

Indian Olympiad Qualifier in Junior Science (IOQJS) 2020-2021

conducted jointly by
Homi Bhabha Centre for Science Education (HBCSE-TIFR)
and
Indian Association of Physics Teachers (IAPT)

Part II: Indian National Junior Science Olympiad (INJSO) **Homi Bhabha Centre for Science Education (HBCSE-TIFR)**

Date: January 17, 2021

Tentative Model Solutions (January 17, 2020)

1. C. Responses to fight-flight situation can either be the result of acute stress such as loss of bowel/bladder control and shivering while some could be to help overcome the situation such as pupil dilation to accept more light.
2. D. Oxygen level in the arteries has to be maintained at the same level. During exercise, since tissues utilizes more oxygen, its level in the veins will decrease.
3. C. I represents bacteria since it does not possess mitochondria but has cell wall; II represents plant cell due to presence of cell wall and nucleus; III represents ribosomes which are found attached to the endoplasmic reticulum in the cytoplasm; IV represent viruses which need host cells for replication.
4. C. Paper is made of cellulose and hence is a good source of carbon while buttermilk contain lactobacilli which help in aerobic decomposition.
5. D. Her field of view will be determined by drawing rays from each of the toys to the right and left edges of the plane mirror. She can see the image if she is within the range of these reflected rays.
6. A. Wires must be connected in parallel to draw maximum power, such that each piece draws maximum current of 5 A. Resistance of each piece will be $220/5 = 44$ ohm. Hence the number of pieces will be $310/44 = 7$. Eighth piece will be too short and should be discarded.
7. D. Water will lose more amount of energy while first converting to ice and releasing heat equivalent to the latent heat.
8. D. Gravitational force is an attractive force and the Coulomb force, which is responsible for the scattering of alpha particles, is repulsive.
9. B. In liquid phase, water molecules have hydrogen bonding between H of one molecule and O of another molecule. In gas phase, the hydrogen bonds don't exist, but the molecules remain intact.
10. B. Diffusion is a slow process and takes time to visibly get completed (at macroscopic level). At molecular level, transport of solute molecules from one region to another never stops but average concentration of molecules in a region remains approximately constant.
11. C. Removal of CO_2 on heating reduces the concentration of H^+ , carbonate, and bicarbonate ions present in rainwater which leads to reduction in electrical conductivity of water.
12. C. In concentrated NaCl solution, chloride ions get oxidized at anode to produce chlorine gas.
13. mass% of $\text{MgCl}_2 = 61.1\%$

Solution:

Moles of AgCl precipitated = 0.0371 mol AgCl

Moles of MgCl_2 in sample = 0.0186 mol

Mass of MgCl_2 in sample = 1.77 g

14.

14.1. (a) Green

(b) $0.5 \times 36 \text{ g} = 18 \text{ g}$ (when the tests are done in order iii \rightarrow i \rightarrow ii, as the same solution can be used for all three tests by a student).

14.2 (a) $\text{H}_2\text{SO}_{4(\text{aq})} + \text{H}_2\text{O}_{2(\text{l})} + 2\text{KI}_{(\text{aq})} \rightarrow 2\text{H}_2\text{O}_{(\text{l})} + \text{I}_{2(\text{s})} + \text{K}_2\text{SO}_{4(\text{aq})}$

(b) KI (or I^-)

(c) A

14.3. (a) Violet / Bluish pink .

(b) K_2O (solid)

(c) B and D

14.4. Bottom layer: Carbon tetrachloride (having higher density than water); with dissolved I_2 .
Top Layer: Water with dissolved KI and I_3^- (both are ionic and highly soluble in water).

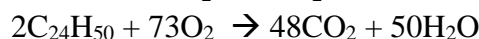
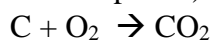
15.

15.1. (a) Point 5

(b) Point 1

(c) Point 5

15.2. Carbon and wax (CO also acceptable)



15.3. A. The flow of air below the flame is from bottom to top. Hence air at point 2 would be ambient air from below which is flowing in toward the flame region. Products of combustion being hotter gases will move upwards and will not come to this region.

15.4. Naphthalene should give brighter (more luminous) flame as it has higher mass percentage of carbon (93.8%) than citric acid (37.5%). Thus naphthalene on burning would produce more carbon particles, which are likely to glow over longer time span.

16.

16.1. (a) False (b) False (c) False (d) True (e) True

16.2. C is correct because not getting regular meals will increase the need for food and hence faster learning is likely to happen when food is given as reward.

Statement A is incorrect because the line that represents the response of rats with reward will always be below the line for group without reward.

Statement B is incorrect because additional food as reward will lead to decrease in errors and not an increase.

Statement D is incorrect because the response will not be the same as line 3 since some learning is likely to happen when reward is given to the rats.

17.

17. 1. D

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

17.3. A, C, E, H (All the preparations that show absence of blue colour as the end result indicate the presence of the active substance.)

18.

18.1. **W**: Tadpole (shows presence of external gills)

X: Prawn (shows presence of internal gills)

Y: Rabbit (shows lungs which is present in mammals)

Z: Cockroach (shows presence of spiracles and tracheae)

18.2. (a) **Y** and **Z** (b) **W** and **X**

18.3.

Column I	Column II	Column III	Column IV
1	A	Increase	Increase
2	L	Decrease	Increase

19. $W_b = 1.100 \text{ kg}$, $W_c = 1.100 \text{ kg}$, $W_d = 1.020 \text{ kg}$

Solution: In the case of b) and c), buoyancy force will contribute to the reading which is 1 N. Both will give same reading regardless of their densities. In d), TT ball can be considered as if it is kept on the floor.

20. $d = 8.35 \text{ m}$

Solution: From the sequence of events presented and the time for each signal recorded in the two smartphones, it may be noted that the starting time for the App ($t = 0$) is not same in the two smartphones. There are two peaks in each graph, 1st peak in Fatima's screen corresponds to the audio signal generated by Bharat and second peak corresponds to the audio signal generated by her. Hence they also have a different amplitudes.

When Bharat claps, his audio signal will take d/v time to reach to Fatima and same goes for the signal received by Bharat when Fatima claps. Let Δt_B and Δt_F be the time differences in the audio peaks recorded in Bharat and Fatima's screen respectively.

Velocity of sound = $2d/(\Delta t_B - \Delta t_F)$

which gives $d = 8.35 \text{ m}$

21.

21.1 $h \approx 1 \text{ m}$

Solution: The amount of water evaporated M_w in one year will be given by

$M_w = \text{Solar power going into evaporation} \times \text{One year in seconds} / \text{Latent heat}$

$$M_w = 5.1 \times 10^{17} \text{ kg / yr}$$

$$\text{Volume of water} = 4\pi R^2 d = 5.1 \times 10^{14} \text{ m}^3/\text{yr}$$

Here R is the radius of earth and d is the depth at which this water can be filled i.e. average rain fall.

21.2. Ratio = 1/10

Solution: For the global population of ~700 crores, water requirement will be $1.7 \times 10^{13} \text{ m}^3/\text{yr}$

Total area of the land on earth is about 30%.

Water falling on land area = $0.3 \times 5.1 \times 10^{14} \text{ m}^3/\text{yr}$

Hence the ratio of water requirement for the population of the world and the total fresh water received through rain over the land annually is close to 1/10.