zigyan

PREVIOUS YEAR PAPER · 2023

OLYMPIAD · STAGE I

NSEJS

National Standard Examination in Junior Science

2023

Question paper, answer key and Zigyan solutions

60	216	120 min	51
Questions	Maximum marks	Time	Paper code

Question paper and official answer key: Indian Association of Physics Teachers (IAPT), NSEJS 2023, paper code 51.
Solutions and notes: Zigyan. This booklet is not an IAPT publication.

Prepare for the Olympiads with Zigyan

www.zigyan.com

zigyan

SCO No. 107, Sector 16, Faridabad, Haryana 121002
0129-4048800 · +91 92115 38800 · info@zigyan.com

zigyan

JEE 2026 RESULTS

OUR TOPPERS

When talent meets the right guidance.

Saksham Bishnoi and Sulokya Bibhuty - our JEE 2026 toppers from Zigyan, Sector 16 - with the programme they took and the rank they earned.



Rahul Kaushik Sir
Founder & Director, Zigyan Eduvision
23 years of teaching



Saksham Bishnoi

4 YEARS CLASSROOM

JEE ADVANCED 2026	JEE MAIN 2026
AIR 168	AIR 811
	99.95 percentile



Sulokya Bibhuty

3 YEARS CLASSROOM

JEE ADVANCED 2026	JEE MAIN 2026
AIR 1,315	AIR 1,095
	99.94 percentile

OLYMPIAD RESULTS

Above the Minimum Admissible Score - the national band for the subject

CHEMISTRY

- Sulokya Bibhuty — 3 Years Classroom
- Anay Gupta — 3 Years Classroom
- Akshat Khator — 3 Years Classroom
- Harshit Goyal — 4 Years Classroom
- Hardik Sharma — 3 Years Classroom
- Aarush Kumar — 1 Year Classroom

PHYSICS

- Sulokya Bibhuty — 3 Years Classroom
- Saksham Bishnoi — 4 Years Classroom

ASTRONOMY

- Sulokya Bibhuty — 3 Years Classroom

MATHEMATICS (IOQM)

- Priyanshi — 4 Years Classroom

Saksham Bishnoi qualified the Chemistry Olympiad twice and was selected for the Orientation-cum-Selection Camp at HBCSE, Mumbai.

16 selections	16 of 35	AIR 168
in JEE Advanced 2026	students of the batch selected	best JEE Advanced rank

Start where they started.

Register for ZEST - ₹200 · www.zigyan.com/scholarship/zest

+91 92115 38800
info@zigyan.com

Given in the question paper

Physical constants you may need….

Mass of electron $m_e = 9.11\times10^{-31}$ kg	Magnitude of charge on electron $e = 1.60\times10^{-19}$ C
Mass of proton $m_p = 1.67\times10^{-27}$ kg	Planck's constant $h = 6.625\times10^{-34}$ Js
Acceleration due to gravity $g = 9.81$ ms^{-2}	Density of water at $\rho = 1.0\times10^{3}$ kg m^{-3}
Universal gravitational constant $G = 6.67\times10^{-11}$ Nm^{2}kg^{-2}	$(1+x)^n \approx 1+nx$, if $\lvert x\rvert << 1$
Universal gas constant $R = 8.31$ Jmol^{-1} K^{-1}	1 eV = 1.6×10^{-19} J
Boltzmann constant $k = 1.38\times10^{-23}$ J K^{-1}	$\sin(A-B) = \sin A\cos B - \cos A\sin B$
Avogadro's constant $A = 6.02\times10^{23}$ mol^{-1}	$E = mc^2$, It's an equation which gives mass and energy equivalence.
Atmospheric pressure (at STP) = 1.013×10^5 Nm^{-2}	One unit of electric power = 1kWh
Speed of light in free space $c = 3.0\times10^8$ ms^{-1}	

PART A-1 · ONE CORRECT OPTION

Q. 1 – 48 · +3 for a correct answer, –1 for a wrong one

1. In animals, heart is the main pumping station, supplying and collecting blood from various parts of the body. In mammals, which of the following structures regulates the unidirectional flow of blood and found between left auricle and ventricle?

(A) Tricuspid valve
(B) Aortic semilunar valve
(C) Pulmonary seminular valve
(D) Mitral valve

Solution · Q1 **Answer: (D)**

The valve between the left auricle and the left ventricle is the bicuspid valve, also called the mitral valve.

It prevents the backward flow of blood into the left auricle.

IAPT answer: (D) | **Zigyan answer:** (D)

2. Which of the following refer to the units involved in most of the Reflex Arcs?

(A) Stimulus receptor, afferent nerve, efferent nerve and an effector neuron
(B) Two receptor neurons, one or more internuncial neuron(s) and an effector neuron
(C) One receptor neuron, one or more internuncial neuron(s) and an effector neuron
(D) One receptor neuron, afferent nerve and an effector neuron

Solution · Q2 **Answer: (C)**

Most reflex arcs are polysynaptic. The path is:

Receptor neuron → internuncial neuron(s) → effector neuron

IAPT answer: (C) | **Zigyan answer:** (C)

3. Through the process of cross-breeding/mutation breeding or cytoplasmic hybridization of animals and plants, new improved, high yielding varieties or exclusively distinct hybrids are obtained. Which of the following are cytoplasmic hybrids/cybrids?

(A) Triticale & Fairchild Mule
(B) Tigon & Leopon
(C) Pomato & Bromato
(D) Jaya & Ratna Rice

Solution · Q3 **As per Zigyan: (C)**

Cytoplasmic hybridisation here means fusion of protoplasts (cells without cell walls), in which the cytoplasm of two plants mixes.

Pomato (potato and tomato) and Bromato (brinjal and tomato) are the hybrids obtained by this method.

The other pairs (Triticale and Fairchild Mule, Tigon and Leopon, Jaya and Ratna Rice) come from sexual crossing.

Reference: NCERT Biotechnology Class XII, Chapter 7 'Plant Tissue Culture': pomato, a hybrid of potato and tomato, was produced through somatic hybridisation, a method that fuses protoplasts of somatic cells.

IAPT answer: (C) | **Zigyan answer:** (C)

4. In a kind of animal tissue all cells rest on a basement membrane, but the basal cells do not reach the free surface of the epithelium. Two layers of cells and two layers of nuclei are, therefore, observable. Thus, without being stratified, the epithelium appears to have 2 or 3 layers of cells. Such epithelia are mostly ciliated and contain mucus-secreting goblet cells. These epithelia are characteristic to which of the following?

(A) Thin bronchioles, Uriniferous tubules, Ciliary body
(B) Bile ducts, lining of stomach, Trachea
(C) Skin epidermis, Anal canal, Cornea of eye
(D) Trachea, Vasa deferentia, Epididymes

Solution · Q4 **Answer: (D)**

All cells rest on the basement membrane, but some do not reach the free surface. This is pseudostratified columnar epithelium.

It lines the trachea, vasa deferentia and epididymes.

IAPT answer: (D) | **Zigyan answer:** (D)

5. Phenylthiocarbamide (PTC) has a bitter taste. Non-tasting ability is reported to be due to recessive allele of the taster gene. In random populations about 30% people lack the ability to taste PTC. A non-taster woman is married to a PTC taster man and has three children. The first two children are born as non-tasters. What is the probability that their third child will be born a non-taster?

(A) 0.25 (B) 0.50 (C) 0.15 (D) 0.75

Solution · Q5 **Answer: (B)**

Let T be the taster allele and t the non-taster allele.

The woman is a non-taster, so she is tt.

Some children are non-tasters, so the taster father also carries t. He is Tt.

Cross:

$$tt \times Tt \rightarrow Tt : tt = 1 : 1$$

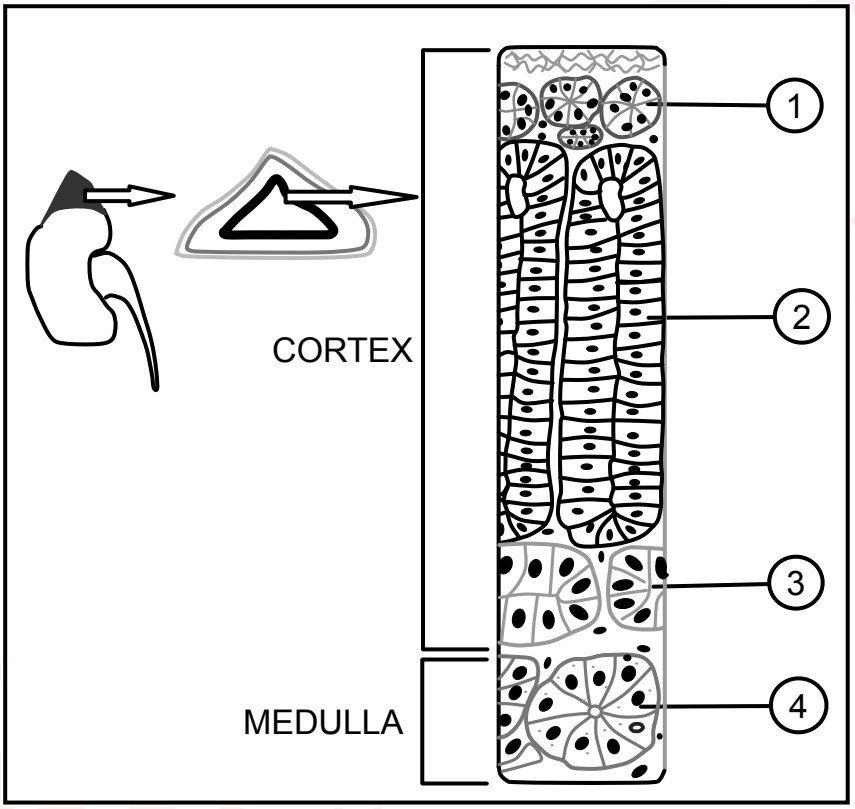
Each child is independent of the earlier children.

Probability of a non-taster child:

$$\Rightarrow 1/2 = 0.50$$

IAPT answer: (B) | **Zigyan answer:** (B)

6. The diagram presented here is a sectional view of an endocrine gland. Its histologically characteristic layers are labeled as 1, 2, 3 and 4. Which of these is/are responsible for the secretion of C_{21} Cortisol and Corticosterone hormones?



(A) 1 (B) 1 and 3 (C) 2 and 4 (D) 2 and 3

Solution · Q6 **Answer: (D)**

In the figure, the layers of the adrenal gland are:

1: zona glomerulosa, 2: zona fasciculata, 3: zona reticularis, 4: medulla.

Cortisol and corticosterone are glucocorticoids. They are secreted mainly by the zona fasciculata, and also by the zona reticularis.

∴ Layers 2 and 3.

IAPT answer: (D) | **Zigyan answer:** (D)

7. Which of the following eye defects, arises due to gradual weakening of the ciliary muscles and diminishing flexibility of the eye lens?

(A) Hyperopia (B) Presbyopia (C) Astigmatism (D) Myopia

Solution · Q7 **Answer: (B)**

With age, the ciliary muscles weaken and the eye lens loses flexibility. The eye cannot focus well on nearby objects.

This defect is presbyopia.

IAPT answer: (B) | **Zigyan answer:** (B)

8. Which of the following is an Angoumois grain moth, causing severe damage to the stored grains, like paddy or wheat?

(A) *Sitophilus* sp. (B) *Sitotroga* sp.

(C) *Gnorimoschema* sp. (D) *Plodia* sp.

Solution · Q8 **Answer: (B)**

The Angoumois grain moth is Sitotroga cerealella, a pest of stored paddy, wheat and other grains.

IAPT answer: (B) | **Zigyan answer:** (B)

9. To effect fertilization in angiosperms, pollen grains germinate on the stigma and give out pollen tubes which grow through the style and reach the ovule where the male gametes are discharged close to the egg. Suppose a brinjal plant has to produce 300 seeds in a particular fruit. How many cell divisions will be required to produce the desired fruit?

(A) 250 Meiotic divisions (B) 375 Meiotic divisions

(C) 375 Mitotic divisions (D) 300 Mitotic and 125 Meiotic divisions.

Solution · Q9 **Answer: (B)**

300 seeds need 300 eggs and 300 pollen grains.

For each egg, one meiosis is needed, as only one of the four megaspores survives.

Meiotic divisions for the eggs:

$\Rightarrow 300$

One meiosis in a pollen mother cell gives four pollen grains.

Meiotic divisions for the pollen grains:

$$\Rightarrow 300 \div 4 = 75$$

Total meiotic divisions:

$$\therefore 300 + 75 = 375$$

IAPT answer: (B) | **Zigyan answer:** (B)

10. In the Kingdom Plantae, which of the following examples is considered peculiar for the anatomical characters namely Carinal canals and Vallecular canals?

(A) *Magnolia* (B) *Gnetum* (C) *Equisetum* (D) *Lycopodium*

Solution · Q10 **Answer: (C)**

The stem of Equisetum (horsetail) has carinal canals below its ridges and vallecular canals in the cortex below its grooves.

IAPT answer: (C) | **Zigyan answer:** (C)

11. The secondary constriction on the chromosomes always has a constant position. Therefore, it can be used as marker to identify specific chromosomes. In addition to the centromere, one or more secondary constrictions can be observed in Metaphase stage chromosomes. These chromosomes are called Satellite or SAT chromosomes. In man they are usually associated with the short arm of acrocentric chromosomes. Select the correct option for such types of chromosomes

(A) 1, 10, 15, 16 and Y
(B) 13, 14, 15, 21 and 22
(C) 13, 14, 16, 18 and 21
(D) 13, 14, 18 and 22

Solution · Q11 **Answer: (B)**

In humans, the acrocentric chromosomes that carry satellites on their short arms are:

D group: 13, 14, 15

G group: 21, 22

IAPT answer: (B) | **Zigyan answer:** (B)

12. In some plants the secondary cell wall has depressions or pits. Adjacent pits are separated by the middle lamella and the primary cell wall, together forming the pit membrane. Which of the following is the thickening formed on the pit membrane by circular deposition of microfibrils?

(A) Margo (B) Torus (C) Zona occludens (D) Sclereid

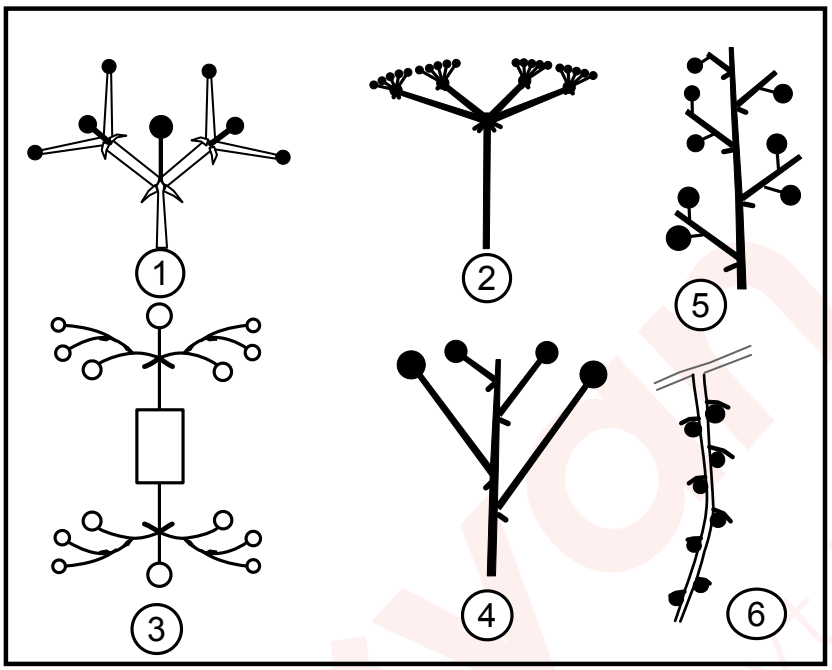
Solution · Q12 **Answer: (B)**

In a pit membrane, microfibrils laid in circles form a thickened central disc called the torus.

The thin, porous part around it is the margo.

IAPT answer: (B) | **Zigyan answer:** (B)

13. The arrangement of flowers and their mode of distribution on the shoot system is characteristic to a particular plant. The diagrammatic presentation given herewith, illustrates various types of inflorescences. Select the option exemplifying a kind of Cymose type:



(A) 2 and 4 (B) 1 and 6 (C) 1 and 3 (D) 3 and 5

Solution · Q13 **Answer: (C)**

In a cymose inflorescence the main axis ends in a flower, so its growth stops.

1 is a compound dichasial cyme.

3 is a verticillaster, made of condensed cymes at each node.

2 (compound umbel), 4 (corymb), 5 (compound raceme) and 6 (catkin) are racemose types.

∴ 1 and 3 are cymose.

IAPT answer: (C) | **Zigyan answer:** (C)

14. Genes that are normally important in mammalian embryogenesis include members of all of the following classes, EXCEPT:

(A) Proto-oncogenes (B) Growth factor genes
(C) Tumor suppressor genes (D) *Hox* genes

Solution · Q14 **As per Zigyan: no option is correct**

Proto-oncogenes and growth factor genes control cell division and growth in the embryo.

Hox genes decide the body plan.

Tumour suppressor genes are also essential:

Mouse embryos lacking both copies of the *Rb* gene cannot survive.

Mouse embryos lacking the *WT1* gene fail to form kidneys and gonads, and die.

∴ All four classes are important in mammalian embryogenesis; none is an exception.

Why Zigyan differs from IAPT: loss of a tumour suppressor gene such as *Rb* or *WT1* kills the mammalian embryo, so this class cannot be left out.

Reference: Dannenberg and others, Genes & Development, 2004 (PMC534655): loss of both copies of Rb through the germ line is lethal to mouse embryos.

Reference: Toska and Roberts, Biochemical Journal, 2014 (PMC8887836): WT1 was among the first tumour suppressor genes cloned; mice without it die as embryos, with no kidneys or gonads.

IAPT answer: (C) | **Zigyan answer:** none of the options is correct

15. During a type of Carbon dioxide fixation occurring at night while the stomata are still open, the first step is the combination of CO_2 with phosphoenolpyruvate (PEP) to form 4-carbon oxaloacetate in the chloroplast of mesophyll cells. To which kind of ecological type of plant this process is related to?

(A) *Cocos* (B) *Rhizophora* (C) *Aloe* (D) *Vallisneria*

Solution · Q15 **As per Zigyan: (C)**

CO_2 taken in and fixed at night is the CAM pathway.

Its first step, by PEP carboxylase, takes place in the cytosol of the mesophyll cells:

$PEP + HCO_3^- \rightarrow$ oxaloacetate + phosphate

CAM is typical of succulent xerophytes, which save water by keeping stomata closed in the day.

Here the succulent xerophyte is *Aloe*.

Reference: Borland and others, Trends in Plant Science, 2014 (PMC4065858): in CAM, CO_2 taken up at night is fixed by PEP carboxylase in the cytosol, and the four-carbon acids formed are stored in the vacuole.

IAPT answer: (C) | **Zigyan answer:** (C)

16. Some plants are specifically called hemiparasitic epiphytes. Included among them are the plants called as mistletoes. Which of the following is the most common hemiparasitic mistletoe occurring in India?

(A) *Monotropa uniflora* (B) *Dendrophthoe falcata*
(C) *Orobanche cernua* (D) *Cuscuta reflexa*

Solution · Q16 **Answer: (B)**

A hemiparasite makes its own food, but takes water and minerals from the host through haustoria.

Dendrophthoe falcata (family Loranthaceae) is the commonest mistletoe in India; it grows on the branches of many trees.

Monotropa and *Orobanche* have no chlorophyll, and *Cuscuta* is a twining parasite, not a mistletoe.

IAPT answer: (B) | **Zigyan answer:** (B)

17. During the formation of which of the following ionic species, the process will be exothermic and endothermic respectively:

(A) Na^+ and Cl^- (B) Cl^- and O^{2-} (C) He^+ and Mg^{2+} (D) F^- and Br^-

Solution · Q17 **Answer: (B)**

For a chlorine atom gaining an electron:

$C\ell(g) + e^- \rightarrow C\ell^-(g)$

$$\Delta H = -349 \text{ kJ mol}^{-1}$$

∴ Formation of $C\ell^-$ is exothermic.

For oxygen:

$O(g) + e^- \rightarrow O^-(g)$

$$\Delta H = -141 \text{ kJ mol}^{-1}$$

$O^-(g) + e^- \rightarrow O^{2-}(g)$

The second electron is repelled by O^-, so this step absorbs much more energy than the first step releases.

∴ Formation of O^{2-} is endothermic.

IAPT answer: (B) | **Zigyan answer:** (B)

18. H_2 reacts faster with Cl_2 at 13 times faster rate than D_2 because:

(A) H_2 has high activation energy

(B) In H_2, H – H bond energy is higher than D – D bond energy in D_2

(C) H_2 has low activation energy because H – H bond energy is lower than D – D bond energy

(D) In H_2 there is no neutron therefore it reacts faster

Solution · Q18 **Answer: (C)**

Bond energy of H–H is lower than that of D–D.

H–H: about 436 kJ mol^{-1}

D–D: about 443 kJ mol^{-1}

So the reaction of H_2 needs a lower activation energy.

Lower activation energy ⇒ faster reaction.

∴ H_2 reacts faster with $C\ell_2$ than D_2 does.

IAPT answer: (C) | **Zigyan answer:** (C)

19. Select the correct order of dielectric constant, refractive index and intermolecular forces for water (H_2O) and heavy water (D_2O) at 293 K respectively among those given below

(i) Dielectric constant – $H_2O > D_2O$

(ii) Dielectric constant – $D_2O > H_2O$

(iii) Refractive index – $H_2O > D_2O$

(iv) Refractive index – $D_2O > H_2O$

(v) Intermolecular forces – $H_2O > D_2O$

(vi) Intermolecular forces – $D_2O > H_2O$

The option containing all correct statements is

(A) (i), (iii), (vi) (B) (i), (iv), (v) (C) (ii), (iii), (v) (D) (i), (iv), (vi)

Solution · Q19 **Answer: (A)**

Dielectric constant of H_2O is slightly higher than that of D_2O.

∴ (i) is correct.

Refractive index at 293 K is about 1.333 for H_2O and 1.328 for D_2O.

∴ (iii) is correct.

D_2O has higher melting point, boiling point and viscosity, so its intermolecular forces are stronger.

∴ (vi) is correct.

IAPT answer: (A) | **Zigyan answer:** (A)

20. The compound which is used to purify air in space shuttles, submarines and breathing masks is:

(A) K_2O_2 (B) KO_2 (C) K_2O (D) Na_2O

Solution · Q20 **Answer: (B)**

Potassium superoxide removes the CO_2 breathed out and releases oxygen:

$4KO_2 + 2CO_2 \rightarrow 2K_2CO_3 + 3O_2$

It also gives oxygen with the moisture in breath:

$4KO_2 + 2H_2O \rightarrow 4KOH + 3O_2$

IAPT answer: (B) | **Zigyan answer:** (B)

21. The total number of lone pairs of electrons in I_3^-.

(A) 3 (B) 6 (C) 2 (D) 9

Solution · Q21 **Answer: (D)**

Total valence electrons in I_3^-:

$$3 \times 7 + 1 = 22$$

The two I–I bonds use 4 electrons.

Electrons left as lone pairs:

$$22 - 4 = 18$$

⇒ 9 lone pairs

(3 on each iodine atom)

IAPT answer: (D) | **Zigyan answer:** (D)

22. Among the elements of atomic number (Z) from 1 to 92 (i.e., from H to U), the elements having atomic number ..... and ..... are not found in nature.

(A) 89, 92 (B) 83, 89 (C) 48, 61 (D) None of these

Solution · Q22 **Answer: (D)**

From H to U, the elements taken as not found in nature are technetium and promethium.

Their atomic numbers are 43 and 61.

Ac (89), U (92), Bi (83) and Cd (48) are all found in natural ores.

So no listed pair is correct; the pair 43, 61 is not given.

∴ None of these.

IAPT answer: (D) | **Zigyan answer:** (D)

23. Which state of matter exists at very high temperature and at very low temperature (near absolute zero) respectively? BEC stands for Bose Einstein Condensate.

(A) BEC, fermionic condensate
(B) Plasma, BEC
(C) Fermionic condensate, Plasma
(D) Gas, BEC

Solution · Q23 **Answer: (B)**

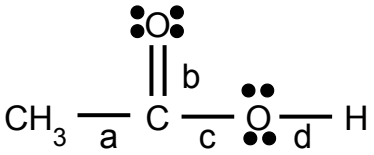
At very high temperature, atoms of a gas ionise into ions and free electrons. This state is plasma.

Near absolute zero, atoms of a very dilute gas of bosons collect in the same lowest energy state. This is the Bose Einstein Condensate.

∴ Plasma, BEC

IAPT answer: (B) | **Zigyan answer:** (B)

24. The bond which will break in first step when following compound reacts with H_3O^+ is



(A) bond a
(B) bond b
(C) bond c
(D) bond d

Solution · Q24 **As per Zigyan: (B)**

The compound is ethanoic acid.

H_3O^+ first gives H^+ to the carbonyl oxygen.

In the ion formed, the π bond of C=O opens and the positive charge is shared with carbon:

$$CH_3C(=O^+H)OH \leftrightarrow CH_3C^+(OH)_2$$

In strong acid, ionisation of the O–H bond (d) is suppressed.

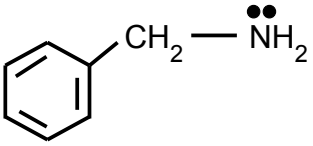
Bond c breaks only in a later step, and bond a stays intact.

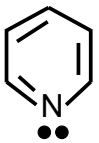
∴ Bond b is the one broken first (its π part).

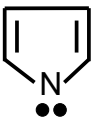
Reference: NCERT Chemistry Class XII (Part II), Unit 8 'Aldehydes, Ketones and Carboxylic Acids', section 8.9.2, mechanism of esterification: the carbonyl oxygen is protonated first; the carbon–oxygen double bond then opens as the nucleophile adds, and the carbon–hydroxyl bond is lost later, as water.

IAPT answer: (B) | **Zigyan answer:** (B)

25. Arrange the following compounds in increasing order of Lewis base strength

(i) 

(ii) 

(iii) 

The option containing correct increasing order is

(A) iii, ii, i (B) i, ii, iii (C) ii, i, iii (D) iii, i, ii

Solution · Q25 **As per Zigyan: (A)**

(iii) is pyrrole; the H atom on its N is not shown in the figure.

(iii): the N lone pair is part of the aromatic ring of six π electrons, so it is hardly free to donate.

Pyridine (ii): the lone pair is in an sp^2 orbital outside that system, so it is free.

Benzylamine (i): sp^3 N, cut off from the ring by CH_2, donates most easily.

Increasing order of Lewis base strength:

$$iii < ii < i$$

Reference: OpenStax Organic Chemistry, section 24.9 'Heterocyclic Amines': pyrrole is not basic as its N lone pair belongs to the aromatic sextet; pyridine (conjugate acid pK_a 5.25) is stronger than pyrrole but weaker than alkylamines.

Reference: NCERT Chemistry Class XII (Part II), Unit 9 'Amines', Table 9.3: pK_b of phenylmethanamine (benzylamine) is 4.70.

IAPT answer: (A) | **Zigyan answer:** (A)

26. The maximum number of $-CH_3$ groups which may be present in alkane $C_{11}H_{24}$ is close to

(A) 6 (B) 7 (C) 8 (D) 2

Solution · Q26 **Answer: (C)**

For the most CH_3 groups, the other carbon atoms should carry no H atom.

2,2,3,3,4,4-Hexamethylpentane:

$(CH_3)_3C–C(CH_3)_2–C(CH_3)_3$

Number of CH_3 groups:

$$3 + 2 + 3 = 8$$

IAPT answer: (C) | **Zigyan answer:** (C)

27. A glass bulb of 1 liter capacity contains 4 g methane. The bulb is so as to burst out if the pressure exceeds just 10 atm. The temperature, at which the pressure of gas reaches the bursting point is close to (Given: R = 0.0821 lit atm K^{-1} mol^{-1})

(A) 480 K (B) 487.6 K (C) 500 K (D) 373 K

Solution · Q27 **Answer: (B)**

Moles of methane:

$$n = \frac{4}{16} = 0.25 \text{ mol}$$

At the bursting pressure, by the ideal gas equation:

$$T = \frac{PV}{nR}$$

$$\Rightarrow T = \frac{10 \times 1}{0.25 \times 0.0821}$$

$$\Rightarrow T \approx 487.2 \text{ K}$$

The closest option is 487.6 K.

IAPT answer: (B) | **Zigyan answer:** (B)

28. The pH of 10^{-8} M HCl is

(A) 7 (B) < 7 (C) 8 (D) > 8

Solution · Q28 **Answer: (B)**

The acid is very dilute, so H^+ from water also counts (25°C).

Let the total concentration be:

$$[H^+] = x \text{ M}$$

Hydroxide ions come only from water:

$$[OH^-] = (x - 10^{-8}) \text{ M}$$

Using the ionic product of water,

$$x(x - 10^{-8}) = 10^{-14}$$

$$\Rightarrow x \approx 1.05 \times 10^{-7}$$

$$\therefore \text{pH} \approx 6.98$$

So the pH is less than 7.

IAPT answer: (B) | **Zigyan answer:** (B)

29. An element X has two natural isotopes: $^{10}_{5}X$ (atomic mass 10.013 u) and $^{11}_{5}X$ (atomic mass 11.009 u). Relative abundance of these isotopes in nature has been recorded 19.8 % and 80.2 % respectively. On the basis of these data, average atomic mass of element X is close to

(A) 10.210 u (B) 10.511 u (C) 10.799 u (D) 10.812 u

Solution · Q29 **Answer: (D)**

Average atomic mass is the weighted mean:

$$M = \frac{10.013 \times 19.8 + 11.009 \times 80.2}{100}$$

$$\Rightarrow M = 10.8118 \text{ u}$$

$$\therefore M \approx 10.812 \text{ u}$$

IAPT answer: (D) | **Zigyan answer:** (D)

30. A mass 0.75 g of the mixture of Na_2CO_3 and K_2CO_3 is completely neutralized by 50 mL 0.25 N HCl. The percentage of Na_2CO_3 in the mixture is:

(A) 50.6 (B) 49.4

(C) 50 (D) data insufficient

Solution · Q30 **As per Zigyan: (B)**

Let the mass of Na_2CO_3 be x g.

Using equivalent masses 53 for Na_2CO_3 and 69 for K_2CO_3:

$$\frac{x}{53} + \frac{0.75 - x}{69} = \frac{50 \times 0.25}{1000}$$

$$\Rightarrow 16x = 5.9625$$

$$\Rightarrow x \approx 0.3727$$

Percentage of Na_2CO_3:

$$\frac{0.3727}{0.75} \times 100 \approx 49.7$$

The nearest listed value is 49.4.

Check: 0.3727 g of Na_2CO_3 and 0.3773 g of K_2CO_3 together hold 0.00625 mol of carbonate, which needs 12.5 mmol of HCℓ, just what 50 mL of 0.25 N acid gives.

IAPT answer: (B) | **Zigyan answer:** (B)

31. A boy gifted a diamond ring to his mother on her wedding anniversary. If this diamond ring contains 3 carat diamond then number of carbon atoms he gifted to his mother is

Given – (1 carat = 200 mg)

(A) 3.01×10^{23} (B) 2.1×10^{23} (C) 3.01×10^{22} (D) 2.1×10^{22}

Solution · Q31 **Answer: (C)**

Diamond is pure carbon. Mass of carbon:

$$3 \times 200 \text{ mg} = 0.6 \text{ g}$$

Number of carbon atoms:

$$N = \frac{0.6}{12} \times 6.022 \times 10^{23}$$

$$\Rightarrow N \approx 3.01 \times 10^{22}$$

IAPT answer: (C) | **Zigyan answer:** (C)

32. Which of the following will form foam in water containing Ca^{2+} and Mg^{2+} ions?

(A) Ba-stearate (B) Na-palmitate

(C) Potassium n-dodecyl benzene sulphonate (D) All of these

Solution · Q32 **Answer: (C)**

With Ca^{2+} and Mg^{2+}, soaps such as Na-palmitate form insoluble scum instead of foam. Ba-stearate is itself insoluble.

Potassium n-dodecyl benzene sulphonate is a synthetic detergent. It does not form scum with these ions, so it gives foam.

IAPT answer: (C) | **Zigyan answer:** (C)

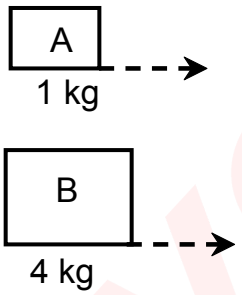
33. Two blocks A and B of masses 1 kg and 4 kg respectively are moving with equal kinetic energies

Read the following statements S_1 and S_2

Statement S_1: Ratio of speed of the block A to that of B is 1: 2

Statement S_2: Ratio of magnitude of linear momentum of A to that of B is 1: 2

Now choose the correct option:



(A) Both S_1 and S_2 are true

(B) Both S_1 and S_2 are false

(C) S_1 is true, S_2 is false

(D) S_1 is false, S_2 is true

Solution · Q33 **Answer: (D)**

Kinetic energies are equal:

$$\frac{1}{2}\times 1\times v_A^2 = \frac{1}{2}\times 4\times v_B^2$$

$$\Rightarrow v_A : v_B = 2:1$$

So S_1 is false.

Momentum in terms of kinetic energy K:

$$p = \sqrt{2mK}$$

$$\Rightarrow \frac{p_A}{p_B} = \sqrt{\frac{1}{4}}$$

$$\Rightarrow p_A : p_B = 1:2$$

So S_2 is true.

IAPT answer: (D) | **Zigyan answer:** (D)

34. The mass of a straight copper wire is 20.95 g and its electrical resistance is 0.065 Ω. If the density and resistivity of copper are d = 8900 kg/m^3 and ρ = 1.7 × 10^{-8} ohm-meter respectively, the length of the copper wire is

(A) 3 m

(B) 6 m

(C) 12 m

(D) date is insufficient

Solution · Q34 **Answer: (A)**

Resistance of the wire:

$$R = \frac{\rho l}{A}$$

From its mass and density:

$$A = \frac{m}{dl}$$

$$\Rightarrow l^2 = \frac{Rm}{\rho d}$$

$$\Rightarrow l^2 = \frac{0.065 \times 0.02095}{1.7 \times 10^{-8} \times 8900}$$

$$\Rightarrow l^2 \approx 9$$

$$\therefore l = 3 \text{ m}$$

IAPT answer: (A) | **Zigyan answer:** (A)

35. It is known that the speed of sound in a gas is directly proportional to square root of its absolute temperature T measured in Kelvin i.e. $v \propto \sqrt{T}$ Speed of sound in air at 0°C is 332 m/s. On a hot day, the speed of sound was measured 360 m/s in NCR Delhi, the temperature of air in Delhi on that very day must have been close to

(A) 40°C (B) 42°C (C) 44°C (D) 48°C

Solution · Q35 **Answer: (D)**

Speed is proportional to the square root of the Kelvin temperature:

$$\frac{360}{332} = \sqrt{\frac{T}{273}}$$

$$\Rightarrow T = 273 \times \left(\frac{360}{332}\right)^2$$

$$\Rightarrow T \approx 321 \text{ K}$$

Temperature on the Celsius scale:

$$321 - 273 = 48°C$$

IAPT answer: (D) | **Zigyan answer:** (D)

36. A small bar magnet is allowed to fall vertically through a metal ring lying in a horizontal plane. During its fall, the acceleration of the magnet in the region close to the ring must be (g is the acceleration due to gravity)

(A) equal to g (B) less than g and uniform

(C) less than g and non-uniform (D) greater than g and uniform

Solution · Q36 **Answer: (C)**

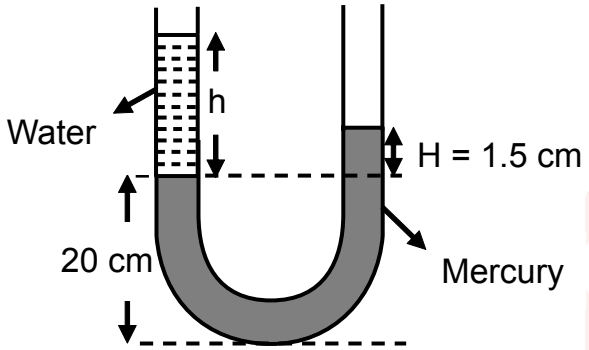
As the magnet falls, the magnetic flux through the ring changes and induces a current in it.

By Lenz's law, this current opposes the motion of the magnet, so its acceleration is less than g.

The induced current changes with the position and speed of the magnet, so the opposing force and the acceleration are not constant.

IAPT answer: (C) | **Zigyan answer:** (C)

37. A U-tube of uniform cross section contains two different liquids in its limbs namely water (density 1.0×10^3 kg / m^3) and Mercury (density 13.6×10^3 kg / m^3) as shown in figure. The difference of height of mercury column in two limbs of the tube is H = 1.5 cm. The height h of the water column in the left limb above the Mercury column must be nearly (Neglect surface tension effects)



(A) 13.6 cm (B) 20.4 cm (C) 27.0 cm (D) 9.0 cm

Solution · Q37 **Answer: (B)**

At the level of the lower mercury surface, the pressure is the same in both limbs.

$$P_0 + \rho_w g h = P_0 + \rho_m g H$$

$$\Rightarrow \rho_w h = \rho_m H$$

$$\Rightarrow (1.0 \times 10^3)h = (13.6 \times 10^3)(1.5)$$

$$\Rightarrow h = 20.4 \text{ cm}$$

IAPT answer: (B) | **Zigyan answer:** (B)

38. An object pin is placed at a distance 10 cm from first focus of a thin convex lens on its principal axis, the lens forms a real and inverted image of this object pin at a distance 40 cm beyond the second focus. The focal length of the lens is

(A) 16 cm (B) 20 cm (C) 25 cm (D) 40 cm

Solution · Q38 **Answer: (B)**

For a real image, the object is beyond the first focus and the image is beyond the second focus.

$$u = -(f + 10),\ v = f + 40$$

By the lens formula,

$$\frac{1}{f+40} + \frac{1}{f+10} = \frac{1}{f}$$

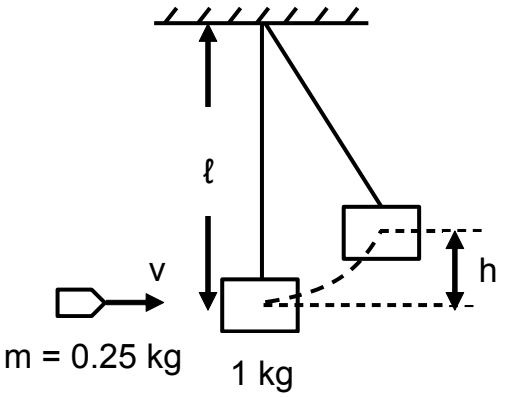
$$\Rightarrow f(2f + 50) = (f + 40)(f + 10)$$

$$\Rightarrow f^2 = 400$$

$$\Rightarrow f = 20 \text{ cm}$$

IAPT answer: (B) | **Zigyan answer:** (B)

39. A bullet of mass 0.25 kg moving horizontally with velocity v (m/s) strikes a stationary block of mass 1.00 kg suspended by a long inextensible string of negligible mass and length ℓ. The bullet gets embedded in the block and the system rises up to maximum height h = 19.6 cm (as shown in the figure. The string still remains taut). The value of initial speed v of the bullet is



(A) 5.9 m/s (B) 7.8 m/s (C) 9.8 m/s (D) 11.8 m/s

Solution · Q39 **Answer: (C)**

Using conservation of momentum in the collision,

$$0.25v = (1.00 + 0.25)V$$

$$\Rightarrow v = 5V$$

For the rise after the collision, by conservation of energy,

$$V^2 = 2gh$$

$$\Rightarrow V^2 = 2 \times 9.8 \times 0.196$$

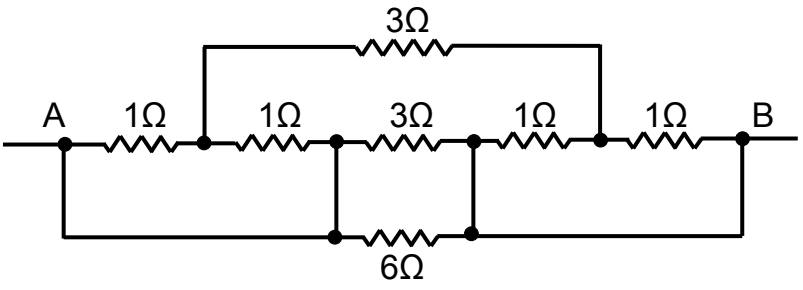
$$\Rightarrow V = 1.96 \text{ m/s}$$

$$\Rightarrow v = 5 \times 1.96$$

$$\Rightarrow v = 9.8 \text{ m/s}$$

IAPT answer: (C) | **Zigyan answer:** (C)

40. The equivalent resistance between points A and B in the following electrical network is



(A) $\frac{3}{4}\Omega$ (B) $\frac{4}{3}\Omega$

(C) $\frac{2}{5}\Omega$ (D) $\frac{9}{14}\Omega$

Solution · Q40 **Answer: (B)**

Name the junctions on the middle line, from A towards B, as P, Q, R and S.

The plain wires join Q to A and R to B.

So two 1 Ω resistors are in parallel between A and P, and the other two between S and B.

$$R_{AP} = R_{SB} = 0.5\ \Omega$$

Along the path through P and S,

$$R_1 = 0.5 + 3 + 0.5$$

$$\Rightarrow R_1 = 4\ \Omega$$

This path, the middle 3 Ω and the 6 Ω are in parallel between A and B.

$$\frac{1}{R_{eq}} = \frac{1}{4} + \frac{1}{3} + \frac{1}{6}$$

$$\Rightarrow R_{eq} = \frac{4}{3}\ \Omega$$

IAPT answer: (B) | **Zigyan answer:** (B)

41. The order of magnitude of the pressure (in pascal) exerted by an adult human on the Earth when he stands bare footed on the Earth on both of his legs, is

(A) 10^2 (B) 10^4 (C) 10^7 (D) 10^9

Solution · Q41 **Answer: (B)**

Take an adult of mass about 60 kg. Two bare feet cover about 0.03 m^2.

$$P = \frac{mg}{A}$$

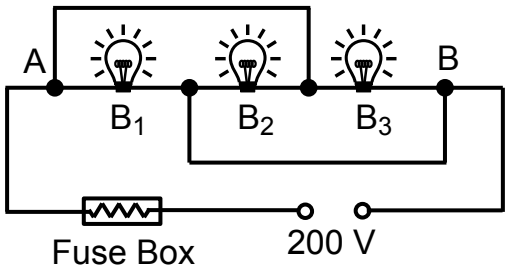
$$\Rightarrow P \approx \frac{60 \times 10}{0.03}$$

$$\Rightarrow P \approx 2 \times 10^4\ \text{Pa}$$

∴ The order of magnitude is 10^4 Pa.

IAPT answer: (B) | **Zigyan answer:** (B)

42. On the board of an experiment, three bulbs B_1 (100 W, 200 V), B_2 (60 W, 200 V) and B_3 (40 W, 200 V) are connected to a 200 V fluctuating supply with a fuse in series as shown in the figure. The electric current rating of the fuse required in the circuit to protect all the three bulbs must be



(A) 0.2 Amp (B) 0.3 Amp (C) 0.5 Amp (D) 1.0 Amp

Solution · Q42 **Answer: (D)**

A is joined to the junction between B_2 and B_3. B is joined to the junction between B_1 and B_2.

So all three bulbs are in parallel, each across 200 V.

$$I_1 = \frac{100}{200} = 0.5\ \text{A}$$

$$I_2 = 0.3 \text{ A and } I_3 = 0.2 \text{ A}$$

The fuse carries the total current.

$$I = 0.5 + 0.3 + 0.2$$

$$\Rightarrow I = 1.0 \text{ A}$$

$\therefore$ A 1.0 A fuse is required.

IAPT answer: (D) | **Zigyan answer:** (D)

43. An ant is sitting on the principal axis of a convex mirror of focal length f, at a distance 2f from the pole in front of the mirror. It starts moving on principal axis towards the mirror. During the course of motion, the distance between the ant and its image

(A) throughout increases
(B) throughout decreases
(C) first increases, then decreases
(D) first decreases, then increases

Solution · Q43 **Answer: (B)**

Let the ant be at distance x from the pole and its virtual image at distance y behind the mirror.

By the mirror formula,

$$\frac{1}{y} - \frac{1}{x} = \frac{1}{f}$$

$$\Rightarrow y = \frac{xf}{x+f}$$

Distance between the ant and its image:

$$d = x + y$$

As the ant approaches the mirror, x decreases and y also decreases.

$\therefore$ d decreases throughout the motion.

IAPT answer: (B) | **Zigyan answer:** (B)

44. You are given three resistance of values 2 Ω, 4 Ω and 6 Ω. Which of the following values of equivalent resistance is not possible to get by using/arranging these three resistors in any circuit?

(A) Less than 2 Ω (B) Equal to 4.4 Ω (C) Equal to 5.5 Ω (D) Equal to 7.6 Ω

Solution · Q44 **Answer: (D)**

All three in parallel give less than 2 Ω:

$$R = \frac{12}{11}\ \Omega$$

2 Ω in series with the parallel pair of 4 Ω and 6 Ω:

$$R = 2 + 2.4 = 4.4\ \Omega$$

4 Ω in series with the parallel pair of 2 Ω and 6 Ω:

$$R = 4 + 1.5 = 5.5\ \Omega$$

The other arrangements of all three give these values:

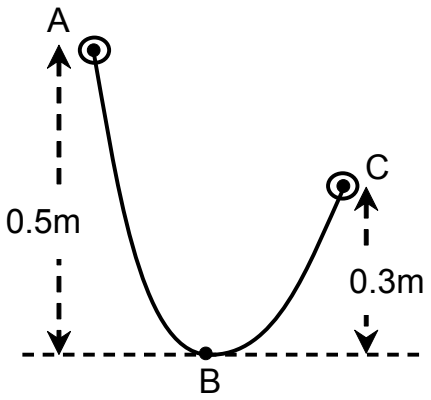
12 Ω, 7.33 Ω, 3 Ω, 2.67 Ω and 1.67 Ω

Using only one or two of them also cannot give 7.6 Ω.

$\therefore$ 7.6 Ω is not possible.

IAPT answer: (D) | **Zigyan answer:** (D)

45. ABC is a 0.8 meter long curved wire track in a vertical plane. A bead of mass 3 g is released from rest at A. It slides along the wire and comes to rest at C. The average frictional force opposing the motion in a single trip from A to C is



(A) 18.40×10^{-3} N (B) 29.4×10^{-3} N (C) 11.04×10^{-3} N (D) 7.36×10^{-3} N

Solution · Q45 **Answer: (D)**

The bead starts and ends at rest, so the loss in potential energy equals the work done against friction.

$$F \times 0.8 = mg(0.5 - 0.3)$$

Value of g used:

$$g = 9.81 \text{ m/s}^2$$

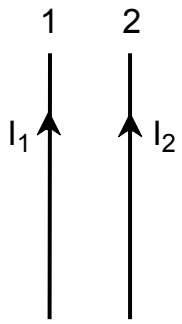
$$\Rightarrow F \times 0.8 = (3 \times 10^{-3})(9.81)(0.2)$$

$$\Rightarrow F = 7.36 \times 10^{-3} \text{ N}$$

IAPT answer: (D) | **Zigyan answer:** (D)

46. Two long straight conductors 1 and 2, carrying parallel currents I_1 and I_2 in the same direction, are lying parallel and close to each other, as shown in the figure. F_e and F_m respectively represent the electric and the magnetic forces, applied by conductor 1 on conductor 2.

Choose the correct alternative regarding nature of F_e and F_m



(A) F_e is repulsive while F_m is attractive

(B) F_e is repulsive and F_m is repulsive too

(C) F_e is zero and F_m is repulsive

(D) F_e is zero and F_m is attractive

Solution · Q46 **Answer: (D)**

A current-carrying wire has no net charge, as its positive and negative charges are equal.

$\therefore F_e$ is zero.

Parallel wires carrying currents in the same direction attract each other.

$\therefore F_m$ is attractive.

IAPT answer: (D) | **Zigyan answer:** (D)

47. A doctor measures the temperature of a patient by a digital thermometer as 37.3° C. As a Physics student you will record his temperature in Kelvin as

(A) 310.30 K (B) 310.45 K (C) 310.46 K (D) 310.31 K

Solution · Q47 **Answer: (B)**

For kelvin (T) and degree Celsius (t) readings,

$$T = t + 273.15$$

$$\Rightarrow T = 37.3 + 273.15$$

$$\Rightarrow T = 310.45 \text{ K}$$

IAPT answer: (B) | **Zigyan answer:** (B)

48. Two planets P_1 and P_2 are moving around the Sun, in circular orbits of radii 10^{13} m and 10^{12} m respectively. The ratio of the orbital speeds of planets P_1 and P_2 in their respective orbits is

(A) $\sqrt{10}$ (B) 10

(C) $10\sqrt{10}$ (D) $\frac{1}{\sqrt{10}}$

Solution · Q48 **Answer: (D)**

The Sun's gravitational force provides the centripetal force.

$$\frac{GMm}{r^2} = \frac{mv^2}{r}$$

$$\Rightarrow v = \sqrt{\frac{GM}{r}}$$

$$\therefore \frac{v_1}{v_2} = \sqrt{\frac{r_2}{r_1}}$$

$$\Rightarrow \frac{v_1}{v_2} = \sqrt{\frac{10^{12}}{10^{13}}}$$

$$\Rightarrow \frac{v_1}{v_2} = \frac{1}{\sqrt{10}}$$

IAPT answer: (D) | **Zigyan answer:** (D)

PART A-2 · ONE OR MORE CORRECT OPTIONS

Q. 49 – 60 · 6 marks only if all correct options are marked · no negative marking

49. In a classroom, students were taught typical mammalian characters along with the names of Orders and representative examples. In the Table given below, column 1 includes the names of examples or Orders whereas column 2 shows related characteristics.

Order/ Representative example	Characteristics
1. Lagomorpha	(i) First finger clawed, tail enclosed in an interfemoral membrane.
2. Microchiroptera	(ii) Toothless and Polyembryony.
3. *Armadillo*	(iii) Baleen.
4. Proboscidea	(iv) Incisors open-rooted and continue to grow throughout life.

Choose the option(s) that has the correct match in the above table.

(A) 1 → (iv) (B) 2 → (i) (C) 3 → (ii) (D) 4 → (iii)

Solution · Q49 **As per Zigyan: (A), (B)**

(A) Lagomorpha (rabbits, hares): the open-rooted incisors keep growing. ∴ correct.

(B) Microchiroptera (small bats): only the first finger is clawed, and the tail is enclosed in the interfemoral membrane. ∴ correct.

(C) Armadillos show polyembryony, but they have small peg-like teeth, so they are not toothless. ∴ wrong match.

(D) Baleen belongs to whales, not to Proboscidea (elephants). ∴ wrong match.

Reference: Animal Diversity Web (University of Michigan Museum of Zoology), account of Dasypus novemcinctus: the nine-banded armadillo has 28 to 32 small, peg-like teeth, and its polyembryony usually gives four identical young.

IAPT answer: (A), (B) | **Zigyan answer:** (A), (B)

50. Continuous inheritance of some characteristics in certain human families had attracted the attention of scientists. To improve human race by selective breeding led Sir Francis Galton to collect and statistically analyze genealogies or pedigrees of a number of families where some or the other traits were regularly transmitted through generations. Which of the following relate(s) to pedigree of beggars and scoundrels?

(A) Bach family of Germany
(B) Zero family of Switzerland
(C) Kallikaks of America
(D) Jukes of New York

Solution · Q50 **Answer: (B), (D)**

Zero family of Switzerland: generations of vagrants and beggars.

Jukes of New York: a family record of crime and pauperism.

Bach family: known for musical talent.

Kallikaks: studied for the inheritance of "feeble-mindedness".

∴ (B) and (D) are correct.

IAPT answer: (B), (D) | **Zigyan answer:** (B), (D)

51. An important feature of plants is the ability to adapt their growth towards or away from external stimuli such as light, water, temperature and gravity. The physiological process of root gravitropism comprises gravity perception, signal transmission, growth response and the reestablishment of normal growth. Following are some of the modern concept(s) explaining the mechanism of root gravitropism. Which of the following best explain(s) the root gravitropism ?

(A) Statoliths within columella cells of root cap sediment in the direction of gravity, resulting in the generation of a signal that causes asymmetric growth.
(B) Auxin influx and efflux carriers facilitate creation of a differential auxin gradient between the upper and lower side of gravi-stimulated roots. This causes differential growth responses in the gravi-responding tissue of the elongation zone, leading to root curvature.
(C) Curvature in geo-stimulated roots is due the lateral redistribution of an inhibitor formed in the root cap.
(D) Proplastids in root cap containg carotenoids and protochlorophyll respond to gravity.

Solution · Q51 **As per Zigyan: (A), (B), (C)**

(A) Starch statoliths in columella cells settle under gravity and start the signal. ∴ correct.

(B) Auxin carriers (AUX1, PIN) send more auxin to the lower side. The elongation zone grows slower there, so the root bends down. ∴ correct.

(C) In the root-cap inhibitor model, the inhibitor shifts sideways to the lower side and slows growth there. ∴ correct.

(D) The gravity sensors are starch-filled amyloplasts, not these proplastids. ∴ wrong.

Reference: OpenStax Biology 2e, section 30.6 'Plant Sensory Systems and Responses': when statoliths (amyloplasts, found in root-cap cells) settle, IAA is moved to the lower side. In roots, much IAA stops cells there from elongating fully.

Reference: Muthert and others, Frontiers in Plant Science, 2020, 'Root Tropisms', section 'Gravitropism': PIN3 and PIN7 in root-cap cells set up unequal auxin, which AUX1 helps to carry towards the elongation zone.

IAPT answer: (A), (B), (C) | **Zigyan answer:** (A), (B), (C)

52. Photosynthesis is the process in which the phosphorylation of ADP to generate ATP occurs with the help of sunlight energy. The process is known as photo-phosphorylation. Only two sources of energy are accessible to living organisms: sunlight and reduction-oxidation (redox) reactions. Following are the requirements of cyclic and noncyclic phosphorylations occurring in green plants. Choose the correct option(s) related to cyclic photo-phosphorylation:

(A) Photo system II is not involved

(B) Only ATP molecules are generated but no NADH

(C) Water is required

(D) P 680 is the active reaction center

Solution · Q52 **Answer: (A), (B)**

In cyclic photophosphorylation only PS I works, with reaction centre P700.

(A) PS II is not involved. ∴ correct.

(B) The electron returns to P700, so only ATP is made; no reduced coenzyme (NADH or NADPH) forms. ∴ correct.

(C), (D) Water is not split, and P680 belongs to PS II. ∴ wrong.

IAPT answer: (A), (B) | **Zigyan answer:** (A), (B)

53. Select the correct statement(s) pertaining to Bohr model of an atom.

(A) An electron near the nucleus is attracted more by the nucleus; thereby has lower potential energy.

(B) An electron continuously radiates energy as long as it revolves in a discrete orbit.

(C) The model could not explain the spectra of multi-electron atoms.

(D) This is the first atomic model based on quantization of energy.

Solution · Q53 **Answer: (A), (C), (D)**

(A) Potential energy of the electron:

$$U = -\frac{kZe^2}{r}$$

A smaller r makes U more negative (lower). ∴ true.

(B) No energy is radiated in a stationary orbit. ∴ false.

(C) The model works only for one-electron species such as H and He^+. ∴ true.

(D) Bohr's was the first atomic model to use quantisation. ∴ true.

IAPT answer: (A), (C), (D) | **Zigyan answer:** (A), (C), (D)

54. The correct order(s) of first ionization energy for the following pairs is/are:

(A) Ag < Au (B) Pd < Pt (C) Pb > Sn (D) Sb > Bi

Solution · Q54 **Answer: (A), (B), (C), (D)**

First ionisation energies (eV):

Ag (7.58) < Au (9.23)

Pd (8.34) < Pt (8.96)

Pb (7.42) > Sn (7.34)

Sb (8.61) > Bi (7.29)

In Au, Pt and Pb the 4f electrons shield poorly, so the outer electrons are held more tightly.

From Sb to Bi the usual fall down the group is seen.

∴ All four orders are correct.

IAPT answer: (A), (B), (C), (D) | **Zigyan answer:** (A), (B), (C), (D)

55. Every solvent undergoes self-ionization (autodissociation) and gives cations and anions. The substances which give solvent **cations** when dissolved in that particular solvent (or) increase the concentration of solvent cations are called acids. Similarly substances which give solvent **anions** when dissolved in that particular solvent (or) increase the concentration of solvent anion are called bases. Autoionisation of H_2O and H_2SO_4 are as below

$2H_2O \rightleftharpoons H_3O^+ + OH^-$

$2H_2SO_4 \rightleftharpoons H_3SO_4^+ + HSO_4^-$

(A) CH_3COOH acts as a strong acid in liquid NH_3 solvent

(B) H_2SO_4 acts as strong acid in H_2O and liquid NH_3 solvent

(C) CH_3COOH acts as base in liquid HCl

(D) H_2O acts as base in liquid NH_3 solvent

Solution · Q55 **Answer: (A), (B), (C)**

(A) In liquid ammonia:

$CH_3COOH + NH_3 \rightarrow NH_4^+ + CH_3COO^-$

The basic solvent makes it a strong acid. ∴ true.

(B) With each solvent:

$H_2SO_4 + H_2O \rightarrow H_3O^+ + HSO_4^-$

$H_2SO_4 + NH_3 \rightarrow NH_4^+ + HSO_4^-$

Solvent cations form. ∴ true.

(C) In liquid HCℓ:

$CH_3COOH + HC\ell \rightarrow CH_3COOH_2^+ + C\ell^-$

It gives the solvent anion. ∴ true.

(D) In liquid ammonia:

$H_2O + NH_3 \rightarrow NH_4^+ + OH^-$

It gives the solvent cation, so water is an acid here. ∴ false.

IAPT answer: (A), (B), (C) | **Zigyan answer:** (A), (B), (C)

56. The reaction $KI + I_2 \rightarrow KI_3$ involves

(A) oxidation
(B) reduction
(C) complex formation
(D) neutralization

Solution · Q56 **As per Zigyan: (C)**

$I^- + I_2 \rightleftharpoons I_3^-$

I^- shares a lone pair with I_2 (coordinate bond) and forms the complex ion I_3^-.

No electron is transferred, so there is no oxidation or reduction.

No acid and base form a salt and water, so it is not neutralisation.

∴ Only complex formation.

Why Zigyan differs from IAPT: −1/3 is only an average over three iodine atoms and does not show that electrons moved. By such averaging, forming the mixed oxide Fe_3O_4 from FeO and Fe_2O_3 would also become redox.

Reference: NCERT Chemistry Class XI (Part II), Unit 7 'Redox Reactions', section 7.3.1, 'The Paradox of Fractional Oxidation Number': for C_3O_2, Br_3O_8 and $S_4O_6^{2-}$, structures show the fraction is only an average of whole-number states; Fe_3O_4 is named as a mixed oxide.

IAPT answer: (A), (B), (C) | **Zigyan answer:** (C)

57. Crane A and crane B take 1 minute and 2 minute respectively to lift a car of mass 2 ton (2000 kg) upward through a vertical height h = 3 meter. If the efficiencies of the engines (defined as the ratio of work output to fuel energy input) of both the cranes are equal, your inference is that

(A) the power supplied by crane B is 1000 kW
(B) the crane A and the crane B consume equal amount of fuel
(C) the power supplied by crane A is more than the power supplied by crane B
(D) the crane A consumes more fuel in lifting the car than the crane B

Solution · Q57 **Answer: (B), (C)**

Work done by each crane:

$$W = mgh$$

$$\Rightarrow W = 2000 \times 9.8 \times 3$$

$$\Rightarrow W = 58800 \text{ J}$$

Equal work and equal efficiency need equal fuel. ∴ (B) true, (D) false.

Output power:

$$P_A = \frac{58800}{60}$$

$$\Rightarrow P_A = 980 \text{ W}$$

$$P_B = \frac{58800}{120}$$

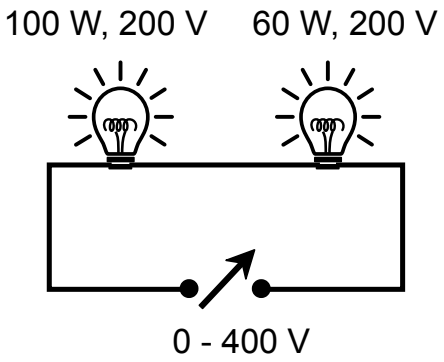
$$\Rightarrow P_B = 490 \text{ W}$$

A is more powerful, so (C) is true.

B's power is nowhere near 1000 kW, so (A) is false.

IAPT answer: (B), (C) | **Zigyan answer:** (B), (C)

58. Two tungsten filament bulbs with rating 100 watt, 200 volt and 60 watt, 200 volt are connected in series with a variable supply of 0 – 400V range, as shown. The supply voltage is gradually increased from 0 to 400 V. Choose the correct statement(s).



(A) When supply voltage is 200 volt, 60 W bulb glows brighter

(B) When supply voltage is 200 volt, total power dissipated in both the bulbs is greater than 37.5 W

(C) When the supply voltage is 400 V, the 100 W bulb gets fused

(D) When supply voltage becomes 400 V, none of the bulbs glow

Solution · Q58 **Answer: (A), (B), (D)**

Rated resistances:

$$R_{100} = \frac{200^2}{100}$$

$$\Rightarrow R_{100} = 400\ \Omega$$

$$R_{60} = \frac{200^2}{60}$$

$$\Rightarrow R_{60} \approx 666.7\ \Omega$$

(A) Same current, and the 60 W bulb has more resistance. ∴ true.

(B) At 200 V both filaments are below rating: cooler, with less resistance. So the current and power exceed the rated-resistance value:

$$P > \frac{200^2}{400 + 666.7}$$

$$\Rightarrow P > 37.5\ W$$

∴ true.

(C), (D) At 400 V the 60 W bulb gets about 250 V, more than its rating. Taking that it then fuses, the circuit breaks.

∴ (D) true, (C) false.

IAPT answer: (A), (B), (D) | **Zigyan answer:** (A), (B), (D)

59. A solid sphere of radius R = 10 cm floats in water with 60% of its volume submerged. In an oil, this sphere floats with 80% of its volume submerged. If the density of water is 1000 kg/m^3. The correct statement(s) is/are that

(A) the density of the material of sphere is 600 kg/m^3

(B) the density of the oil is 750 kg/m^3

(C) the weight of the sphere in air is close to 24.64 N

(D) the loss in weight of the sphere when floating in oil is close to 30.82 N

Solution · Q59 **Answer: (A), (B), (C)**

For a floating body, weight equals buoyant force.

In water:

$$\rho = 0.60 \times 1000$$

$$\Rightarrow \rho = 600 \text{ kg/m}^3$$

In oil:

$$\rho_o = \frac{600}{0.80}$$

$$\Rightarrow \rho_o = 750 \text{ kg/m}^3$$

Taking g as 9.8 m/s^2 and π as 22/7:

$$W = 600 \times \frac{4}{3} \times \frac{22}{7} \times (0.1)^3 \times 9.8$$

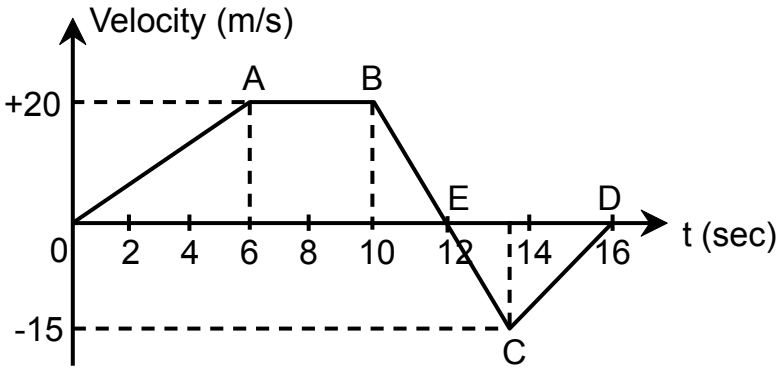
$$\Rightarrow W \approx 24.64 \text{ N}$$

∴ (A), (B), (C) are true.

(D) While floating, the loss in weight equals the full weight, 24.64 N. ∴ false.

IAPT answer: (A), (B), (C) | **Zigyan answer:** (A), (B), (C)

60. A particle starts moving from origin O along x axis. The velocity-time graph of motion of particle is given below. The positive values of v refer to direction of motion along +x axis, the negative values of v refer to direction of motion along – x direction. Choose the correct statement(s).



(A) Initial acceleration of the particle is 4 m/s^2

(B) The displacement of particle from origin is 130 m after 16 second

(C) Average speed of the moving particle during 0 –16 second is 11.88 m/s

(D) Somewhere during the motion for 0 – 16 second, the retardation of the particle is 10 m/s^2

Solution · Q60 **Answer: (B), (C), (D)**

(A) Initial acceleration:

$$a = \frac{20}{6}$$

$$\Rightarrow a \approx 3.33 \text{ m/s}^2$$

$\therefore$ false.

(B) Areas above and below the time axis:

$$S_1 = \frac{1}{2}(4 + 12) \times 20$$

$$\Rightarrow S_1 = 160 \text{ m}$$

$$S_2 = \frac{1}{2} \times 4 \times 15$$

$$\Rightarrow S_2 = 30 \text{ m}$$

Displacement:

$$s = 160 - 30$$

$$\Rightarrow s = 130 \text{ m}$$

$\therefore$ true.

(C) Average speed:

$$v_{av} = \frac{160 + 30}{16}$$

$$\Rightarrow v_{av} \approx 11.88 \text{ m/s}$$

$\therefore$ true.

(D) From B to E:

$$a = \frac{0 - 20}{2}$$

$$\Rightarrow a = -10 \text{ m/s}^2$$

$\therefore$ true.

IAPT answer: (B), (C), (D) | **Zigyan answer:** (B), (C), (D)

zigyan Eduvision Pvt Ltd

ANSWER KEY

NSEJS 2023 · PAPER CODE 51

60
QUESTIONS · 216 MARKS

IAPT final answer key for paper code 51. ★ marks an answer given as per Zigyan.

1	(D)	2	(C)	3	(C)★	4	(D)	5	(B)
6	(D)	7	(B)	8	(B)	9	(B)	10	(C)
11	(B)	12	(B)	13	(C)	14	—★	15	(C)★
16	(B)	17	(B)	18	(C)	19	(A)	20	(B)
21	(D)	22	(D)	23	(B)	24	(B)★	25	(A)★
26	(C)	27	(B)	28	(B)	29	(D)	30	(B)★
31	(C)	32	(C)	33	(D)	34	(A)	35	(D)
36	(C)	37	(B)	38	(B)	39	(C)	40	(B)
41	(B)	42	(D)	43	(B)	44	(D)	45	(D)
46	(D)	47	(B)	48	(D)	49	(A), (B)★	50	(B), (D)
51	(A), (B), (C)★	52	(A), (B)	53	(A), (C), (D)	54	(A), (B), (C), (D)	55	(A), (B), (C)
56	(C)★	57	(B), (C)	58	(A), (B), (D)	59	(A), (B), (C)	60	(B), (C), (D)

★ Answers as per Zigyan

- **Q3** — As per Zigyan: (C); IAPT key (C).
- **Q14** — As per Zigyan: no option is correct; IAPT key (C).
- **Q15** — As per Zigyan: (C); IAPT key (C).
- **Q24** — As per Zigyan: (B); IAPT key (B).
- **Q25** — As per Zigyan: (A); IAPT key (A).
- **Q30** — As per Zigyan: (B); IAPT key (B).
- **Q49** — As per Zigyan: (A), (B); IAPT key (A), (B).
- **Q51** — As per Zigyan: (A), (B), (C); IAPT key (A), (B), (C).
- **Q56** — As per Zigyan: (C); IAPT key (A), (B), (C).

zigyan

OLYMPIADS · 2026

Olympiad results



TOP ACHIEVEMENT · CHEMISTRY

Qualified the Chemistry Olympiad twice, and selected for the HBCSE camp.

Saksham Bishnoi reached the national stage of the Chemistry Olympiad in two consecutive years and was selected for the Orientation-cum-Selection Camp at HBCSE, Mumbai. 4 Years Classroom - the same student who took AIR 168 in JEE Advanced 2026.

Qualified twice | HBCSE selection camp | Only student from Faridabad

Above MAS means above the **Minimum Admissible Score**: clearing it puts a student in the national band for their subject. It is a real threshold, not a participation marker.

CHEMISTRY · ABOVE MAS



Sulokya Bibhuty
Class XII
3 Years Classroom
Above MAS



Anay Gupta
Class XI
3 Years Classroom
Above MAS



Akshat Khator
Class XI
3 Years Classroom
Above MAS



Harshit Goyal
Class XII
4 Years Classroom
Above MAS



Hardik Sharma
Class XI
3 Years Classroom
Above MAS



Aarush Kumar
Class XII
1 Year Classroom
Above MAS

PHYSICS · ASTRONOMY · MATHEMATICS

PHYSICS



Sulokya Bibhuty
Class XII
3 Years Classroom
Above MAS

PHYSICS



Saksham Bishnoi
Class XII
4 Years Classroom
Above MAS

ASTRONOMY



Sulokya Bibhuty
Class XI
3 Years Classroom
Above MAS

MATHEMATICS · IOQM



Priyanshi
Class XI
4 Years Classroom
IOQM Qualifier

OLYMPIADS WE PREPARE STUDENTS FOR

NSEP	NSEC	NSEB	NSEA	IOQM	NSEJS
Physics	Chemistry	Biology	Astronomy	Mathematics	Class X and below

The olympiad pathway starts in Class 8.

NSEJS is open to Class 10 and below - the habit of staying with one hard problem is the one JEE Advanced rewards.

Zigyan Eduvision Pvt. Ltd. · SCO No. 107, Sector 16, Faridabad 121002
0129-4048800 · +91 92115 38800 · info@zigyan.com

zigyan

RESULTS · 2021 – 2026

Our toppers, year by year

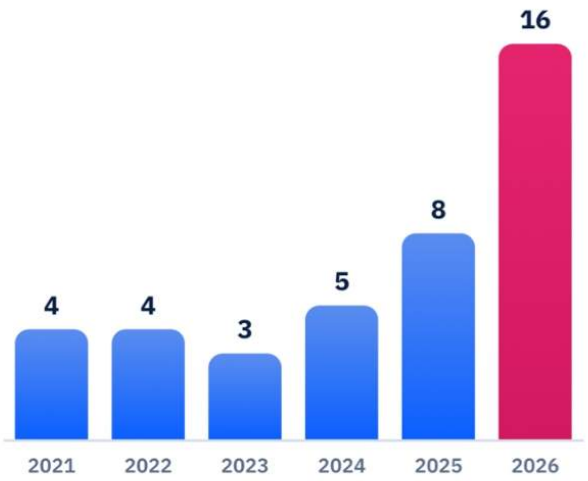
40
JEE Advanced selections in 6 years

AIR 168
best rank — Saksham Bishnoi, 2026

16 of 35
students selected, JEE Advanced 2026

14 of 35
above 98 percentile, JEE Main 2026

JEE ADVANCED SELECTIONS PER YEAR



BEST RANK EACH YEAR

YEAR	JEE ADVANCED	JEE MAIN
2026	**Saksham Bishnoi** AIR 168 · 4 Years Classroom	**Saksham Bishnoi** AIR 811 · 99.95 %ile
2025	**Chakshu** AIR 4,233 · 2 Years Classroom	**Chakshu** AIR 8,538 · 99.44 %ile
2024	**Harshit** AIR 777 · 2 Years Classroom	**Harshit** AIR 1,473 · 99.91 %ile
2023	**Aditya Jain** AIR 2,373 · 2 Years Classroom	**Aditya Jain** AIR 2,503 · 99.79 %ile
2022	**Rachit Sharma** AIR 698 · 1 Year Classroom	**Rachit Sharma** AIR 1,016 · 99.90 %ile
2021	**Sparsh Mittal** AIR 2,237 · 1 Year Classroom	**Sparsh Mittal** AIR 1,562

JEE ADVANCED 2026 — THIRTEEN NAMED SELECTIONS



Saksham Bishnoi
AIR 168
4 Years Classroom



Sulokya Bibhuty
AIR 1,315
3 Years Classroom



Aarush
AIR 2,699
1 Year Classroom



Manishka
AIR 2,869
4 Years Classroom



Oojit Kumar
AIR 5,765
4 Years Classroom



Harshit Goyal
AIR 6,407
4 Years Classroom



Pranab Sharma
AIR 6,750
3 Years Classroom



Aditya Dhar
AIR 15,183
3 Years Classroom



Arpit Anshuman
AIR 19,308
4 Years Classroom



Lokesh
AIR 22,857
3 Years Classroom



Arjun
AIR 24,674
3 Years Classroom



Sanyam Gulyani
AIR 25,123
1 Year Classroom



Saket
AIR 27,628
3 Years Classroom

Sixteen students of the 2026 batch were selected in JEE Advanced; the thirteen above are named with their All India Rank.

JEE MAIN 2026 — TOP SIX, WITH PERCENTILE



Saksham Bishnoi
AIR 811
99.95 %ile
4 Years Classroom



Sulokya Bibhuty
AIR 1,095
99.94 %ile
3 Years Classroom



Harshit Goyal
AIR 2,662
99.83 %ile
4 Years Classroom



Manishka
AIR 4,817
99.70 %ile
4 Years Classroom



Oojit Kumar
AIR 5,040
99.69 %ile
4 Years Classroom



Aarush
AIR 5,276
99.67 %ile
1 Year Classroom

14 of the 35 students in the 2026 batch scored above the 98th percentile in JEE Main.

Zigyan Eduvision Pvt. Ltd. · SCO No. 107, Sector 16, Faridabad 121002
0129-4048800 · +91 92115 38800 · info@zigyan.com