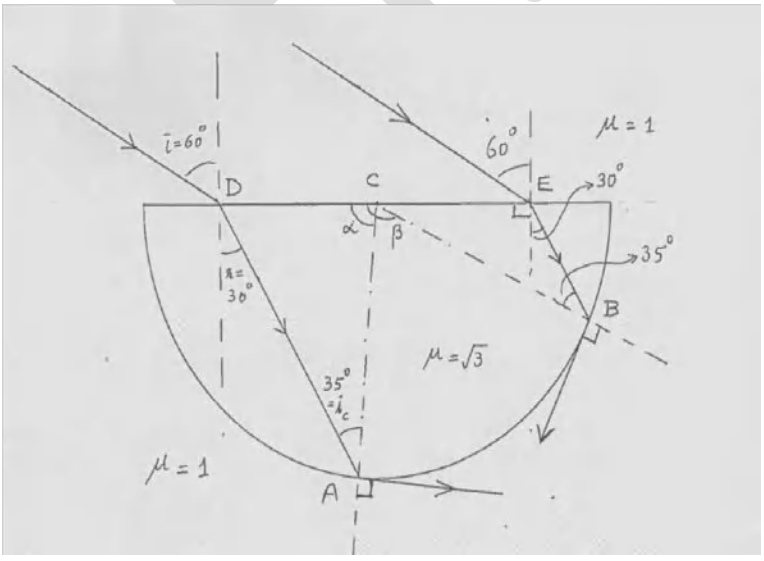
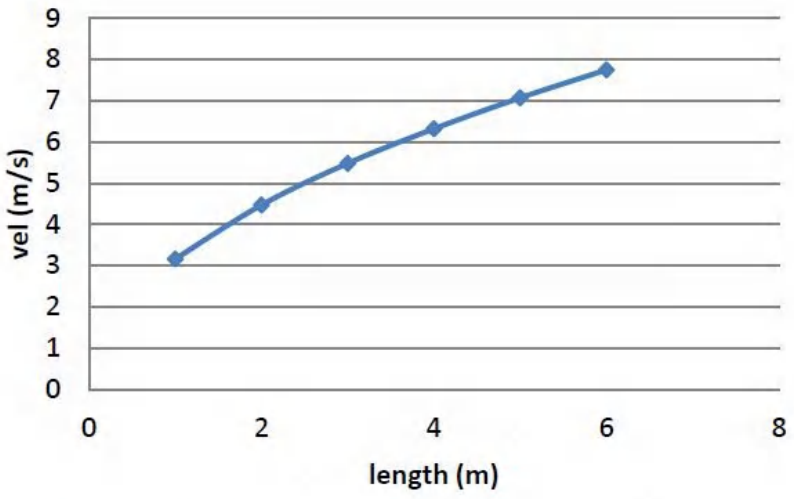


Diagram given may not be to the scale.

B. λ = 20 g/m = 0.02 kg/m, g = 10 m/s^2

Distance x in metre from the free end	Tension T = mg in newton at that distance	$\frac{T}{\lambda}$ in m^{2}s^{-2}	$v = \sqrt{\frac{T}{\lambda}}$ in m/s
1	0.2	10	3.16
2	0.4	20	4.47
3	0.6	30	5.48
4	0.8	40	6.32
5	1.0	50	7.07
6	1.2	60	7.75

Final ans 5.9 m/s



QUESTION 39

A. Given C: H :: 10.5:1 Total : 11.5

For molecular weight of hydrocarbon in gas phase

PV= $\frac{W}{M}\ RT$

1×1 = $\frac{2.8}{M}\ 0.0821 \times 400$ M=92

11.5g of hydrocarbon has 1.0g of hydrogen

92. g of hydrocarbon will have $\frac{92}{11.5} \times \frac{1.0}{1} = 8\ g\ of\ hydrogen$

Hydrocarbon will have 92−8 = 84 g of carbon

8 g of hydrogen = 8 atoms of hydrogen

84 g of carbon = $\frac{84}{12}$= 7 atoms of carbon

Molecular formula: C_7H_8

B.

$H_2 + \frac{1}{2}O_2 \rightarrow H_2O$

$2H_2 + O_2 \rightarrow 2H_2O$

Volume before reaction	a	b
Volume after reaction	(a-2b)	0

a+b = 40

a-2b = 10

a= 30 ml, b= 10 ml

Mole % of hydrogen = Volume % of hydrogen = $\frac{30}{30+10} \times 100 = 75$

Ans : 75 %.

QUESTION 40

I. a) False
b) False
c) True

II. (i) chloroplast, (ii) photosynthesis (iii) decreases (iv) endosmosis (v) higher (vi) lower (vii) increase

III. c) Decrease in the rate of nitrogen fixation.

IV. a) The environment is hypertonic with respect to cell A.

V. c) Water will flow out from the guard cell

VI. a) Stoma remains in state 1 for an extended period of time.

QUESTION 41

3.5 hrs = 3.5 × 60 = 210 min

Amount of air inhaled = 210 × 8 = 1680 litres

20 % of oxygen present in air ,

Amount of oxygen in 1680 litres air = $\frac{1680\times20}{100}$ = 336 litres

5% of it is consumed by the body at STP

Amount of oxygen consumed by body in 3.5 hrs at STP = $\frac{336\times5}{100} = 16.8\ litres$

22.4 litres = 1 mole at STP

Hence 16.8 litres of oxygen at STP = $\frac{16.8}{22.4} = 0.75mole$

$C_6H_{12}O_6$ (aq) + $6O_2$ (g) → $6CO_2$ (g) + $6H_2O$ (l) + Energy

1Mole 6 Mole 6 Mole

0.125mole 0.75 mole 0.75 mole

Molecular mass of $C_6H_{12}O_6$ = 72+12+96 = 180

0.125 mole of $C_6H_{12}O_6$ = 0.125 ×180 = 22.5g

Amount of carbon dioxide exhaled in 3.5 hrs during the process = 0.75 mole

= 0.75× 44 (molecular mass of CO_2) = 33 g

QUESTION 42

Volume of 40% of 1000 litre is 400 L whose mass is 400 * 1000 * 1.1 g = 440 kg

Volume of 60% of 1000 litre of H_2O has mass of 600 * 1000 * 1 g = 600 kg.

Energy required to raise temperature from 4 to 10 degrees = 440 * (10-4) * 4.25 + 600 * (10-4) * 4.15 = 11220 + 14940 = 26160 KJ

At 4 degrees the melting of D_2O will require *L.m* = 340 * 440 = 149600 KJ

Now change of water from 0 to 4 degrees requires

600 * (4-0) * 4.15 = 9960 KJ

melting of ice requires 600 * 330= 198000 KJ

remaining energy = 3440 KJ

sp heat = 3440/(4 * 440) = 1.95 kJ/kg/K

At point A, Q = 198000 kJ, T = 0 ^{0}C
At point B, Q = 211400 kJ, T = 4 ^{0}C
At point C, Q = 361000 kJ, T = 4 ^{0}C
At point D, Q = 387160 kJ, T = 10 ^{0}C