

**Indian National Junior Science Olympiad - 2013**  
**Question Paper and Correct Choice is in *BOLD***

Roll Number: 

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Date: **2<sup>nd</sup>** February 2013

Maximum Marks: 296

Name

Time: 02.00 - 05.00 p.m.

**Instructions:**

1. Please write your Name and Roll Number on top of this page in the space provided.
2. Before starting, please ensure that you have received a copy of this Question Paper containing a total of 26 pages including this page.
3. There are 75 multiple choice questions with 4 alternatives, out of which only 1 is correct. You get 4 mark for every correct answer and **-1 mark for every wrong answer.**
4. Four possible answers (**A, B, C and D**) are given and only one of the choices is the best. Choose this most appropriate choice and darken the appropriate bubble completely and properly in the answer sheet with **blue / black pen**. For example:

Q.No. 22.    A    B    C    D  
                         

Please be very careful in darkening the appropriate bubble. Cutting and erasing is not allowed.

5. Blank space have been provided in this Question Paper for rough work.
6. Computational tools such as calculators, mobiles, pagers, smart watches, slide rules, log tables etc. are **not** allowed.
7. You may take this Question Paper back with you. **However you must return the following:**
  - (i) Candidates details with the attached Performance Card. **Do not detach the Performance Card**
  - (ii) The OMR answer sheet.

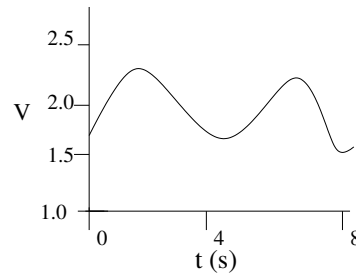
**Kindly fill both (i) and (ii) carefully and return both before you leave.**

### Table of Information

Gravitational acceleration on the surface of Earth $g$	=	$10 \text{ m/s}^2$ .
Constant for Coulomb's law in electrostatics $1/4\pi\epsilon_0$	=	$9 \times 10^9$ SI units.
Magnitude of the charge on electron	=	$1.6 \times 10^{-19} \text{ C}$ .
Average distance between Sun Earth	=	$1.5 \times 10^{11} \text{ m}$ .
Mechanical equivalent of heat	=	$4.2 \text{ J/cal}$ .
Specific heat capacity of water	=	$1 \text{ cal/g/C}$ .
Specific latent heat of fusion of ice	=	$80 \text{ cal/g}$ .
Specific latent heat boiling of water	=	$540 \text{ cal/g}$ .
Speed of light in vacuum	=	$3 \times 10^8 \text{ m/s}$ .
Radius of the Sun	=	$7 \times 10^8 \text{ m}$ .
Radius of Earth	=	$6.4 \times 10^6 \text{ m}$ .
Avogadro's number $N_A$	=	$6.022 \times 10^{23}/\text{mol}$
Atomic mass of Ca	=	$40.1 \text{ amu}$ .
Atomic mass of Mg	=	$24.3 \text{ amu}$ .
Atomic mass of Cl	=	$35.5 \text{ amu}$ .
Atomic mass of K	=	$39.1 \text{ amu}$ .

1. Which of the following ecosystems will exhibit maximum fixation of carbon averaged over a year through photosynthesis?
  - A. Farm ecosystem.
  - B. Ocean ecosystem.**
  - C. Rainforest ecosystem.
  - D. Pond ecosystem.
  
2. The human blood pigment Haemoglobin has maximum affinity towards
  - A.  $\text{NH}_3$
  - B. CO**
  - C.  $\text{CO}_2$
  - D.  $\text{O}_2$
  
3. Which of the following is a common character shown by both bryophytes and pteridophytes?
  - A. Semi-parasitic gametophytic stage.
  - B. Presence of vascular tissues.
  - C. Independent gametophytic and sporophytic generations.
  - D. Water is essential for fertilization.**
  
4. Consider the following ecological pyramids
  - I. Pyramid of numbers.
  - II. Pyramid of biomass.
  - III. Pyramid of energy.The one(s) which is / are always upright are
  - A. I only.
  - B. II and III only.
  - C. III only.**
  - D. I and II only.
  
5. Respiratory quotient (R.Q.) is defined as the ratio of volume of  $\text{CO}_2$  evolved to the volume of  $\text{O}_2$  taken in during the respiration process. Value of R.Q. depends on the nature of respiratory substrate and to the extent to which this substance is broken down into simpler products. Which of the following situation will give us the R.Q. value as infinity?
  - A. Fats used as substrate under aerobic conditions.
  - B. Organic acid is used as a substrate under aerobic conditions.
  - C. Any type of substrate used under anaerobic conditions.**
  - D. Any type of substrate used under aerobic conditions.

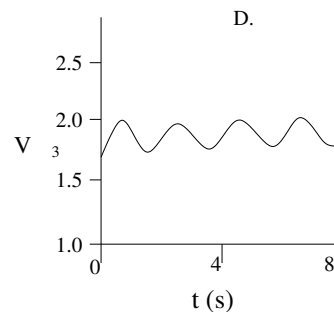
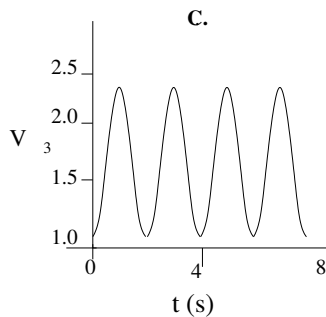
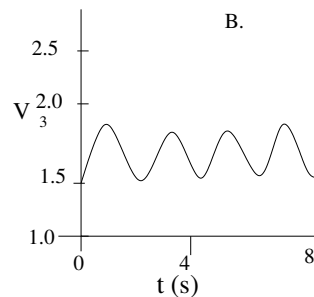
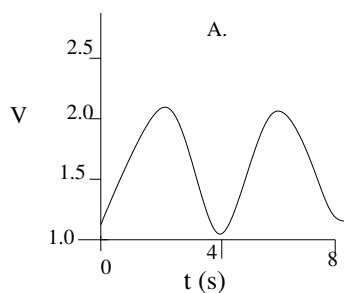
6. The following graph depicts the rate and extent of a person's breathing just before exercise.



Here  $V$  is the volume of air in lungs in  $\text{dm}^3$  and  $t$  is the time in seconds.

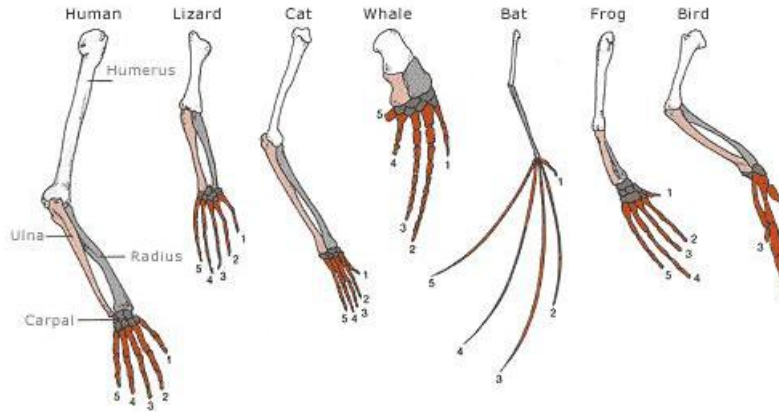
Which of the following graph best depicts the rate and extent of breathing of the same person immediately after a period of exercise?

**Correct choice is C**



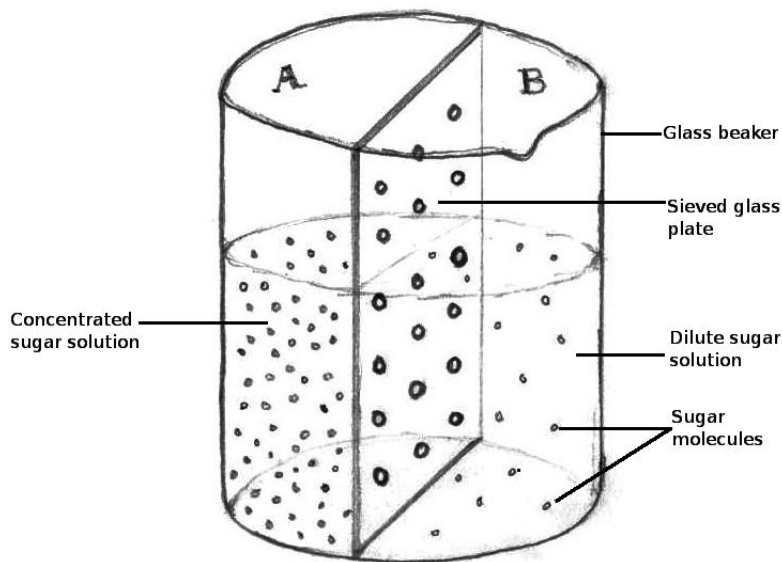
7. The following picture depicts the internal arrangement (anatomy) of bone structures in the limbs of different organisms. Which of the following statement is the **most valid** inference that can be drawn from a careful analysis of the limbs of different organisms in the diagram below?

- A. **Bones of limbs of all the organisms have similar basic plan therefore may have common ancestor.**
- B. Bones of limbs of all the organisms have the same basic structure but different shapes, therefore bone expression is controlled only by the environmental factor.
- C. Bones of limbs of all the organisms do not have similar bone structure therefore they may have evolved differently.



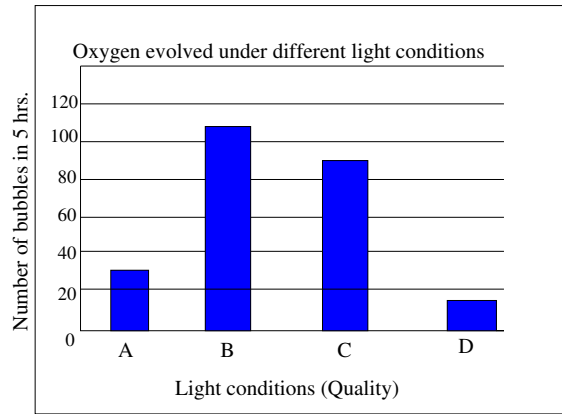
D. Systematic increase in the number of digits (fingers) exemplify use and disuse of organs.

8. Consider a beaker with a partition made up of sieved glass plate such that the beaker now contains two spaces - 'A' and 'B'. The beaker contains distilled water to which sugar was added in space A.



As you can see in the image, some molecules of sugar have moved to the region B. Which of the following is the correct term for describing this process?

- A. Osmosis.
  - B. Diffusion.**
  - C. Plasmolysis.
  - D. Imbibition.
9. *Hydrilla spp.*, an aquatic plant is immersed in water in a beaker. A funnel is kept inverted on it. A test tube filled with water is inverted on the nozzle of the funnel. Four such sets are prepared and each of them is exposed to different wavelengths of light, which were as follows:
- Set I: Yellow light
  - Set II: Blue light
  - Set III: Red light
  - Set IV: Green light



The experiment is continued for 5 hours and the amount of oxygen evolved by the plant (measured in terms of number of bubbles) in each set is measured. The following graph is obtained from the data which details different quantities of oxygen evolved when exposed to different quality of light A, B, C and D.

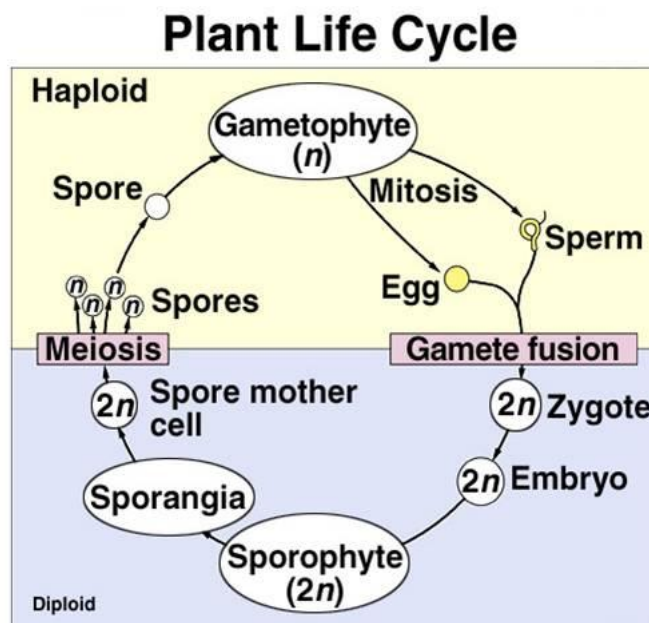
Which of the following combinations match correctly with the data represented in the graph?

- A. A - Red, B - Green, C - Blue and D - Yellow.
- B. A - Green, B - Yellow, C - Red and D Blue.
- C. A - Blue, B - Red, C - Yellow and D - Green.
- D. A - Yellow, B - Red, C - Blue and D- Green.**

10. Monozygotic twins have

- A. same genetic make up and different biological sex.
- B. same genetic make up and same biological sex.**
- C. dissimilar genetic make up and different biological sex.
- D. dissimilar genetic make up but same biological sex.

11. The life cycle of plants shows two distinct phases: a diploid (sporophytic) phase and haploid (gametophytic) phase which alternate with each other. The generalized pattern can be represented as in the following diagram:



Afreen studied the life cycles of 3 different plants: I, II, III, and made the following observations.

Plant I: Shows dominant gametophyte, sporophyte semi-parasitic on parent gametophyte.

Plant II: Shows reduced gametophyte, dominant sporophyte. Both phases are independent.

Plant III: Shows reduced gametophyte, dominant sporophyte. Gametophyte is produced within the sporophyte and not as separate generation.

Based on the information provided, which of the following options do you think represents the correct sequence of plant groups to which plants I, II and III belong to?

- A. I: Gymnosperm, II: Pteridophyte, III: Bryophyte.
  - B. I: Bryophyte, II: Pteridophyte, III: Gymnosperm.**
  - C. I: Bryophyte, II: Gymnosperm, III: Pteridophyte.
  - D. I: Pteridophyte, II: Bryophyte, III: Gymnosperm.
12. A section of a tissue was studied for the composition of various cell organelles. It was found that the cells contained extensive Golgi apparatus. The organelle composition suggests predominance of which of the following activities within the cells?
- A. Synthesis of ATP molecules.
  - B. Packaging of macromolecules.**
  - C. Production of protein molecules.
  - D. Storage of large quantities of food.
13. Cartilage is a connective tissue that smoothens bone surfaces at the joints. It is also present in nose, ear, trachea and larynx. Matrix of hyaline cartilage is predominantly composed of
- A. proteins and sugars.**
  - B. calcium and phosphorus.
  - C. calcium and fibres.
  - D. sugars and calcium.
14. Which of the following statement(s) is(are) correct statement(s) with respect to motor neurons?
- I. They are multipolar.
  - II. They are unipolar.
  - III. They carry messages from CNS (Central Nervous System) to muscle fibres or glands.
  - IV. They carry messages from sensory receptors to CNS.
- A. I only.
  - B. II only.

- C. I and III only.**
- D. I and IV only.
15. The transitional epithelium lines inner surface of urinary bladder and ureter. This epithelial layer is thinner and more stretchable as compared to the stratified epithelium. The best possible explanation for such a structural feature of transitional epithelium is that it
- A. prevents infection to the organs.
  - B. accommodates fluctuation of volume of the liquid in an organ.**
  - C. enables re-absorption of salts from urine.
  - D. helps in micturition (process of urination).
16. Anna is studying salt uptake (absorption) by the roots in a plant. Which of the following features DOES NOT play a role in the salt uptake in plants?
- A. pH of the soil.
  - B. Temperature.
  - C. Light conditions.
  - D. Soil bacteria.**
17. A rare plant in a botanical garden has been infected with specific fungi that feed on sugar molecules. After careful examination, a botanist suggested the following surgical intervention to get rid of the fungi and prevent its spread to apical portions: removing the infected portion so that a ring of bark about 2 inches in height and about 1-2 cms wide is removed. This will remove the cambial cells, phloem, endodermis, cortex and epidermis of the stem. Which of the following will be a consequence of such a surgical intervention?
- A. Flow of food will be affected but flow of water upwards will be maintained.**
  - B. Flow of water upward will be lost but flow of food will be maintained.
  - C. Both flow of food and water upward will be lost
  - D. Neither the flow of food nor water movement will be affected.
18. In a bee hive, there are thousands of worker bees performing number of day-to-day activities. Genetically, the worker bees are
- A. Sterile males.
  - B. Fertile males.
  - C. Fertile females.
  - D. Sterile females.**
19. In certain plant species, red flower colour is incompletely dominant to white flower colour (the heterozygote is pink) and tall stems are completely dominant to dwarf stems. If the pink plant (TtRr) is crossed with a tall white plant (TTrr), which of the following types of plants would be produced in the offsprings?



- A. Dwarf pink and tall red.
- B. Tall pink and tall white.**
- C. Dwarf red and tall pink.
- D. Tall pink and dwarf white.

20. Consider the following characters

- I. Flowers with trimerous symmetry.
- II. Vascular bundles scattered in ground tissue.
- III. Leaves with reticulate venation.
- IV. Plant with tap root system.

The characters exhibited by monocotyledons are

- A. I and III only.
- B. III and IV only.
- C. I and II only.**
- D. II and IV only.

21. Which of the following secretions of the alimentary canal in human DO NOT contain any enzymes?

- A. Salivary Juice.
- B. Gastric juice.
- C. Bile juice.**
- D. Pancreatic juice.

22. Humans are called ureotelic animals as they excrete nitrogen primarily in the form of urea. However, urine of a healthy human being also contains traces of uric acid. The source of this waste product is:

- A. Metabolism of DNA and RNA.**
- B. Lipid metabolism.
- C. Carbohydrate metabolism.
- D. Protein metabolism.

Answer question number (23-25) based on the following passage.

A farmer is growing a crop regularly in his field. He uses chemical fertilizers, pesticides, organic manure as well as bio-fertilizers. Very close to his field is a factory which emits smoke as a by product. There is also a huge lake in the nearby area.

23. A considerable increase in plant life in the lake was noticed after the farming activity intensified. The *most likely reason* for this could be:

- A. Chemical fertilizers leached into the lake from the field.**

- B. Pesticides leached into the lake from the field.
  - C. Organic manure leached into the lake from the field.
  - D. Smoke particles from the industry got settled in moist surroundings of the lake.
24. Consider the following food chain in the same lake.  
Aquatic plant → Small fish → Big fish → Birds

Which of the above organisms is likely to show minimum amount of pesticide concentration in them after considerable time?

- A. Aquatic plants.**
  - B. Small fish.
  - C. Big fish.
  - D. Birds.
25. An expert agriculturist suggests to the farmer to minimize the use of chemical fertilizers and instead use biofertilizers as they have many advantages over chemical fertilizers. Which of the following is NOT true for biofertilizers?
- A. They are economical.
  - B. They help in reducing pollution in the lake
  - C. They are renewable
  - D. They require large set-up for their production.**
26. The density of water at room temperature is 1 g/ml (mili-litre). Consider a spherical drop of water having volume 0.05ml. The drop evaporates at a uniform rate in one hour. The number of molecules leaving the liquid surface per second is approximately
- A. Zero
  - B.  $5 \times 10^{17}$**
  - C.  $3 \times 10^{14}$
  - D.  $2 \times 10^{21}$
27. 50 ml of 0.20 M solution of washing soda reacts with one of the acids in aqua regia. One of the products is Chile saltpetre. If the strength of the acid is 0.25 M, what volume of it will be required to react with the above solution?
- A. 40 ml.
  - B. 10 ml.
  - C. 20 ml .
  - D. 80 ml.**
28. Oxides are acidic, basic or amphoteric based on their metallic or non-metallic character. Which one of the following oxides reacts with both HCl and NaOH?

- A. CaO
  - B. ZnO**
  - C. SO<sub>2</sub>
  - D. CO<sub>2</sub>
29. 1.84 g of Dolomite (CaMg(CO<sub>3</sub>)<sub>2</sub>) ore was heated resulting in a residue of constant weight 0.96 g. During heating the metal of one of the products burnt with a brick red flame and the second burnt with a dazzling white flame. The approximate percentage composition of the two products in the residue are respectively
- A. 54 and 46
  - B. 46 and 54
  - C. 42 and 58
  - D. 58 and 42**
30. Colloid consists of dispersed phase and dispersion medium. Aerosol is one type of colloid. Aerosol is made up of which of the following combination?
- I. Gas in liquid.
  - II. Liquid in gas.
  - III. Solid in gas.
- A. II only.
  - B. I, II and III.
  - C. I and II only.
  - D. II and III only.**
31. Tyndall effect can be observed in a colloidal solution. Consider light scattering in the following:
- I. When sunlight passes through the canopy of a dense forest.
  - II. When normal light passes through lead iodide solution.
  - III. When monochromatic light passes through solution of K<sub>2</sub>SO<sub>4</sub>(Al)<sub>2</sub>SO<sub>4</sub>·24H<sub>2</sub>O.
- Tyndall effect is observed in:
- A. I, II and III.
  - B. I only.**
  - C. I and III only.
  - D. III only .
32. A compound used for cleaning purpose having hydrophobic and hydrophilic ends is
- A. Sodium or potassium salt of saturated or unsaturated fatty acids.**
  - B. Triglycerides of saturated or unsaturated fatty acids.
  - C. Monoesters of saturated or unsaturated fatty acids.

D. Triglycerides of unsaturated fatty acids.

33. Hydrogenation is a reaction in which hydrogen is added to a compound. One of the applications of hydrogenation reaction is to convert unsaturated compounds into saturated ones. This reaction is applicable to which of the following compounds?

- A. Ethyl alcohol.
- B. Chloroethane.
- C. Vegetable oil.**
- D. Animal fat.

34. One of the tests used to distinguish a saturated from an unsaturated compound is bromine water test. Ethene and ethane are reacted with bromine water and the results are displayed on the table given below. From the following table choose the correct observation. **Correct Choice is C**

	Ethene	Ethane
A.	$\begin{array}{c} \text{Br} \quad \text{Br} \\   \quad   \\ \text{H}-\text{C}-\text{C}-\text{H} \\   \quad   \\ \text{H} \quad \text{H} \end{array}$ with decolourisation	$\begin{array}{c} \text{Br} \quad \text{H} \\   \quad   \\ \text{Br}-\text{C}-\text{C}-\text{H} \\   \quad   \\ \text{H} \quad \text{H} \end{array}$ with decolourisation
B.	$\begin{array}{c} \text{Br} \quad \text{H} \\   \quad   \\ \text{Br}-\text{C}-\text{C}-\text{H} \\   \quad   \\ \text{H} \quad \text{H} \end{array}$ with no decolourisation	$\begin{array}{c} \text{Br} \quad \text{Br} \\   \quad   \\ \text{H}-\text{C}-\text{C}-\text{H} \\   \quad   \\ \text{H} \quad \text{H} \end{array}$ with no decolourisation
C.	$\begin{array}{c} \text{Br} \quad \text{Br} \\   \quad   \\ \text{H}-\text{C}-\text{C}-\text{H} \\   \quad   \\ \text{H} \quad \text{H} \end{array}$ with decolourisation	no reaction
D.	no reaction	$\begin{array}{c} \text{Br} \quad \text{Br} \\   \quad   \\ \text{Br}-\text{C}-\text{C}-\text{Br} \\   \quad   \\ \text{H} \quad \text{H} \end{array}$ with decolourisation

35. Atomic number decides chemical property of an element. It also decides which group the element belongs to. Identify which of the following elements are from the same group in the periodic table.

- A. 1,3,11,19,37.**
- B. 8,24,42,74.
- C. 4,12,20,58.
- D. 5,13,27,47.

36. Riya took two containers in which chlorine and oxygen are kept under STP with both containing the same number of molecules represented by  $n$ . The molecules of oxygen gas occupy  $V$  litres and have a mass of 8 grams. Under the same conditions, the mass and volume of  $3n$  molecules of chlorine gas are respectively. **THIS QUESTION IS DROPPED**

- A. 17.75 grams and 5.6 litres.
- B. 35.5 grams and 11.2 litres.

C. 52.75 grams and 33.6 litres.

D. 26.25 grams and 8.4 litres.

37. Esha performed a simple experiment to distinguish strong from weak acid. For this she performed qualitative experiments with universal indicator, using tamarind and the acid present in gastric juice and she recorded her observations. Which of the following findings did she observe?

	Acid present in gastric juice		Acid present in tamarind	
	Strength	Colour of universal indicator	Strength	Colour of universal indicator
A	weak	Red	Strong	Red
B	weak	Yellow	Weak	Green
C	strong	Light red	Weak	Yellow
D	strong	Green	Strong	Blue

**Correct Choice is C**

38. Haber's process for the production of ammonia is an industrially important process used mainly in fertilizer industry. Due to some accident only 10% conversion took place. If all the volumes are measured in litres at STP, what volume of reactants are needed for this conversion?
- A.  $1/2$  of the total volume of hydrogen and nitrogen.  
B.  $1/5^{th}$  of the total volume of hydrogen and nitrogen.  
**C.  $1/10^{th}$  of the total volume of hydrogen and nitrogen.**  
D.  $1/5^{th}$  of the total volume of nitrogen.
39. Sugarcane plants are one of the most efficient converters of one form of energy to another form. What type of energy conversion takes place in sugarcane plant?
- A. Biochemical energy to mechanical energy.  
**B. Solar energy to chemical energy.**  
C. Chemical energy to solar energy.  
D. Solar energy to magnetic energy.
40. A solid compound X was treated with a liquid Y. During the reaction a colourless gas was evolved. The evolved gas turned lime water milky. The evolved gas when treated with acidified potassium dichromate solution turned the solution green. The aqueous solution of X gives a white precipitate when treated with barium chloride solution which is soluble in dilute HCl. Identify the anion present in compound X.
- A. carbonate.  
B. sulphate.  
**C. sulphite.**  
D. chloride

41. X is a member of alkene series with a molecular mass 28 amu. 200 cm<sup>3</sup> X is burnt in just sufficient air (containing 20 % oxygen) to form carbon dioxide and steam. If all the measurements are made at constant pressure and 100°C, find the composition of the products formed and the unreacted air.
- A. 400 cm<sup>3</sup>, 400 cm<sup>3</sup>, 600 cm<sup>3</sup> respectively.
  - B. 200 cm<sup>3</sup>, 200 cm<sup>3</sup>, 2400 cm<sup>3</sup> respectively.
  - C. 200 cm<sup>3</sup>, 400 cm<sup>3</sup>, 2400 cm<sup>3</sup> respectively.
  - D. 400 cm<sup>3</sup>, 400 cm<sup>3</sup>, 2400 cm<sup>3</sup> respectively.**
42. Thermit reaction is one of the important reactions in the metallurgical industry. This reaction is best described as:
- A. iron is displacing aluminium from its ore where iron acts as reducing agent and aluminium as oxidizing agent.
  - B. aluminium is displacing iron from its ore where iron acts as oxidizing agent and aluminium as reducing agent.**
  - C. aluminium is displacing iron from its ore where iron acts as a reducing agent and aluminium as oxidizing agent.
  - D. iron is displacing aluminium from its ore where iron acts as a oxidizing agent and aluminium as reducing agent.
43. Metals are arranged in reactivity series according to their order of reactivity. Depending upon order of metal in the reactivity series it will be extracted from its ore. Which of the following methods will be used to extract copper from its alloy cupferronickel?
- I. Electrolysis.
  - II. Reduction with Carbon.
  - III. Calcination.
  - A. I and II only.**
  - B. I, II and III.
  - C. II and III only.
  - D. I and III only.
44. A student makes the following statements concerning Bose-Einstein Condensate (BEC):
- I. It is formed at very low temperature.
  - II. It is formed at very low densities.
  - III. It was first formed by Bose and Einstein.
  - IV. It consists of ionizing super-energetic and excited particles.

The correct statements regarding BEC are

- A. I and II only.**
- B. II and III only.

- C. I and III only.  
D. I and IV only.
45. Which of the following set of elements have the strongest tendency to form anions?  
**A. N, O and P.**  
B. P, S and Cl.  
C. N, P and Cl.  
D. N, P and S.
46. Halides of sodium are soluble in water. Arrange these halides in the decreasing order of their solubility.  
A.  $\text{NaF} > \text{NaCl} > \text{NaBr} > \text{NaI}$   
**B.  $\text{NaI} > \text{NaBr} > \text{NaCl} > \text{NaF}$**   
C.  $\text{NaI} > \text{NaCl} > \text{NaBr} > \text{NaF}$   
D.  $\text{NaI} > \text{NaBr} > \text{NaF} > \text{NaCl}$
47. For a redox reaction between one mole of potassium dichromate and x moles of hydrochloric acid, products are formed out of which one product is y moles of chromyl chloride ( $\text{CrCl}_2$ ). The values of x and y are:  
A. 8 and 4 respectively.  
**B. 8 and 2 respectively.**  
C. 2 and 8 respectively.  
D. 4 and 8 respectively.
48. Rahul dropped 150 g of marble chips into 1 kg of HCl solution containing 0.1 of its weight of pure acid. The mass of marble chips that remained undissolved will approximately be:  
A. 6.50 g.  
**B. 13 g.**  
C. 26 g.  
D. 15 g.
49. Alkaline  $\text{KMnO}_4$  was added to substance A and heated. The product formed B, was isolated and reacted with another aliquot of substance A in presence of a base to form the product C. To confirm the identity of C, a qualitative test was performed which was as follows: C was reacted with a drop of dilute NaOH solution in presence of ethanol to give product D. The observations of the above reaction were:  
A. pink colour of the reaction mixture disappears and it has a fruity odour.  
**B. pink colour of the reaction mixture disappears but it does not have any characteristic odour.**  
C. pink colour of the reaction mixture persists and it has a fruity odour.

- D. pink colour of the reaction mixture persists but it does not have any characteristic odour.
50. Arrange the following elements in the increasing order of their atomic radii.
- A.  $\text{Na} < \text{Li} < \text{Rb} < \text{C} < \text{K}$   
 B.  $\text{Cs} < \text{Rb} < \text{K} < \text{Na} < \text{Li}$   
 C.  $\text{K} < \text{Rb} < \text{Cs} < \text{Na} < \text{Li}$   
**D.  $\text{Li} < \text{Na} < \text{K} < \text{Rb} < \text{Cs}$**
51. Estimate the order of magnitude of the pressure in  $\text{N/m}^2$  exerted on the Earth by an average adult human being when standing bare feet on both legs.
- A.  $10^3$   
**B.  $10^5$**   
 C.  $10^7$   
 D.  $10^9$
52. Three observers A, B and C measure the speed of light in vacuum from a source to be  $V_A$ ,  $V_B$  and  $V_C$  respectively. The observer A moves towards the source and observer C moves away from the source at the same speed. The observer B stays stationary. Consider the following expressions.
- I.  $V_A > V_B > V_C$ .  
 II.  $V_A = V_B = V_C$ .  
 III.  $V_B = (V_A + V_C)/2$   
 IV.  $V_B = \sqrt{V_A V_C}$
- The correct expressions are:
- A. I only.  
 B. I and III only.  
 C. I, and IV only.  
**D. II, III and IV only.**

53. A 2.00 kg ball and a 1.00 kg ball collide with each other. The data from their collision is shown on the table given below:

	2.00 kg ball		1.00 kg ball	
Time	$p_x$	$p_y$	$p_x$	$p_y$
Before collision	15.00	0.00	0.00	5.00
After collision	12.00	9.00	3.00	-4.00

Here  $p_x$  and  $p_y$  are  $x$  and  $y$  components respectively of linear momentum. The angle between the balls after collision is:

- A.  $150^\circ$



- B.  $120^\circ$
- C.  $90^\circ$**
- D.  $60^\circ$

54. A monkey is holding onto one end of a light rope which passes over a frictionless pulley and at the other end there is a plane mirror which has a mass equal to the mass of the monkey. At equilibrium the monkey is able to see her image in the mirror. Consider three situations:

- I. The monkey climbs up the rope.
- II. The monkey tries to push the rope down.
- III. The monkey lets go of the rope.

Under which of the above conditions does the monkey continue to see her image?

- A. I only.
- B. II only.
- C. III only.
- D. I, II and III.**

55. A lens is held directly above a pencil lying on a floor and forms an image of it. After the lens has been moved vertically a distance equal to its focal length, it forms image of equal size to the previous image. If the length of the pencil is 8 cm, the length of the image is:

- A. 8 cm.
- B. 12 cm.
- C. 16 cm.**
- D. 24 cm.

56. A steel ball is dropped from a height of 1 m on to a horizontal non-conducting surface. Every time it bounces, it reaches 80% of its previous height. Nearly by how much will the temperature of the ball rise after 4 bounces? Specific heat capacity of the ball (steel) =  $0.1 \text{ cal/g}^\circ\text{C}$ . Neglect loss in heat to the surroundings and the floor.

- A.  $0.014^\circ\text{C}$**
- B.  $0.059^\circ\text{C}$
- C.  $0.59^\circ\text{C}$
- D.  $1.4^\circ\text{C}$

57. A circular metal washer is uniformly heated. Select the correct statement.

- A. Both its external and internal diameters increase.**
- B. Its external diameter increases and internal diameter decreases.
- C. Its external diameter is unchanged and internal diameter decreases.
- D. Its external diameter increases and internal diameter is unchanged.

58. Books A and B are made from paper of the same roll. The dimensions of book B are double those of book A. Both the books are kept with their largest area flat on a horizontal table. Select the correct statement.
- Volume of book B is 6 times that of book A.
  - Pressure exerted by book B on the table is 4 times that by book A.
  - Weight of book B is 4 times that of book A.
  - None of the statements above is correct.**
59. A hot solid at temperature  $t_1$  is placed in a cool liquid at temperature  $t_2$ . Both acquire a common temperature  $t_0$ . Then:
- $t_0 = (t_1 + t_2)/2$  always.
  - $t_0 > (t_1 + t_2)/2$  if mass of solid is greater than the mass of the liquid.
  - $t_0 > (t_1 + t_2)/2$  if specific heat capacity of solid is greater than the specific heat capacity of the liquid.
  - Information provided is insufficient to draw any of the above conclusion.**
60. A 100 m sprinter increases her speed from rest uniformly at the rate of  $1 \text{ m/s}^2$  upto 40 m and covers the remaining distance with uniform speed. The sprinter covers the first half of the run in  $t_1$  s and the second half in  $t_2$  s. Then:
- $t_1 > t_2$
  - $t_1 < t_2$
  - $t_1 = t_2$
  - information given is incomplete.
61. Rain is falling vertically with a speed of  $1.7 \text{ m/s}$ . A girl is walking with speed of  $1.0 \text{ m/s}$  in the  $N - E$  (north-east) direction. To shield herself she holds her umbrella making an approximate angle  $\theta$  with the vertical in a certain direction. Then:
- $\theta = 60^\circ$  in  $N - E$  direction.
  - $\theta = 30^\circ$  in  $N - E$  direction.
  - $\theta = 60^\circ$  in  $S - W$  direction.
  - $\theta = 30^\circ$  in  $S - W$  direction.
62. The atmospheric pressure on the earth's surface is  $P_a \text{ N/m}^2$ . A table of area  $2 \text{ m}^2$  is tilted at  $45^\circ$  to the horizontal. The force on the top surface of the table due to the atmosphere is (in newtons):
- $2 P_a$
  - $\sqrt{2} P_a$
  - $2\sqrt{2} P_a$
  - $P_a/\sqrt{2}$
63. The ratio of the size of the atom to the size of the nucleus is typically:
- 10
  - $10^2$
  - $10^4$
  - $10^8$

64. A mixture of 50 g of ice and 50 g of water, both at 0°C, is kept in a calorimeter of water equivalent 22 g. 30 g of steam is slowly and uniformly passed through this mixture. Neglecting exchange of heat to the surrounding (except for the steam), final temperature of the mixture and mass of the contents (water) in the calorimeter is
- 100°C, 130 g.**
  - 0°C, 130 g.
  - 100°C, 126 g.
  - 66.7°C, 120 g.
65. In a heating experiment in which heat is supplied at a steady rate it was noted that temperature of the liquid in a beaker rose at 4 K/minute just before it began to boil and 40 minutes later all the liquid had boiled away. Numerical ratio of specific heat capacity to specific latent heat (in same system of units) for this liquid is
- 1/10
  - 1/40
  - 1/160**
  - 1/640
66. The natural voices of men, women and children are different and can be distinguished. A student makes three hypotheses
- The amplitudes of sounds emitted by them are different.
  - The vocal cords are of different sizes.
  - The vocal cords vibrate with different frequencies.
- The correct option is
- I only.
  - II only.**
  - III only.
  - I and III only.
67. On a hot, dry summer day a boy is standing between plane parallel vertical cliffs separated by 75 m. He is 30 m away from one of the cliffs. Consider speed of sound in air on that hot day to be 360 m/s. The boy claps loudly and hears its successive echoes. The time in seconds at which he hears the first four echoes are respectively:
- $\frac{1}{6}, \frac{1}{4}, \frac{5}{12}, \frac{5}{12}$
  - $\frac{1}{6}, \frac{1}{4}, \frac{7}{12}, \frac{2}{3}$
  - $\frac{1}{4}, \frac{1}{3}, \frac{5}{12}, \frac{7}{12}$
  - $\frac{1}{6}, \frac{1}{4}, \frac{1}{3}, \frac{5}{12}$

68. A load that has resistance of  $10\ \Omega$  is to be connected to a constant voltage ( $120\ \text{V}$ ) supply. Desired variation in the current through the load is from  $3\ \text{A}$  to  $5\ \text{A}$ . The resistance and current range of the rheostat should be:
- $0 - 36\ \Omega, 0 - 5\ \text{A}$
  - $14 - 24\ \Omega, 0 - 3\ \text{A}$
  - $14 - 30\ \Omega, 0 - 5\ \text{A}$**
  - $0 - 24\ \Omega, 3 - 5\ \text{A}$
69. Point charges  $q_1 = +1\ \mu\text{C}$  and  $q_2$  whose magnitude is  $64/27\ \mu\text{C}$  are fixed  $5\ \text{m}$  apart along a vertical line with  $q_1$  being at **lower** position. These two charges together are able to hold an oil drop of mass  $1\ \mu\text{g}$  and charge  $Q$  stationary when it is  $3\ \text{m}$  away from  $q_1$  and  $4\ \text{m}$  away from  $q_2$ . The sign of the charge  $q_2$  and the value of  $Q$  are respectively:
- $q_2$  is positive,  $Q = 6.25\ \text{pC}$ .
  - $q_2$  is positive,  $Q = 6\ \text{pC}$ .
  - $q_2$  is negative,  $Q = 6.25\ \text{pC}$ .
  - $q_2$  is negative,  $Q = 6\ \text{pC}$ .**

Answer question numbers 70 and 71 based on the following passage.

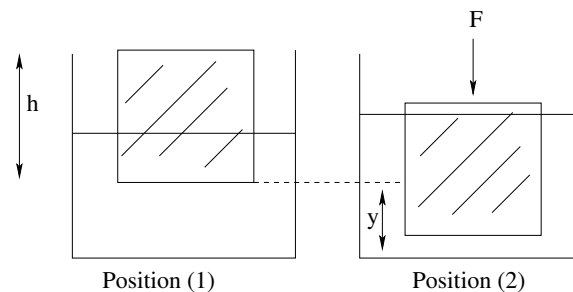


Figure: Block in a liquid

A cubical box of height  $h$  and mass  $m$  floats upright in a liquid of density  $\rho$  in position (1) as depicted in the figure. When a downward force of magnitude  $F$  is applied on the top of the block, the block moves down through a distance  $y$  with some part of the block being still above the liquid in position (2) as shown in the figure. Force  $F$  is now suddenly removed so that the block start moving up. Neglect the effect of viscosity throughout the motion.

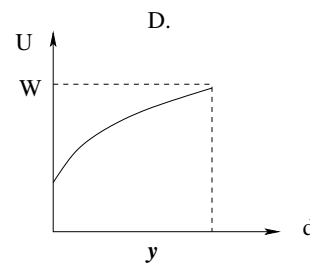
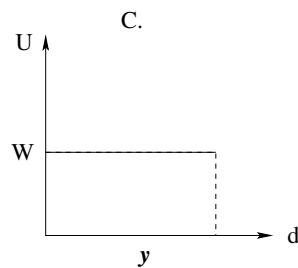
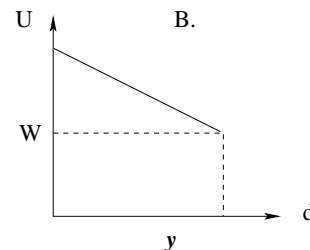
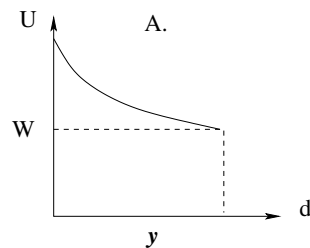
70. Consider following statements.
- At position (1), the vertical distance from surface of the liquid to the bottom of the block is  $m/h^2\rho$ .
  - After removal of force  $F$ , the upward velocity of the block continuously increases until it reaches position (1).

- III. During upward motion, after crossing position (1), the velocity of the block goes on decreasing.
- IV. During upward motion, from position (2), the velocity of the block increases **linearly** till it reaches position (1).

Which of the above statements are correct?

- A. I, II, III and IV.
- B. I, II and III only.**
- C. I and III only.
- D. I and II only.
71. Let  $W$  be the weight of the block. Upthrust ( $U$ ) experienced by the block is plotted against upward distance ( $d$ ) travelled by the block from position (2) until it reaches position (1). Select the option showing correct nature of the graph.

**Correct Choice is B**



Answer question numbers 72 and 73 based on the following information.

Solar surface radiates energy uniformly at a rate of  $4 \times 10^{26}$  W. This energy spreads or distributes uniformly and normally outwards.

72. Considering Earth and the Sun to be spherical object, the amount of radiant energy received by the Earth per second is nearly
- A. 1360 W.
- B.  $1.75 \times 10^{17}$  W.**
- C.  $3.5 \times 10^{17}$  W.
- D.  $7 \times 10^{17}$  W.

73. A solar cooker used for heating water has solar panel of effective area  $1 \text{ m}^2$ . Only 10% of the energy received by the solar panel is utilized for heating the contents. Time taken by this solar cooker to heat 1 litre of water from  $30^\circ\text{C}$  to  $80^\circ\text{C}$  is nearly
- A. 10 minutes
  - B. 15 minutes
  - C. 25 minutes**
  - D. 40 minutes
74. Astronomers have discovered a planet orbiting a nearby star. It is estimated that the mass of this planet is 16 times that of our earth and its density is one-fourth of the earth's density. Assume that planets are spheres of uniform density. If your weight on the earth is 1000 N, then your weight on this planet would be
- A. 5000 N
  - B. 1000 N**
  - C. 2000 N
  - D. 4000 N
75. The absolute refractive index of medium  $P$  is 1.5. When light is incident on an interface between medium  $P$  and medium  $Q$  at an angle of incidence of  $30^\circ$  in medium  $P$ , the angle of refraction is  $\theta$  where  $\sin \theta = 7/20$ . The speed of light in medium  $Q$  is given by
- A.  $1.4 \times 10^8 \text{ m/s}$**
  - B.  $3.0 \times 10^8 \text{ m/s}$
  - C.  $2.5 \times 10^8 \text{ m/s}$
  - D.  $2.1 \times 10^8 \text{ m/s}$

\*\*\*\*\* End of The Question Paper \*\*\*\*\*

# EXTRA SHEET FOR ROUGH WORK

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