INDIAN OLYMPIAD QUALIFIER IN JUNIOR SCIENCE (2021)
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PART – 2
ANSWER KEYS 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

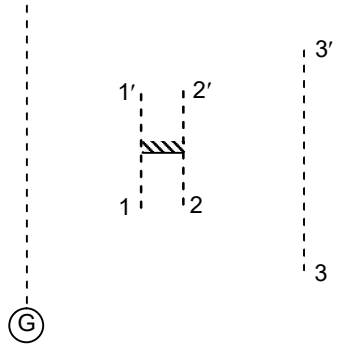
Sol. Sample-I: Bacteria, Sample-II: Plant cell
Sample-III: Ribosome, Sample-IV: Virus

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) $4KI + O_2 \longrightarrow 2K_2O + 2I_2$

(b) Color of gas is violet. Sold left in the container is K_2O.

(c) It is a displacement 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

$\therefore$ 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.
$\therefore$ 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) 1
(c) 5

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

15.3 A

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) False

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 → Tadpole, X → Prawn, Y → Rabbit, Z → Cockroach

18.2. (a) → Y,Z; (b) → 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

$\Rightarrow \quad W_B = 1 + (1000)\,(10^{-4}) = 1.1$ kg

Reading of third beaker = weight of water + Buoyant force by ball

$\Rightarrow \quad W_B = 1 + (1000)\,(10^{-4}) = 1.1$ kg

Reading of fourth beaker = weight of water + Weight of TT ball

$\Rightarrow \quad W_d = 1 + 0.02 = 1.02$ 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) $h = \dfrac{\text{Volume of water collected}}{\text{Area of Earth surface}} = \dfrac{V}{4\pi R^2}$

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

$\Rightarrow$ 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 = $\dfrac{\text{Water requirement}}{\text{Total water received}}$

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