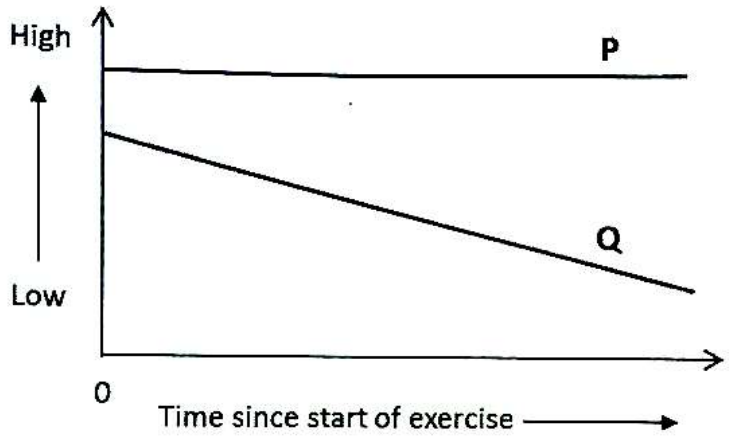
INDIAN OLYMPIAD QUALIFIER IN JUNIOR SCIENCE (2021)
PAPER CODE: 52
DATE OF CONDUCTION: JAN 17, 2021
PART – 2
QUESTION PAPER

1. The autonomous nervous system regulates involuntary functions of the body and can be subdivided into the sympathetic and the parasympathetic nervous system. Both of these systems control the same group of body functions, but have opposite effects on the functions they regulate. The sympathetic nervous system prepares the body for intense physical activity like the fight – or – flight response. The parasympathetic nervous system has the opposite effect and relaxes the body and inhibits or slows many high energy functions. Which of the following involuntary effects in the body are brought about the sympathetic nervous system during a fight or flight situation?

i. Increased salivation
ii. Increased digestion
iii. Loss of bowel and bladder control
iv. Body shivering
v. Crying
vi. Pupil dilation

A. i, ii and vi
B. I, iv and v
C. iii, iv and vi
D. iii and v

2. When a person starts exercising, many body parameters change from the original state of rest. The trends in two such parameters are shown in the graph during the initial phase of exercise.



P and Q most likely represent

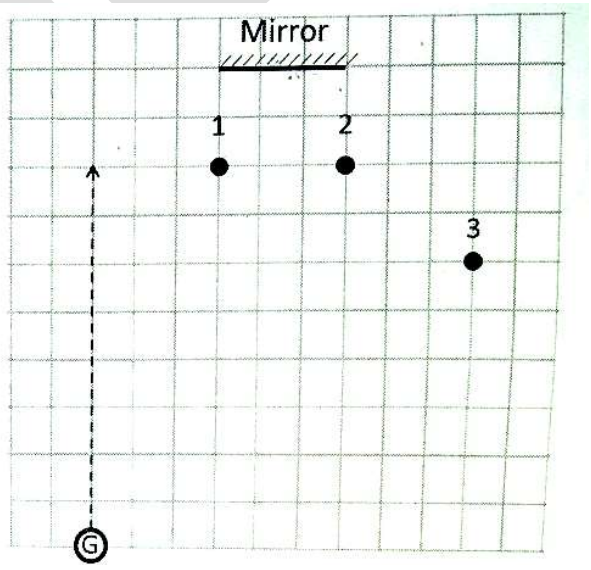
A. P: carbon dioxide level in vein Q oxygen level in artery
B. P breathing rate Q carbon dioxide level in artery
C. P oxygen level in artery Q carbon dioxide level in vein
D. P oxygen level in artery Q oxygen level in vein

3. Descriptions of four biological samples (I – IV) are given below:
I: Can be viewed using a light microscope with a total magnification of 1000X, possesses cell wall and does not possess mitochondria.

II: Can be seen using a light microscope with a total magnification of 100X: possess cell wall and has a nucleus
III: Needs election microscope for viewing, can be found attached to the membrane system in the cytoplasm
IV: Needs electron microscope for viewing, cannot replicate on its own, needs other specific cells for replication.
I, II, III and IV respectively represent
A. virus; plant cell; ribosome; bacteria
B. plant cell, bacteria, vacuole, virus
C. bacteria, plant cell, ribosome, virus
D. bacteria; protest; plant cell vacuole, mitochondria

4. Raja's mother collects all the kitchen waste every day and puts it in a pot. She then adds a few cut pieces of old papers, a spoonful of sour buttermilk and some soil. She covers the pots, and keeps it aside with Intermittent mixing. After several days, it turns into a nutrient rich compound to grow plants. In the context of decomposition in this composting process, the most appropriate statement among the following is
A. Paper acts as a good source of carbon while buttermilk gives the correct acidity to the mixture
B. Soil acts as a good source of inorganic nitrogen while buttermilk is a good source of proteins
C. Paper is a good source of carbon while buttermilk is a good source of starter bacteria
D. Paper is a good source of fibre while buttermilk is a good source of fat.

5. A girl (G) walks into a room along the path shown by the dashed line (see figure on right) She tries to observe image of small toys numbered 1, 2 and 3 in the plane mirror on the wall.

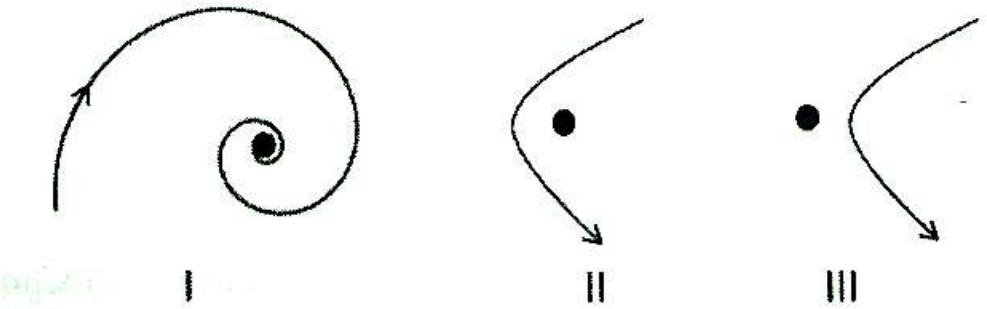


The order in which she will see images of the toys is:
A. 3, 2, 1
B. 3, 2
C. 1, 2, 3
D. 2, 3

6. A heating element in the form of a wire with uniform circular cross sectioned area has a resistance of 310 Ω and can bear a maximum current of 5.0 A. The wire can be cut into pieces of equal length. The number of pieces, arranged suitably, so as the draw maximum power when connected to a constant voltage of 220 V, is
A. 7
B. 8
C. 44
D. 62

7. Consider the following two statements:
Statement S1: If you put100 g ice at 0^0 C and 100 g water of 0^0 C into a freezer, which is maintained at -10^0 C, the ice will eventually lose the larger amount of heat.
Statement S2: At 0^0 C, water is denser than ice.
Choose the correct statement among the following:
A. Both S1 and S2 are true and S2 is the correct explanation of S1
B. Both S1 and S2 are true but S2 is not the correct explanation of S1
C. S1 is true but S2 is false
D. S1 is false but S2 is true

8. Consider the paths of (1) Halley's Comet near the sun and (2) an alpha particle scattered by a nucleus. In the figure below, the dots represent the Sun/Nuclei, and the curves with arrows mark the paths of the comet/alpha particles schematically.



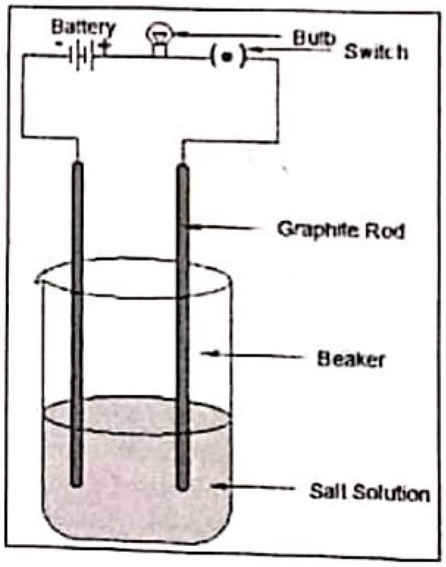
The correct statement about the trajectories is:
A. I represents trajectory for Halley's Comet and II for the scattering of alpha particles
B. III represents trajectory for Halley's Comet and II for the scattering of alpha particles
C. II represents trajectory for Halley's Comet and I for scattering of alpha particles
D. II represents trajectory for Halley's Comet and III for scattering of alpha particles

9. When water changes phase from liquid to vapor, some bonds are broken. The correct statement relating to this change is:
A. New bonds are formed between nearby H/H and O/O while H-O bonds break
B. Hydrogen bonds between H_2O molecules are broken
C. Covalent bonds existing within the H_2O molecules are broken
D. Ionic bonds existing between H ions and OH ions are broken

10. Jyoti was asked by her mother to add a pinch of potassium permanganate to water in a container to disinfect it. As she added the crystals and observed the change in water, the phenomena of diffusion came to her mind. She wrote the following statements. Identify the statement made by Jyoti that is Incorrect.
A. When the entire liquid is of uniform color, no further diffusion can be observed
B. The diffusion gets completed almost instantaneously
C. Diffusion will take place slower if they water is colder
D. Maximum color in liquid originates from the bottom of the flask

11. Ramen collected rain water and measured its electrical conductivity. He boiled the water for a few minutes. Then he covered the container and allowed the water to cool to room temperature. Electrical conductivity of water now measured was lower than that measured before boiling. The reason for this most likely is
A. precipitation of $CaCO_3$ from the water during boiling
B. removal of dissolved oxygen from the water
C. removal of dissolved carbon dioxide from the water
D. reaction of cationic species in the water with atmospheric oxygen

12. Consider a setup in which two graphite rods are immersed in a 2 M NaCl (aq.) solution. The rods are connected to two terminals of a 9 V battery with a bulb in series as shown in the figure. Of the following, the change that will NOT be observed when the circuit is closed for a few minutes is:



A. The bulb will glow
B. The pH of solution near the cathode will increase
C. Oxygen gas would be generate near the +ve electrode which will oxidize the graphite electrode
D. Total mass of liquid in the beaker will decrease

SECTION II

13. (3 marks) A student was given 2.89 g f a mixture of containing anhydrous $MgCl_2$ and KNO_3 and had to quantify amount f $MgCl_2$ in the mixture. The student uses excess $AgNO_3$ (aq) to precipitate the chloride ion as AgCl(s), and finds the mass of the AgCl precipitate to be 5.32 g Calculate the mass percentage of $MgCl_2$ in the original mixture (Atomic masses should be taken as per the data given.)

14. (12 marks) Iodine, an essential element for humans, is naturally present in some marine fishes, plants and ecosystems at large. Solubility of element iodine in water is negligible but is high in non – polar organic solvents. The most common form of iodine used in the diet of humans and animals is potassium iodide (KI), a white solid powder at room temperature, which is highly soluble in water.

14.1 In a chemistry laboratory period, 36 students of a class had to perform the following tests:
i. 0.5 gram KI is dissolved in about 5 cm^2 distilled water. A drop of this solution is put on a moist pH paper.
ii. 0.5 gram KI is dissolved in about 5 cm^2 distilled water. Part of this solution is mixed with lead (II) nitrate solution. The colour changes in the mixture are observed.
iii. 0.5 gram KI is put in a test tube containing about 5 cm^2 distilled water. Then they are to observe whether the test tube becomes hot or cool on mixing.

In test ii, a yellow precipitate is observed. In test III, the test tube becomes colder as KI dissolves.

(a) Identify the colour imparted on pH paper in test i.
(b) Being very expensive, KI should be economically used. What is the minimum amount of KI (in grams) required for the complete class for carrying out the above three tests procedures?
Write necessary calculations/reasoning needed to arrive at your answer.

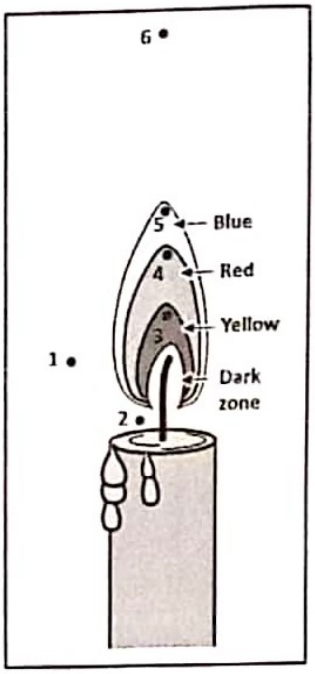
14.2 An aqueous solution of KI treated with acidified solution of hydrogen peroxide (in sulphuric acid) gives a precipitate of Iodme crystals
a. Write the balanced molecular equation for the reaction.
b. Identify the reducing agent in the reaction
c. The most appropriate option to separate iodine from the above mixture is:
A. filtration B. distillation C. stem distillation D. chromatography
E. using a magnet

14.3 When solid KI is heated in an open dry test tube, a gas is liberated from the test tube
a. What is the colour of gas?
b. After the gas evolution stops, what remains in the test tube? Write its chemical symbol/formula (if mixture, write formulae of components) and its state (solid/lquid)
c. The reaction can be classified as (identify the correct options)
A. thermal combination B. thermal decomposition
C. double displacement D. displacement reaction

14.4 Tincture iodine is an antiseptic, also effective in inactivating the novel corona virus. It is prepared by dissolved 20 g of Iodine and 25 g of KI in 500 ml alcohol and then adding distilled water to make the volume 1000 ml. In this process, iodine combines with I^- t produce I_3^- species. Sumit and Rekha were separately preparing tincture iodine using the above procedure. Sumit was working hurriedly, as he wanted to join a birthday party By mistake, he added carbon tetrachloride in the flash instead of alcohol. At the end of the procedure, two immiscible liquid lavers appeared in his flask. Sumit shook the flash vigorously and kept it for some time. The two layers remained separate. He observed that the lower layer was strongly colored while the upper layer had a faint colour different from the lower layer Rekha followed the protocol perfectly and got a homogenous mixtgure.

Identify the compositions of the top and bottom layers in Sumit's flask.

15. (8 marks) Flame is a hot bright stream of burning gases. Flames have different structure and properties depending on fuel and burning conditions. The attached figure (drawn approximately to scale) shows a candle flame burning in open are in which three regions are distinctly visible surrounding a dark zone. An innermost zone that is pale yellow in colour, surrounded by a red zone with a blush envelop at the outside Points 1 6 represent different locations in the inside the surrounding region of the flame. Consider was to have chemical formula $C_{24}H_{50}$.



15.1 Among points 1.6 identify
a. the hottest point
b. the coldest point
c. the point where point vapour concentration is the highest

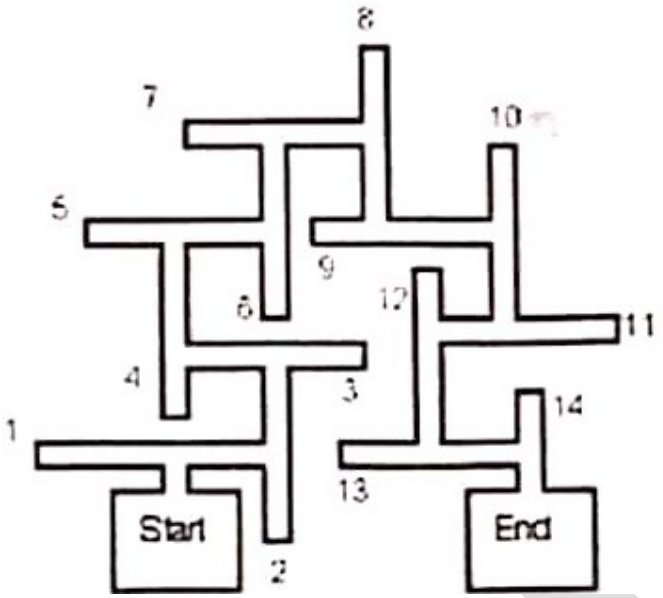
15.2 From the following list, identify two substances that are present at point 3 but not at point 6 Also write chemical equations for the reactions causing removal of these substances
List: Oxygen, Nitrogen, Carbon, Wax, Carbon dioxide, Carbon monoxide, Water

15.3 The space at point 2 prominently has (identify the correct option)
a. Only air
b. air with freshly evaporating was vapour
c. air with extra carbon dioxide released from combustion
d. oxygen rich an (as oxygen concentration has locally increased due to diffusion)

15.4 Another flame used in laboratories is produced from Bunsen burner. It is used for heating, combustion, sterilization processes, etc. By adjusting the ratio of gas (fuel) and air in Bunsen burner, it is possible to get a stable blue flame, which is largely non luminous. Sholk was given two different organic compounds: naphthalene ($C_{10}H_8$) and citric acid ($C_6H_8O_7$). He burned 1.0 g of each compound separately in a porcelain piece in a blue Bunsen burner flame.

For which of the two compounds, the flame would emit more yellow light? Write reason for your answer, along with necessary supporting calculations/arguments.

16. (8 marks) A famous experiment performed by Tolman and Honzik (in 1930) studied the behavious of rats in a complex maze (shown in the figure) for a period of 17 days. The rats had to find their way around the maze once every day. All rats were healthy and were given regular meals throughout the experiment.
The rats were divided into 3 groups, which were treated as follows on reaching the end of the maze.

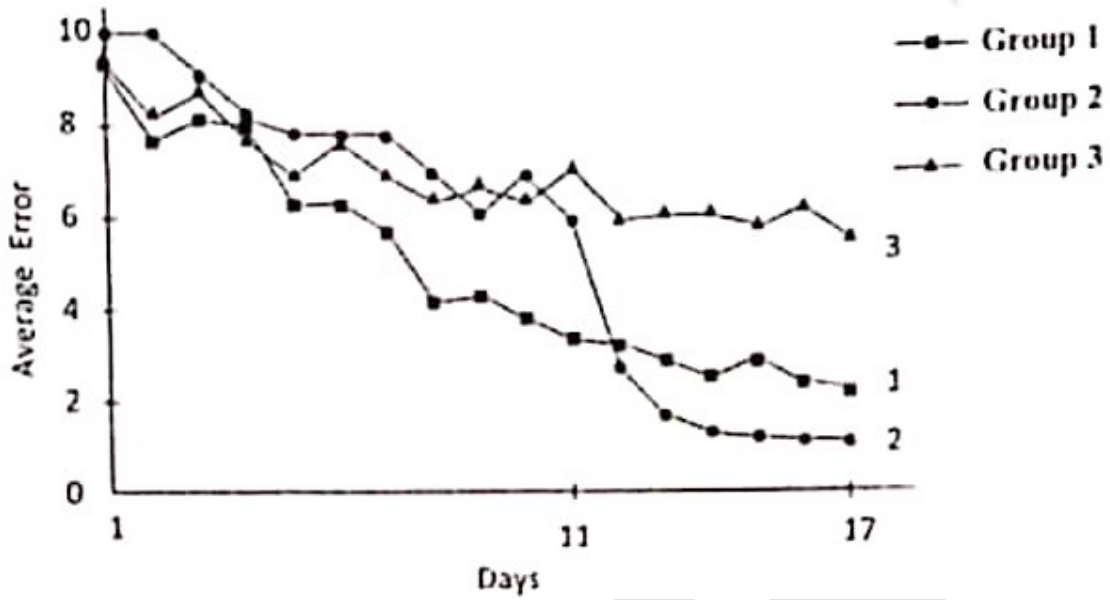


Group 1:
Day 1 – 17 every time the rats reached the end, they were given additional food.

Group 2:
Day 1 -10 every time the rats reached the end, they were removed from the maze.
Day 11 – 17 every time the rats reached the end, they were given additional food

Group 3:
Day 1 – 17 every time the rats reached the end, they were removed from the maze.

The average number of errors (any deviation from the shortest correct path to reach the end) observed for each group of rats is shown in the graph below.



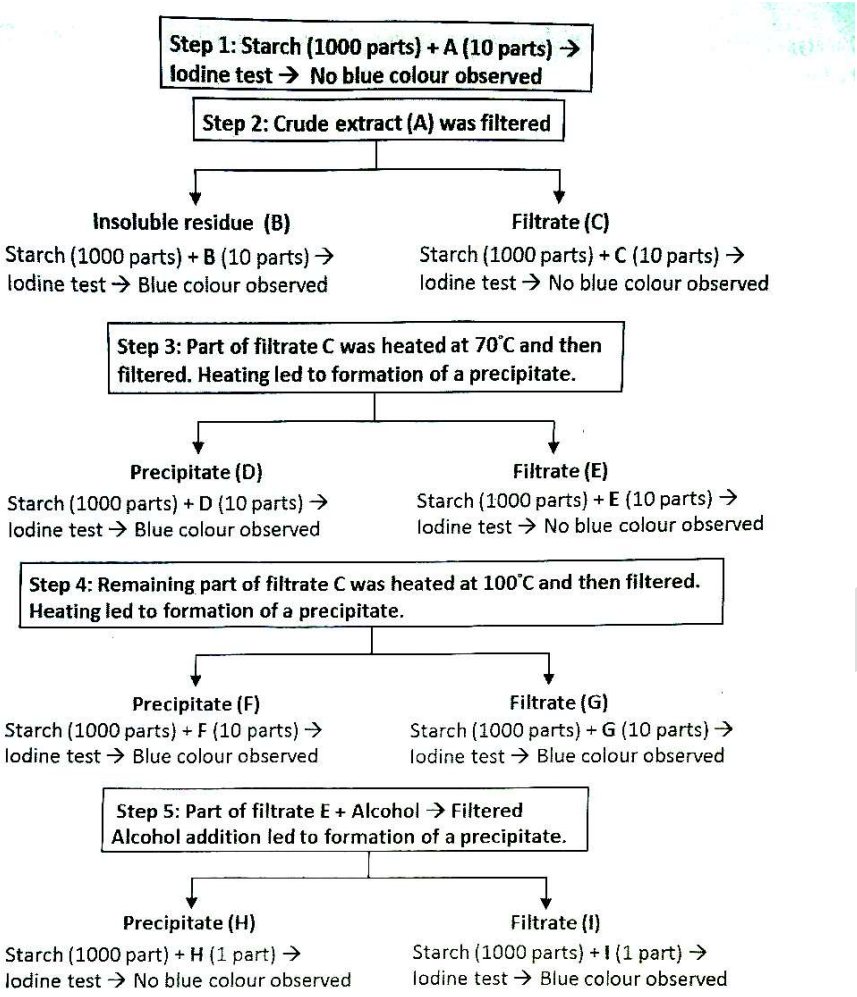
16.1 A few statements are listed below. Based on the results of the experiment, identify each of the statements as True of False.
a. Rats need good nutritional status to perform well in the maze.
b. Result shows characteristic stimulus (maze) response (teaching the end) behaviour which is genetically determined and hence not changeable.
c. The find of end of the maze is by the trial and error method and not due to learning
d. Rewarding the rats has improved the end results
e. There was active learning happening in rats in groups 2 even before day 11

16.2 What response can be expected if the rats in the group I were kept hungry before the experiment? Assume that all other conditions in the above experimental setup remain the same. Choose the most appropriate option from choices below and justify your choice based on the experimental observations presented above (only). Also give reasons for rejecting the other three options.
A. Overall rise of line 1 above line 3
B. Increase in errors as the experiment proceeds
C. Steeper decrease in the line 1 in lesser time
D. Same response as line 3 in the graph

17. (7 marks) In the early nineteenth century, two scientists Payen and Person ground barley seeds in water to prepare a crude extract (A). The Scientists then carried out a series of treatments on the extract A. At every step, iodine tests were carried out as follows:

Iodine test: Mixture (Starch + sample) $\rightarrow$ Wait for 10 mins $\rightarrow$ Add iodine $\rightarrow$ Check for colour changes

The different steps of treatment and the result recorded are shown in the flow chart below:

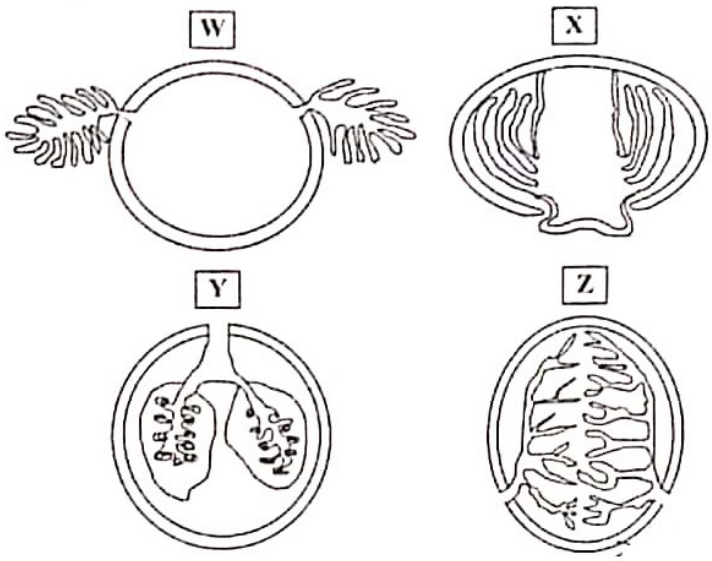


17.1 Blue colour indicates (identify the correct option)
A. that starch is a polymer of glucose units
B. that starch id digested into small units of glucose
C. glucose units released from starch have formed a complex with iodine
D. iodine is trapped in the intact polymer of starch

17.2. Based on the observations, identify each of the following statements as True or False
a. Barley seeds contain a substance that converts glucose to starch
b. Barley seed coat contains a substance that can convert starch to glucose but it gets destroyed by heat
c. The substance present in barely seeds is water soluble and breaks starch into small units
d. The process of heating up to 70^0 C enhances the chemical activity of the barley filtrate but heating above 70^0 C inactivates it

17.3 Which of the preparation's (A to I) indicate/s the presence of the 'active substance' being analyzed in barley?

18. (7 marks) Different types of respiratory organs in animals occupying different habitats are represented in the figure (W – Z) below:



18.1 The organs most likely belong to (choose from the options) cockroach, prawn, tadpole, and rabbit?

The Fick's law of diffusion shows how various factors influence the rate of diffusion and is represented as:
$Q = D A (P1 – P2) / L$

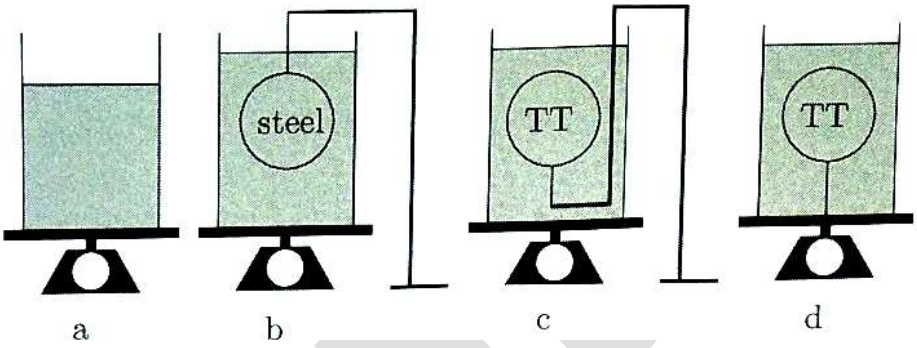
Where Q = rate at which a gas such as O_2 diffuses between two locations
D = diffusion coefficient, which is characteristic of the diffusing substance (e.g., a gas), the medium and the temperature
A = cross sectional area over which the gas is diffusing
P1 and P2 are the partial pressures of the gas at the two locations
L = path length or distance between the two locations

18.2 If the temperature of the habitats, in which the four animals having the organs of type W – Z live, are the same, then, based on the medium used for gas exchange, the value of D would be higher for animals possessing respiratory organs of the types (a) ___ as compared to animals with organs of type (b) ___ (choose from W – Z).

18.3 Two features of respiratory organs in animals are listed in Column I in the given table. Fill in
– column II with the appropriate factor from Fick's law equation that will be affected by the feature mentioned in column I.
– column III with the effect that the feature will have on the factor mentioned in Column II, and
– column IV with the corresponding effect on the rate of diffusion (Q)
(Marks will be given only for completely correct row)

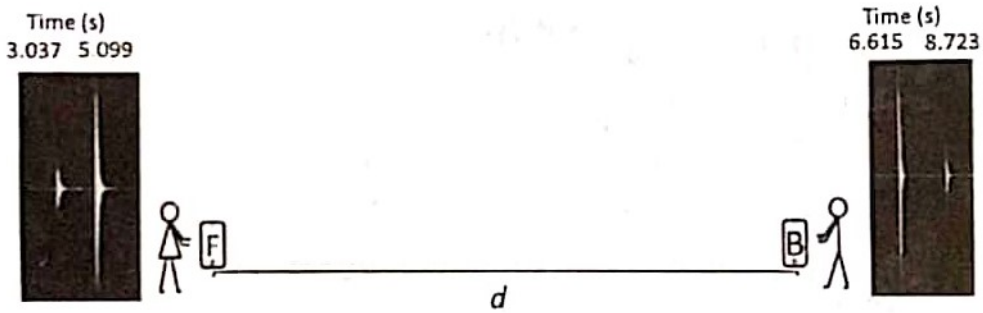
Column I	Column II	Column III	Column IV
Feature	**Factor affected (*D* / *A* / *P1* or *P2* / *L* or none)**	**Effect (increase/ decrease/ no change)**	**Effect on *Q* (increase/ decrease/ no change)**
1. Highly branched and folded extensions	–	–	–
2. Presence of very thin-walled tissues	–	–	–

19. (7 marks) Four identical beakers, as shown below, contain the same amount of water. Beaker 'a' contains only water. A steel ball (mass 0.800 kg) is held submerged in the beaker 'b' by a string from above. A same sized plastic TT ball (0.020 kg) is held submerged in beaker 'c' by a string attached to a stand from outside, as shown in the figure. Beaker 'd' contains same sized TT ball held submerged from a string attached to the bottom of the beaker. The volume of each ball is 10^{-4} m^3. These beakers (without stands) are placed on weighing pans and register reading W_a, W_b, W_c and W_d for a, b, c and d respectively.



It W_a = 1 kg, then obtain W_b, W_c and W_d. Show the main steps of your calculations. For calculation purpose, ignore the part of stand and the thread submerged in water.

20. (6 marks) Smart phones can be perform simple experiments related to sound. There are various apps which record the intensity of an audio signal. An app (WaveEditor™ here) displays the audio signal in the form of a wave, whose amplitude is proportional to the loudness of the audio signal.



Two students Fatima (F) and Bharat (B) conduct a simple experiment using smart phones. In an open field, both place their smart phones at a distance d from each other as shown in the figure. They stand next to their smart phones, and clap one after another. The audio signals from the claps are digitally recorded by WaveEditor™ and the output produced on their smart phone screens are shown next to their sketches. Note that the figure is not to scale. The time mentioned above the screen images is the time of the peak amplitude for each

clap's audio signal received in their phones, respectively. They determine the speed of sound from the experiment to be 363 m/s.
Calculate the distance d (in m). Show the main steps of your calculation:

21. (6 marks) With about half of its surface always having day. Earth constantly receives heat from the Sun and maintains an average temperature of 288 K. From this heat an average power of 4.3×10^{16} W goes into the evaporation of water. The water evaporated form the Earth finally precipitates over its surface. Suppose one collects this water for one year and the thickness of this water shell is h over the surface of the Earth, thus value in meters is the well – known average annual rainfall on the globe. For the following two questions, make suitable assumptions wherever needed.

21.1 Estimate h.
21.2 The fresh water requirement is about 6800 l/day per head, which includes domestic water usage and water used for irrigation and industry. Estimate the ratio of water requirement for the population of the world and the total water received through rain over the land annually.

HINTS AND SOLUTIONS

1. C

Sol. Sympathetic nervous system cause body shivering, loss of bowel and bladder control & dilation of pupils.

2. D

Sol. During the initial phase of exercise the oxygen level in artery is constant (P) and oxygen level in vein is decreases (Q).

3. C

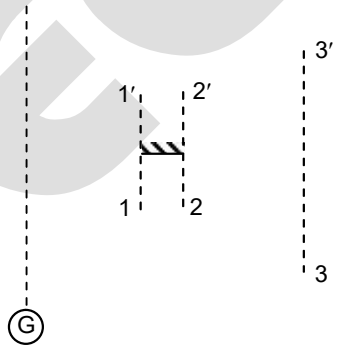
Sol. Sample-I: Bacteria, Sample-II: Plant cell
Sample-III: Ribosome, Sample-IV: Virus

4. C

Sol. If we add paper then it act as carbon source & buttermilk faster the rate of decomposition & act as starter bacteria.

5. D

Sol. This is a simple question based on field of view. In order to obtain field of view one needs to draw lines over the ends of mirror from the image of source. From the figure, it is clear that image of 2 becomes visible first & than image of 3 will be visible. However, Girl will never be able to see the image of 1.



6. A

Sol. If the wire is cut into n pieces, then resistance of each part will be $R = \frac{310}{n}$ and when these n parts will be joined in parallel, then resistance of the combination would be $R_{eq} = \frac{310/n}{n} = \frac{310}{n^2}$. Power output of cell would be Vi where V is the EMF of battery which is given 220 V. Therefore in order to maximize power, current should be maximized and current through each branch in parallel can be maximum 5A which means current through the combination would be n×5 as there are n branches in parallel.

$$i = n \times 5 = \frac{220}{R_{eq}}$$

As $R_{eq} = \frac{310}{n^2}$

$$\Rightarrow n \times 5 = \frac{220}{310} \times n^2$$

$$\Rightarrow n = \frac{31 \times 5}{22} = \frac{155}{22} \approx 7$$

7. D

Sol. (i) As the freezer is maintained at -10°C which is less than 0°C, therefore the final temperature of the mixture will also be -10°C. So water will lose more heat as water will lose heat in phase change too, so statement 1 is false.
(ii) At 0°C density of water is more then ice. So statement 2 is correct.

8. D

Sol. Halley's comet will be attracted by sun, hence it will move in elliptical orbit. Its orbit around sun is highly elliptical. The perihelion point on its trajectory around sun is just 0.6 AU. It will follow path II. Alpha particle is the Nucleus of Helium, which means it is positively charged, that means it will be repelled by Nucleus & will follow path III.

9. B

Sol. Water contains intermolecular hydrogen bonds. When it is vapourised we get H_2O vapours.

$$H_2O(\ell) \longrightarrow H_2O(g)$$

In this process no covalent bond in water (0–H bond) is broken and no covalent bonds (like O–O and H–H) are formed. Only the hydrogen bonds are broken in the vaporization process.

10. B

Sol. Diffusion of liquid is slower than that of gases. So, $KMnO_4$ is a solution. It diffuses slower on water. When the resultant solution will acquire a uniform colour. No further diffusion will be observed.

11. C

Sol. On boiling rain water, the quantity of water and dissolved gases (responsible for acid rain) decreases. The gases form oxo-acids with water. Since the amount of water decreases, the concentration of oxo-acids increases. Since, most of the acids are weak acid, their dissociation into H^+ and oxo-anion decreases. Hence, conductivity decreases.

12. C

Sol. Aqueous NaCl solution produces H_2 gas at cathode and Cl_2 gas at anode during electrolysis. The remaining solution after expulsion of H_2 and Cl_2 becomes richer with Na^+ and OH^- ion. Hence, the pH of the solution will increases, O_2 gas will not be evolved as long as Cl^- ion are present in solution.

SECTION – II

13. Mass of mixture of $MgCl_2$ and KNO_3 = 2.89 g

$$MgCl_2 + 2AgNO_3 \longrightarrow 2AgCl + Mg(NO_3)_2$$

Mass of AgCl = 5.32 g

Molar mass of AgCl = 107.87 + 35.45

= 143.32

Molar mass of $MgCl_2$ = 24.43 + 2(35.45) = 95.2

Moles of AgCl formed = $\frac{5.32}{143.32}$ = 0.0371

$\Rightarrow$ 2 moles of AgCl are formed from one mole of $MgCl_2$

$\Rightarrow$ 0.0371 mole AgCl will be formed from

$$= \frac{0.0371}{2} = 0.0185 \text{ mole of } MgCl_2$$

$\Rightarrow$ Mass of $MgCl_2$ = mole $\times$ molar mass

$= 0.0185 \times 95.2 = 1.7612$

% of $MgCl_2$ = $\frac{1.7612}{2.89} \times 100 = 60.94\%$

14.1 (a) **KI** is a neutral salt. The pH of aqueous solution is 7. So the colour on pH paper is green.

(b) $36 \times 0.5 = 18$ Only one test is sufficient.

14.2 (a) $2KI + H_2O_2 + H_2SO_4 \longrightarrow I_2 + K_2SO_4 + 2H_2O$

(b) The reducing agent is KI.

(c) Filtration

14.3 (a) $2KI \longrightarrow 2K + I_2$

(b) The color of gas is violet. Solid left in container is potassium.

(c) It is a thermal decomposition reaction.

14.4 Mass of I_2 = 20 g

Moles of I_2 = $\frac{20}{253.8} = 0.078$

Mass of $KI = 25$ g

Moles of KI = $\frac{25}{165.99} = 0.1506$

No. of moles $I_2 + KI \rightleftharpoons KI_3$

Before reaction $\begin{pmatrix} 0.078 \\ -0.078 \end{pmatrix}\begin{pmatrix} 0.1506 \\ -0.078 \end{pmatrix}$ 0.078

∴ After reaction

Mole of KI = 0.1506

Moles of KI_3 = 0.078

I_2 is completely consumed

After addition of CCl_4

After I_2 is completely consumed KI and KI_3 left in the solution. They are more soluble in polar solvent like water and not in CCl_4 which is non – polar.
∴ KI and KI_3 will remain in aqueous solution and CCl_4 will form a separate layer.
The aqueous layer will contain
The concentration of K^+ ion -= 0.1506 M
The concentration of I^- ion = 0.1506 M
The concentration of I_3^- ion = 0.078 M
The CCl_4 layer will contain 500 ml volume.

15.1 (a) 5
(b) 2
(c) 6

15.2 Carbon monoxide and carbon
$2CO + O_2 \rightarrow 2CO_2$
$C + O_2 \rightarrow CO_2$

15.3 (D)

15.4 Naphthalene will produce more yellow light than citric acid.
Naphthalene is unsaturated and contains higher percentage of carbon than citric acid.
So, the flame will contain more soot than that of citric acid and will impart more yellow colour.

Naphthalene is $C_{10}H_8$

$$\text{Percentage of Carbon} = \frac{12\times10}{(12\times10)+8}\times100$$

$$= 93.75\%$$

Citric acid $C_6H_8O_7$

$$\text{Percentage of carbon} = \frac{(6\times12)}{(6\times12)+(1\times8)+(16\times7)}\times100$$

$$= 37.5\%$$

16.1. a $\rightarrow$ T, b $\rightarrow$ F, c $\rightarrow$ F, d $\rightarrow$ T, e $\rightarrow$ T

16.2. We choose option C because the rats are hungry & they reach the end by making less error.
Option a rejected because the chances of making errors are not going to increase.

Option b is rejected because there is decrease in errors not increase.
Option d is rejected because the line 1 is not as line 3 in the graph.

17.1 D
Statement D is correct, because iodine gives blue colour with starch.

17.2 (a) True
(b) False
(c) True
(d) True

17.3 A, C, E, H contain active substances which does not produce blue color with starch. The active substance is always present in filtration.

18.1. W $\rightarrow$ Tadpole, X $\rightarrow$ Prawn, Y $\rightarrow$ Rabbit, Z $\rightarrow$ Cockroach

18.2. (a) $\rightarrow$ Y,Z; (b) $\rightarrow$ X,W

18.3.

Column-I	Column-II	Column-III	Column-IV
1	A	Increase	Increase
2	D	Increase	Increase

19. Reading of first beaker = weight of water = 1 kg
Reading of second beaker = weight of water + Buoyant force by ball
$\Rightarrow$ $W_B = 1 + (1000)(10^{-4}) = 1.1$ kg
Reading of third beaker = weight of water + Buoyant force by ball
$\Rightarrow$ $W_B = 1 + (1000)(10^{-4}) = 1.1$ kg
Reading of fourth beaker = weight of water + Weight of TT ball
$\Rightarrow$ $W_d = 1 + 0.02 = 1.02$ kg

$\Rightarrow W_a = 1$ kg, $W_B = 1.1$ kg, $W_C = 1.1$ kg, $W_d = 1.02$ kg

20. v = 363 m/s
$\Delta t_F = 5.099 - 3.037 = 2.062$

$\Delta t_B = 8.723 - 6.615 = 2.108$

As per the situation shown in the figure, it is clear that Bharat (B) generated a loud signal to start time measurement on both phones. Then the phone F at the other end will start its measurement at a delay equal to the time Δt, it takes for the sound to travel the distance d between both phones.

Then, while both phones are running, Fatima (F) generates a second acoustic signal to stop both phones. Again, the distant phone, which is in this case phone B, gets a delayed trigger. This means that phone B which started earlier by Δt, now also stops later by Δt. Therefore phone B measures a total time Δt_B equal to the time Δt_F measured by phone F plus two times Δt the time the signal takes to move from one location to another.

$\Delta t_B = \Delta t_F + 2\Delta t$

Now speed of sound $v = \dfrac{d}{\Delta t} = \dfrac{2d}{\Delta t_B - \Delta t_F}$

Therefore, we can get Δt from the difference of both measured time intervals, resulting in the following equation for the distance between phones:

$$d = \frac{v(\Delta t_B - \Delta t_F)}{2} = \frac{363(2.108 - 2.062)}{2} = 8.349 \text{ m}$$

21. $T = 288$ K

$P = 4.3 \times 10^{16}$ W

$$P = \frac{dm}{dt}L$$

$$\Rightarrow \quad \frac{dm}{dt} = \frac{P}{L} = \frac{4.3 \times 10^{16}}{2.26 \times 10^{6}}$$

$$\Rightarrow \quad \frac{dm}{dt} = 1.9 \times 10^{10} \text{ kg/s}$$

Density of water = 1000 kg/m^3

$$\Rightarrow \quad \frac{dV}{dt} = \frac{1.9 \times 10^{10}}{10^3} = 1.9 \times 10^7 \text{ m}^3/\text{s}$$

$\Rightarrow$ Water collection in a year = $1.9 \times 10^7 \times 365 \times 86400$

$V = 6 \times 10^{14}$ m^3

(a) $$h = \frac{\text{Volume of water collected}}{\text{Area of Earth surface}} = \frac{V}{4\pi R^2}$$

$$\Rightarrow \quad h = \frac{6 \times 10^{14}}{4 \times 3.14 \times (6.4 \times 10^6)^2} = \frac{6 \times 10^2}{4 \times 3.14 \times 6.4 \times 6.4}$$

$\Rightarrow$ h = 1.16 m

(b) Water requirement per person = 6800 L/day

= 6.8 m^3/day

$\Rightarrow$ Water requirement per person in a year = $6.8 \times 365 = 2482$ m^3

$\Rightarrow$ Water required for population of world = 2482 × Population of world

$= 2482 \times 7.8 \times 10^9 = 1.94 \times 10^{13}$ m^3

$\therefore$ Required ratio = $\dfrac{\text{Water requirement}}{\text{Total water received}}$

$$= \frac{1.94 \times 10^{13}}{6 \times 10^{14}} = 0.03$$