zigyan

PREVIOUS YEAR PAPER · 2020-21

OLYMPIAD · STAGE I

# IOQJS

## Indian Olympiad Qualifier in Junior Science (Part I)

# 2020-21

Question paper, answer key and Zigyan solutions

| 32 | 120 | 60 min | 51 |
|---|---|---|---|
| Questions | Maximum marks | Time | Paper code |

Question paper and official answer key: Indian Association of Physics Teachers (IAPT), IOQJS 2020-21, paper code 51.
Solutions and notes: Zigyan. This booklet is not an IAPT publication.

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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 |

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**Given in the question paper**

| Some useful physical constants and useful data | | |
|---|---|---|
| Physical Constant | Symbol | Magnitude with SI units |
| Gravitation Constant | $G$ | $6.67\times10^{-11}$ $Nm^2/kg^2$ |
| Solar mass | $M_\odot$ | $2\times10^{30}$ kg |
| Acceleration due to gravity on earth | $g$ | 9.8 $ms^{-2}$ |
| Charge of an electron | $e$ | $1.6 \times 10^{-19}$ C |
| Mass of an electron | $m$ | $9.1 \times 10^{-31}$ kg |
| 1 eV = $1.6 \times 10^{-19}$ J | | |
| An α particle is a doubly ionized He atom | | |

## PART A-1 · ONE CORRECT OPTION

**Q. 1 – 24 · +3 for a correct answer, –1 for a wrong one**

**1.** Gravitational collapse is the contraction of an astronomical object under its own gravity. This draws the matter inwards towards the centre of gravity. A neutron star is an example of the collapsed core of a giant star. A certain neutron star of radius 10 km is of mass 1.5 $M_\odot$. The acceleration due to gravity on the surface of the neutron star is nearly

(A) $2.0 \times 10^8$ m/s$^2$ (B) $2.0 \times 10^{12}$ m/s$^2$

(C) $2.6 \times 10^{16}$ m/s$^2$ (D) $2.6 \times 10^{20}$ m/s$^2$

**Solution · Q1** **Answer: (B)**

Mass and radius of the star:

$$M = 1.5 \times 2 \times 10^{30} = 3 \times 10^{30} \text{ kg}$$

$$R = 10^4 \text{ m}$$

$$g = \frac{GM}{R^2}$$

$$\Rightarrow g = \frac{6.67 \times 10^{-11} \times 3 \times 10^{30}}{\left(10^4\right)^2}$$

$$\Rightarrow g \approx 2.0 \times 10^{12} \text{ m/s}^2$$

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

**2.** The tympanic membrane (ear drum) is a very delicate component of the human ear. Typically, its diameter is 1 cm. The maximum force the ear can withstand is 2.5 N. In case a diver has to enter sea water of density 1.05 X $10^3$ kg/m$^3$ without any protective gear, the maximum safe depth for the diver to go into water is about

(A) 12 m (B) 9 m (C) 3 m (D) 1.5 m

**Solution · Q2** **Answer: (C)**

Air pressure acts on both sides of the ear drum, so only the water pressure gives the net force.

$$F = h\rho gA$$

Area of the ear drum:

$$A = \pi \times (0.5 \times 10^{-2})^2 = 7.85 \times 10^{-5}\ m^2$$

$$h = \frac{2.5}{1.05 \times 10^3 \times 9.8 \times 7.85 \times 10^{-5}}$$

$$\Rightarrow h \approx 3.1\ m$$

The safe depth is about 3 m.

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

**3.** Two illuminated point objects $O_1$ and $O_2$ are placed at a distance 24 cm from each other along the principal axis of a thin convex lens of focal length 9 cm such that images of both the objects are formed at the same position. Then the respective distances of the lens from $O_1$ and $O_2$ (in cm) are

(A) 12 and 12 (B) 18 and 6 (C) 14 and 10 (D) 16 and 8

**Solution · Q3** **Answer: (B)**

The lens lies between the objects, so one image is real and the other is virtual.

Take the image of $O_1$ as real. Let $O_1$ be x cm from the lens, and the common image v cm from the lens on the side of $O_2$.

For $O_1$ (real image):

$$\frac{1}{v} + \frac{1}{x} = \frac{1}{9}$$

For $O_2$ (virtual image):

$$-\frac{1}{v} + \frac{1}{24 - x} = \frac{1}{9}$$

Adding the two,

$$\frac{1}{x} + \frac{1}{24 - x} = \frac{2}{9}$$

$$\Rightarrow x^2 - 24x + 108 = 0$$

$$\Rightarrow x = 18 \text{ or } 6$$

A real image needs x to be more than 9 cm. So the distances of $O_1$ and $O_2$ are 18 cm and 6 cm.

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

**4.** A nuclear reactor is working at 30% efficiency (i.e. conversion of nuclear energy to electrical energy). In this reactor $^{235}_{92}U$ nucleus undergoes fission and releases 200 MeV energy per atom. If 1000 kW of electrical power is obtained in this reactor, then the number of atoms disintegrated (undergone fission) per second in the reactor is

(A) $1.04 \times 10^{17}$ (B) $6.5 \times 10^{12}$ (C) $3.125 \times 10^{12}$ (D) $3.25 \times 10^{32}$

**Solution · Q4** **Answer: (A)**

Nuclear power needed:

$$P = \frac{10^6}{0.30}\ W$$

Energy released in one fission:

$$E = 200 \times 10^6 \times 1.6 \times 10^{-19} = 3.2 \times 10^{-11}\ J$$

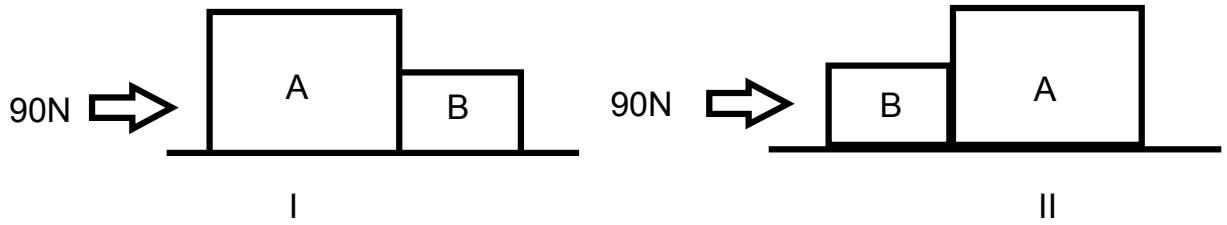
Number of fissions per second:

$$N = \frac{P}{E} = \frac{10^6}{0.30 \times 3.2 \times 10^{-11}}$$

$$\Rightarrow N \approx 1.04 \times 10^{17}$$

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

**5.** Two blocks A and B are in contact with each other and are placed on a frictionless horizontal surface. A force of 90N is applied horizontally on block A (situation I) and the same force is applied horizontally on block B (situation II). Mass of A is 20 kg and B is 10 kg. Then the correct statement is




(A) Since both the blocks are in contact, magnitude of force by block A on B will be 90 N (situation I) and magnitude of force by block B on A will also be 90 N (situation II).

(B) Magnitude of force by block A on B is 30 N (situation I) and magnitude of force by block B on A is 60 N (situation II).

(C) Magnitude of force by block A on B is 60 N (situation I) and magnitude of force by block B on A is 30 N (situation II).

(D) The 90 N force will produce acceleration of different magnitudes in A and B.

**Solution · Q5** **Answer: (B)**

In both situations the two blocks move together.

$$a = \frac{90}{20 + 10} = 3\ m/s^2$$

In situation I, only the force by A moves B.

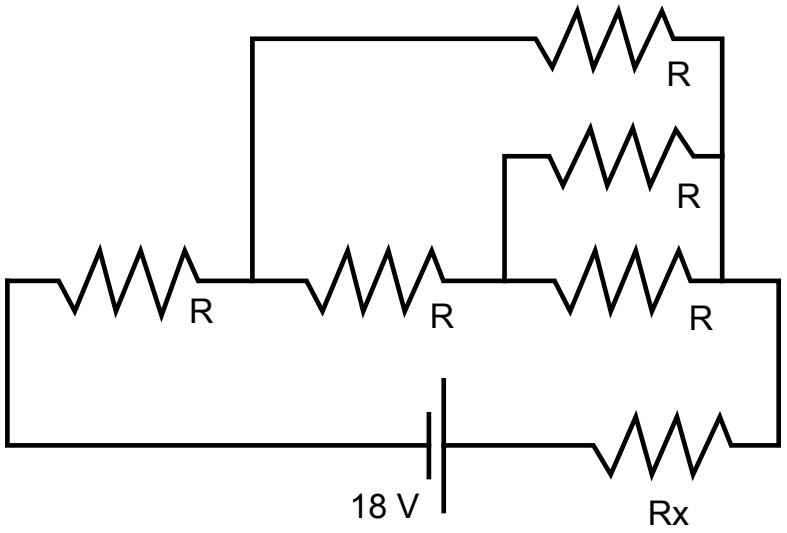
$$F_{AB} = 10 \times 3 = 30\ N$$

In situation II, only the force by B moves A.

$$F_{BA} = 20 \times 3 = 60\ N$$

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

**6.** In the adjoining circuit, R = 5 Ω. It is desired that the voltage across $R_x$ should be 6 V, then the value of $R_x$ should be




(A) 4 Ω (B) 12 Ω (C) 16 Ω (D) 20 Ω

**Solution · Q6** **Answer: (A)**

The last resistor on the main line and the one just above it are in parallel.

$$R_1 = R/2$$

Add the middle resistor of the main line in series:

$$R_2 = R + R/2 = 3R/2$$

This is in parallel with the top resistor.

$$R_3 = \frac{1.5R \times R}{1.5R + R} = \frac{3R}{5}$$

Add the first resistor of the main line in series:

$$R + 3R/5 = 8R/5 = 8\ \Omega$$

Voltage across $R_x$:

$$\frac{18R_x}{8 + R_x} = 6$$

$$\Rightarrow R_x = 4\ \Omega$$

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

**7.** In one process for waterproofing, a fabric is exposed to $(CH_3)_2SiCl_2$ vapors. The vapors react with the hydroxyl groups on the surface of the fabric or with traces of water to form the waterproofing film $[(CH_3)_2SiO]_n$, by the reaction; $n(CH_3)_2SiCl_2 + 2nOH^- \rightarrow 2nCl^- + nH_2O + [(CH_3)_2SiO]_n$ where n stands for a larger integer. The waterproofing film is deposited on the fabric layer upon layer. Each layer is 6 Å thick [the thickness of the $(CH_3)_2SiO$ group]. How much $(CH_3)_2SiCl_2$ is needed to waterproof one side of a piece of fabric, 1m by 2m, with a film 300 layers thick? The density of the film is 1.0 g/cm$^3$.

(A) 0.63g (B) 0.36g (C) 6.3g (D) 3.6g

**Solution · Q7** **Answer: (A)**

Volume of the film is area times thickness, in cm units:

$$V = 2 \times 10^4 \times 300 \times 6 \times 10^{-8} = 0.36 \text{ cm}^3$$

So the film weighs 0.36 g.

One $(CH_3)_2SiO$ unit (74 g/mol) comes from one molecule of $(CH_3)_2SiC\ell_2$ (129 g/mol).

Mass needed:

$$m = \frac{0.36 \times 129}{74}$$

$$\Rightarrow m \approx 0.63 \text{ g}$$

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

**8.** Given that at a certain temperature, in 1.5 L vessel, 5.0 mole of A, 7.0 mole of B and 0.1 mole of C are present. Then the value of equilibrium constant for the reaction: $A + B \rightleftharpoons 2C$ + heat is about

(A) $7.22 \times 10^{-4}$ (B) $2.31 \times 10^{-4}$ (C) $7.22 \times 10^{-5}$ (D) $6.11 \times 10^{-4}$

**Solution · Q8** **As per Zigyan: no option is correct**

Take the given amounts as the equilibrium amounts.

$$K = \frac{[C]^2}{[A][B]}$$

$$\Rightarrow K = \frac{(0.1/1.5)^2}{(5.0/1.5)(7.0/1.5)}$$

The volume cancels.

$$\Rightarrow K = \frac{(0.1)^2}{5.0 \times 7.0}$$

$$\Rightarrow K \approx 2.86 \times 10^{-4}$$

Why Zigyan differs from IAPT: $2.31 \times 10^{-4}$ is obtained when the concentration of C, about 0.0667 mol/L, is cut to 0.06 mol/L before squaring. Without this cut the value is $2.86 \times 10^{-4}$, which no option shows.

**Reference:** NCERT Chemistry Class XI (Part I), Unit 6 'Equilibrium', section 6.3: the equilibrium constant uses equilibrium molar concentrations, each raised to its coefficient in the balanced equation, with products over reactants.

**Check:** the powers on top and bottom both add to two, so mole numbers alone work; 0.01 divided by 35 gives about 0.000286.

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

**9.** An alcohol (A) on dehydration with conc. $H_2SO_4$ at a high temperature yields compound (B). On ozonolysis every molecule of compound (B) yields two molecules of acetaldehyde. Which of the following is the starting alcohol (A)?

(A) 1- butanol (B) 2- butanol (C) propanal (D) 2-propanol

**Solution · Q9** **As per Zigyan: (B)**

Ozonolysis cuts the double bond. Both pieces are acetaldehyde, so B is but-2-ene.

$$CH_3CH{=}CHCH_3 \rightarrow 2CH_3CHO$$

With conc. $H_2SO_4$ and heat, 2-butanol loses water and gives mainly but-2-ene.

$$CH_3CH(OH)CH_2CH_3 \rightarrow CH_3CH{=}CHCH_3 + H_2O$$

**Reference:** NCERT Chemistry Class XII (Part II), Unit 7 'Alcohols, Phenols and Ethers', section 7.4.4: alcohols lose water on treatment with concentrated sulphuric acid and form alkenes.

**Reference:** NCERT Chemistry Class XI (Part II), Unit 9 'Hydrocarbons', section 9.3.5: ozonolysis breaks an alkene into smaller molecules and helps to locate its double bond.

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

**10.** In an experiment with 100 mL 0.1 M solution of Copper Chloride, by mistake 5 gm of a mixture containing equal weights of Tin, Silver, Lead and Calcium, was added. Finally after some time the solution gets completely decolorized. This is mainly due to:

(A) Silver reacts with Copper Chloride

(B) Calcium reacts with Copper Chloride

(C) All the metals react with Copper Chloride

(D) Only Lead reacts with Copper Chloride forming white precipitate of lead chloride

**Solution · Q10** **Answer: (B)**

Each metal weighs 1.25 g. Silver is below copper in the reactivity series, so it cannot react.

Calcium is the most reactive metal here.

Moles of calcium:

$$n(Ca) = 1.25/40 \approx 0.031 \text{ mol}$$

Moles of $Cu^{2+}$ ions:

$$n(Cu^{2+}) = 0.1 \times 0.1 = 0.01 \text{ mol}$$

So calcium is more than enough to remove all the blue $Cu^{2+}$ ions. The $Ca^{2+}$ ions formed are colourless.

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

**11.** Triclosan ($C_{12}H_7Cl_3O_2$) is an antibacterial and antifungal agent. It is a polychloro phenoxy phenol. It is widely used as a preservative and antimicrobial agent in personal care products such as soaps, skin creams, and deodorants etc. A label on a 200 mL hand sanitizer bottle claims that it contain Triclosan 0.2% w/v. What will be the number of molecules of Triclosan present in the bottle? ($N_A$ is Avogadro's Number)

(A) $1.4 \times 10^{25}\ N_A$ (B) $1.4 \times 10^{24}\ N_A$ (C) $1.4 \times 10^{23}\ N_A$ (D) $1.4 \times 10^{22}\ N_A$

**Solution · Q11** **As per Zigyan: no option is correct**

A strength of 0.2% w/v means 0.2 g in every 100 mL.

Mass of triclosan in 200 mL:

$$m = 0.4\ g$$

Molar mass of $C_{12}H_7C\ell_3O_2$:

$$M = 144 + 7 + 106.5 + 32 = 289.5\ g/mol$$

Number of molecules:

$$N = \frac{0.4}{289.5} N_A$$

$$\Rightarrow N \approx 1.38 \times 10^{-3}\ N_A$$

$$\Rightarrow N \approx 8.3 \times 10^{20}$$

Each option is far larger than this, so none of them is correct.

**Reference:** NCERT Chemistry Class XI (Part I), Unit 1 'Some Basic Concepts of Chemistry', section 1.8: one mole of a substance contains about $6.022 \times 10^{23}$ particles, called the Avogadro constant.

**Check:** a full mole of triclosan weighs 289.5 g, but the bottle holds only 0.4 g, so the count is far below one Avogadro number.

**IAPT answer:** question dropped by IAPT | **Zigyan answer:** none of the options is correct

**12.** Suppose that A and B forms compound $B_2A_3$ and $B_2A$. If 0.05 mole of $B_2A_3$ weighs 12 g and 0.1 mole of $B_2A$ weighs 10 g, what are the atomic weight of A and B respectively?

(A) 70 and 25 (B) 50 and 20 (C) 40 and 30 (D) 30 and 40

**Solution · Q12** **As per Zigyan: no option is correct**

Molar masses of $B_2A_3$ and $B_2A$, in that order:

$$M_1 = \frac{12}{0.05} = 240\ g/mol$$

$$M_2 = \frac{10}{0.1} = 100\ g/mol$$

Take the atomic weights of A and B as a and b.

Then, for the two compounds in the same order,

$$2b + 3a = 240$$

$$2b + a = 100$$

Subtracting the second from the first,

$$\Rightarrow 2a = 140$$

$$\Rightarrow a = 70$$

$$\Rightarrow b = 15$$

So the atomic weights of A and B are 70 and 15. No option has this pair.

**Check:** The pairs in options (A) to (D) give molar masses of the two compounds as 260 and 120, 190 and 90, 180 and 100, and 170 and 110. None gives both 240 and 100.

**IAPT answer:** question dropped by IAPT | **Zigyan answer:** none of the options is correct

**13.** If in a wheat mutant, the length of chromosome 1B was found to be 6.7 μm instead of 5.0 μm, approximately how many additional base pairs are incorporated in the mutant chromosome?

(A) $0.5 \times 10^4$ bp (B) $5 \times 10^4$ bp (C) $1.7 \times 10^4$ bp (D) $5.78 \times 10^4$ bp

**Solution · Q13** **Answer: (A)**

Extra length of the chromosome:

$$6.7\ \mu m - 5.0\ \mu m = 1.7\ \mu m = 1700\ nm$$

Taking it as a straight B-DNA double helix, one base pair covers 0.34 nm.

Number of extra base pairs:

$$n = \frac{1700}{0.34} = 5000$$

$$\Rightarrow n = 0.5 \times 10^4 \text{ bp}$$

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

**14.** Considering following characteristics, identify the correct inheritance pattern from the given options.

- Most affected individuals are male.
- Affected sons result from female parents who are either affected or who are known to be carriers because they have affected brothers, fathers, or maternal uncles.
- Affected daughters are born to affected fathers and either affected or carrier mothers.
- The sons of affected mothers should be affected.
- Approximately half the sons of carrier mothers should be affected.

(A) Autosomal Recessive Inheritance (B) Autosomal Dominant Inheritance
(C) Sex-Linked Recessive Inheritance (D) Sex-Linked Dominant Inheritance

**Solution · Q14** **Answer: (C)**

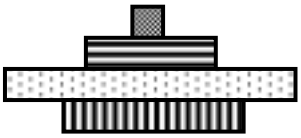
Males have only one X chromosome, so one recessive gene on it is enough to affect them. Females are affected only when both X chromosomes carry it.

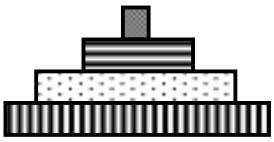
So mostly males are affected, an affected mother passes it to her sons, and a carrier mother to about half of her sons.

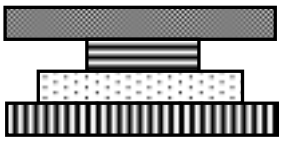
This is sex-linked recessive inheritance.

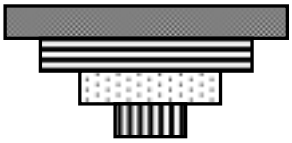
**IAPT answer:** (C) | **Zigyan answer:** (C)

**15.** In a marine ecosystem with rich diversity of fauna, which of the following images would be a correct representation of pyramid of biomass?

(A) 

(B) 

(C) 

(D) 

**Solution · Q15** **Answer: (D)**

In the sea, the producers are tiny, short-lived phytoplankton, so their biomass at any time is small.

Biomass is larger higher up, and that of fishes far exceeds that of phytoplankton. So the pyramid is inverted: narrowest at the base and widest at the top.

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

**16.** The transpiration pull is maximum under which of the following conditions?

(A) Closed stomata, low light intensity, humid air

(B) Open stomata, dry air, moist soil

(C) Open stomata, dry air, dry soil

(D) Open stomata, high humidity in air, moist soil

**Solution · Q16** **Answer: (B)**

Transpiration pull is produced when water evaporates from the leaves.

Open stomata and dry air give the fastest loss of water, while moist soil keeps up the supply to the roots.

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

**17.** *Curcuma longa*, *Azadirachta indica,* Basmati Rice, Indian Ginseng are all related to which of the following concepts?

(A) Bioterrorism (B) Biomagnification (C) Biopiracy (D) Biodegradation

**Solution · Q17** **Answer: (C)**

Biopiracy is the commercial use of a country's biological resources or traditional knowledge, often through patents, without proper permission or payment.

Turmeric (Curcuma longa), neem (Azadirachta indica), Basmati rice and Indian ginseng (ashwagandha) are Indian examples linked with it.

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

**18.** Read following criteria carefully.

- Slow evolutionary change relative to similar entities
- Gross similarity to an ancestral fossil
- Very low taxonomic richness today compared to the past
- Phylogenetic inference of specific characters as plesiomorphic
- Phylogenetic inference of a genealogical divergence between other groups that diverged in the distant past
- Known in the fossil record before being discovered alive

These criteria can be used to categorize a group of organisms the most probably into

(A) Connecting links (B) Living fossils

(C) Endangered species (D) Extinct species

**Solution · Q18** **Answer: (B)**

A living fossil has changed very little over a very long period and still resembles its fossil ancestors.

Such a group has very few species today, and some were known from fossils before being found alive, for example the coelacanth.

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

**19.** If $x^2 + ax + b = 0$ and $x^2 + bx + a = 0$ have one common root, then

(A) $a + b = 0$ (B) $a + b = 1$ (C) $a + b = -1$ (D) $a^2 + b^2 = 1$

**Solution · Q19** **Answer: (C)**

Let $\alpha$ be the common root.

$$\alpha^2 + a\alpha + b = 0$$

$$\alpha^2 + b\alpha + a = 0$$

On subtracting,

$$(a - b)(\alpha - 1) = 0$$

Only one root is common, so the two equations are not the same.

$a \neq b$

$$\Rightarrow \alpha = 1$$

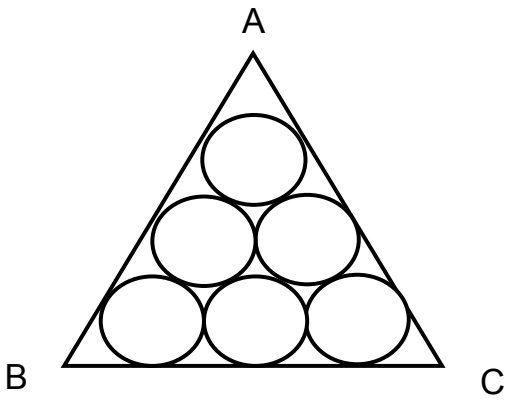
Substituting this in the first equation,

$$1 + a + b = 0$$

$$\Rightarrow a + b = -1$$

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

**20.** Six circles each of radius 3 cm are inscribed in an equilateral triangle ABC such that they touch each other and also touch the sides of the triangle as shown in the adjacent figure. Then height of triangle ABC is




(A) $6\left(2\sqrt{3}+3\right)$
(B) $3\left(2\sqrt{3}+6\right)$
(C) $3\left(2\sqrt{3}+3\right)$
(D) $6\left(2+\sqrt{3}\right)$

**Solution · Q20** **Answer: (C)**

The centres of the three corner circles form an equilateral triangle of side 4r. Its height is

$$h_1 = \frac{\sqrt{3}}{2}(4r) = 2\sqrt{3}\ r$$

Distance of A from the centre of the top circle:

$$\frac{r}{\sin 30^\circ} = 2r$$

The two lower corner centres are at a distance r above BC. So the height of triangle ABC is

$$h = 2r + 2\sqrt{3}\ r + r$$

Putting in the radius,

$$r = 3 \text{ cm}$$

$$\Rightarrow h = 3\left(2\sqrt{3}+3\right) \text{ cm}$$

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

**21.** Find the remainder when $x^{51}$ is divided by $x^2 - 3x + 2$

(A) x
(B) $(2^{51} - 2)x + 2 - 2^{51}$
(C) $(2^{51} - 1)x + 2 - 2^{51}$
(D) 0

**Solution · Q21** **Answer: (C)**

Factorising the divisor,

$$x^2 - 3x + 2 = (x - 1)(x - 2)$$

The remainder has degree less than 2, so take it as px + q. With quotient Q(x),

$$x^{51} = (x - 1)(x - 2)\ Q(x) + px + q$$

Using the two zeros of the divisor:

$$x = 1 \Rightarrow p + q = 1$$

$$x = 2 \Rightarrow 2p + q = 2^{51}$$

$$\Rightarrow p = 2^{51} - 1$$

$$\Rightarrow q = 2 - 2^{51}$$

So the remainder is

$(2^{51} - 1)x + 2 - 2^{51}$

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

**22.** If $\frac{3}{x-2} < 1$, where x is a real number, then

(A) $2 < x < 5$ (B) $x < 2$ or $5 < x$ (C) $x < -2$ or $x > 5$ (D) None of these

**Solution · Q22** **Answer: (B)**

$$\frac{3}{x-2} - 1 < 0$$

$$\Rightarrow \frac{5-x}{x-2} < 0$$

$$\Rightarrow \frac{x-5}{x-2} > 0$$

This needs the numerator and the denominator to have the same sign.

$$\therefore x < 2 \text{ or } x > 5$$

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

**23.** If $100^{25} - 25$ is written in decimal notations, then the sum of its digits is

(A) 444 (B) 442 (C) 424 (D) 422

**Solution · Q23** **Answer: (A)**

The expression can be written as:

$$100^{25} - 25 = 10^{50} - 25$$

This number has forty-eight digits 9, followed by 7 and 5.

Sum of the digits:

$$S = 48 \times 9 + 7 + 5$$

$$\therefore S = 444$$

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

**24.** ABC is a triangle, the bisector of angle A meets BC in D. The relation between AD, AB and AC is

(A) $AD > \sqrt{AB.AC}$ (B) $AD > AB.AC$

(C) $AD = \sqrt{AB.AC}$ (D) $AD < \sqrt{AB.AC}$

**Solution · Q24** **Answer: (D)**

Extend AD to meet the circumcircle of triangle ABC again at E, and join EC.

In triangles ABD and AEC, AD bisects angle A, so:

$$\angle BAD = \angle EAC$$

Angles in the same segment are equal, so:

$$\angle ABD = \angle AEC$$

$\Rightarrow \Delta ABD \sim \Delta AEC$

$$\Rightarrow \frac{AB}{AE} = \frac{AD}{AC}$$

$$\Rightarrow AB \times AC = AD \times AE$$

$$\Rightarrow AB \times AC = AD \times (AD + DE)$$

$$\Rightarrow AB \times AC = AD^2 + AD \times DE$$

Since AD × DE is positive:

$$AD^2 < AB \times AC$$

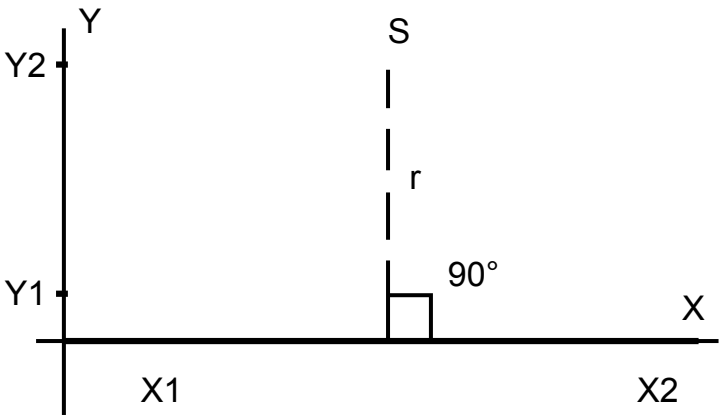
$$\therefore AD < \sqrt{AB \cdot AC}$$

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

## PART A-2 · ONE OR MORE CORRECT OPTIONS

**Q. 25 – 32 · 6 marks only if all correct options are marked · no negative marking**

**25.** An infinitely long conductor when carrying current I, produces a magnetic field B around it. If such a conductor is placed along the X-axis, then the magnitude of B at a distance r is given by the relation $B = \frac{\mu_0}{4\pi}\frac{2I}{r}$, (where $\frac{\mu_0}{4\pi} = 10^{-7}\ NA^{-2}$ is a constant). The following figure shows such an infinitely long conductor placed along X-axis carrying current I and B at S is $2 \times 10^{-4}$ T, directed into the plane of the paper at S. Given r = 1 cm. Then, the correct statements are




(A) I = 10 A

(B) The number of electrons transported across the cross section of the conductor during time 1s is $6.25 \times 10^{19}$

(C) The direction of current I is from $X_2$ to $X_1$.

(D) The electrons will flow in the direction $X_2$ to $X_1$.

**Solution · Q25** **Answer: (A), (B), (C)**

For the long straight conductor:

$$2 \times 10^{-4} = 10^{-7} \times \frac{2I}{10^{-2}}$$

$$\Rightarrow I = 10\ A$$

So (A) is true.

Number of electrons crossing in 1 s:

$$n = \frac{It}{e} = \frac{10 \times 1}{1.6 \times 10^{-19}}$$

$$\Rightarrow n = 6.25 \times 10^{19}$$

So (B) is true.

At S, above the wire, B is into the page. By the right-hand thumb rule, the current is from $X_2$ to $X_1$, so (C) is true.

Electrons move opposite to the current, so (D) is false.

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

**26.** The ratio of the charge of an ion or subatomic particle to its mass (q/m) is called specific charge. Then the correct options are

(A) SI unit of specific charge can be written as A·s /kg.

(B) If all the isotopes of hydrogen are ionized then tritium will have least specific charge among them.

(C) specific charge of an α- particle will be greater than that of an electron.

(D) specific charge ratio of an electron is $1.75 \times 10^{11}$ C/kg.

**Solution · Q26** **As per Zigyan: (A), (B), (D)**

(A) Charge is current × time, so C/kg is the same as A·s/kg. It is true.

(B) The ions of the three isotopes have equal charge, and the tritium ion is the heaviest. It is true.

(C) For an α-particle:

$$\frac{q}{m} = \frac{2 \times 1.6 \times 10^{-19}}{4 \times 1.67 \times 10^{-27}}$$

$$\Rightarrow q/m \approx 4.8 \times 10^{7}\ C/kg$$

For an electron:

$$\frac{e}{m_e} = \frac{1.6 \times 10^{-19}}{9.1 \times 10^{-31}}$$

$$\Rightarrow e/m_e \approx 1.758 \times 10^{11}\ C/kg$$

The α-particle value is much smaller, so (C) is false.

The value given in (D) agrees with the electron value, so (D) is true.

**Reference:** NCERT Chemistry Class XI (Part I), Unit 2 'Structure of Atom', section 2.1.2 'Charge to Mass Ratio of Electron': Thomson's value for the electron is about $1.7588 \times 10^{11}$ coulomb per kilogram.

**Check:** an α-particle has only twice the charge of an electron but several thousand times its mass, so its specific charge is far smaller.

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

**27.** Acetylene torches and burners used by glassblowers produce intense ultraviolet light. Glassblowers wear special glasses that contain which of the following elements to absorb the UV?

(A) Neodymium (B) Praseodymium (C) Cerium (D) Didymium

**Solution · Q27** **As per Zigyan: (A), (B)**

The special goggles of glassblowers are made of didymium glass.

This glass contains two elements, neodymium and praseodymium. So (A) and (B) are correct.

(C) Cerium is not one of the two elements of didymium.

(D) Didymium is a name for the mixture of the two, not an element.

**Reference:** Royal Society of Chemistry Periodic Table, pages 'Neodymium' and 'Praseodymium': these two elements are components of didymium glass, which is used in goggles for glass blowing.

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

**28.** Equal lengths of magnesium ribbons are taken in four test tubes A, B, C, and D. In test tube A, 1M acetic acid is added; in test tube B, 1M HCl is added; in test tube C, 1M $HNO_3$ is added; and in test tube D, 1M NaOH is added. The observed results will be:

(A) The fizzing occurs more vigorously in A (B) The fizzing occurs more vigorously in B

(C) The fizzing occurs more vigorously in C (D) The fizzing occurs more vigorously in D

**Solution · Q28** **Answer: (B), (C)**

$HC\ell$ and $HNO_3$ are strong acids. They give many more $H^+$ ions than 1 M acetic acid, a weak acid.

So gas bubbles off the magnesium much faster in B and C than in A.

Magnesium does not react with NaOH, so there is no fizzing in D.

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

**29.** Choose the correct statements from following options.

(A) A robust adaptive immune response is initiated using weakened forms of the bacterium known as live attenuated vaccines.

(B) Administration of a killed or chemically inactivated virus can trigger a weaker adaptive immune response, but can be strengthened with booster doses.

(C) A conjugate or multivalent component always reduces immunogenicity of the vaccine.

(D) Inclusion of alum, cytokines, and/or lipids always reduces the immune response to a vaccine.

**Solution · Q29** **Answer: (A), (B)**

(A) Weakened living germs give a strong adaptive immune response. It is true.

(B) A killed or inactivated virus cannot multiply, so its response is weaker and booster doses help. It is true.

(C) Conjugation raises immunogenicity, and a multivalent vaccine widens protection. It is false.

(D) Alum, cytokines and lipids are used as adjuvants, which strengthen the response. It is false.

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

**30.** The minimum energy required to exist that is the energy required to perform chemical reactions even when a person is at rest is called the *basal metabolic rate* (BMR), which accounts for about 50 to 70 per cent of the daily energy expenditure in most sedentary individuals. It is influenced by many factors. Some statements are made about these factors. Choose the correct statements from the following options.

(A) Thyroid hormone decreases metabolic rate
(B) Growth hormone increases metabolic rate
(C) Fever decreases metabolic rate
(D) Malnutrition decreases metabolic rate

**Solution · Q30** **Answer: (B), (D)**

(A) Thyroid hormone raises the metabolic rate. It is false.

(B) Growth hormone raises the metabolic rate. It is true.

(C) Fever speeds up body reactions and raises the metabolic rate. It is false.

(D) In malnutrition the body saves energy, so the metabolic rate falls. It is true.

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

**31.** If $0 \le x \le \pi$ and $81^{\sin^2 x} + 81^{\cos^2 x} = 30$, then x =

[Useful information: $\pi^c = 180°$, $\sin(180 - \theta) = \sin\theta$, $\sin\theta \ge 0$ when $0 \le \theta \le 180°$]

(A) $\frac{\pi}{6}$
(B) $\frac{\pi}{3}$
(C) $\frac{5\pi}{6}$
(D) $\frac{2\pi}{3}$

**Solution · Q31** **Answer: (A), (B), (C), (D)**

Put:

$$y = 81^{\sin^2 x}$$

Also:

$$\cos^2 x = 1 - \sin^2 x$$

$$\Rightarrow 81^{\cos^2 x} = \frac{81}{y}$$

$$\Rightarrow y + \frac{81}{y} = 30$$

$$\Rightarrow y^2 - 30y + 81 = 0$$

$$\Rightarrow y = 3 \text{ or } 27$$

Writing both sides as powers of 3:

$$3^{4\sin^2 x} = 3 \text{ or } 3^3$$

$$\Rightarrow 4\sin^2 x = 1 \text{ or } 3$$

Here sin x cannot be negative.

$$\Rightarrow \sin x = \frac{1}{2} \text{ or } \frac{\sqrt{3}}{2}$$

$$\therefore x = \frac{\pi}{6}, \frac{5\pi}{6}, \frac{\pi}{3}, \frac{2\pi}{3}$$

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

**32.** Given $(a-b)^2 + (a-c)^2 = (b-c)^2$, then which of the following statements are true?

(A) equation is valid when $b = c$ and $a \neq c$

(B) equation is valid when $a = b$

(C) equation is valid when $a = c$

(D) Given equation is not valid when a, b and c are distinct.

**Solution · Q32** **Answer: (B), (C), (D)**

Expanding both sides:

$$a^2 - 2ab + b^2 + a^2 - 2ac + c^2 = b^2 - 2bc + c^2$$

$$\Rightarrow a^2 - ab - ac + bc = 0$$

$$\Rightarrow (a-b)(a-c) = 0$$

$$\therefore a = b \text{ or } a = c$$

So (B) and (C) are true.

If all three are distinct, neither bracket is zero, so (D) is true.

For (A), take:

$$b = c, a \neq c$$

$$\Rightarrow (a-b)(a-c) = (a-c)^2 \neq 0$$

So (A) is false.

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

# ANSWER KEY

IOQJS 2020-21 · PAPER CODE 51

**32**
QUESTIONS · 120 MARKS

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

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | (B) | 2 | (C) | 3 | (B) | 4 | (A) | 5 | (B) |
| 6 | (A) | 7 | (A) | 8 | —★ | 9 | (B)★ | 10 | (B) |
| 11 | —★ | 12 | —★ | 13 | (A) | 14 | (C) | 15 | (D) |
| 16 | (B) | 17 | (C) | 18 | (B) | 19 | (C) | 20 | (C) |
| 21 | (C) | 22 | (B) | 23 | (A) | 24 | (D) | 25 | (A), (B), (C) |
| 26 | (A), (B), (D)★ | 27 | (A), (B)★ | 28 | (B), (C) | 29 | (A), (B) | 30 | (B), (D) |
| 31 | (A), (B), (C), (D) | 32 | (B), (C), (D) | | | | | | |

**★ Answers as per Zigyan**

- **Q8** — As per Zigyan: no option is correct; IAPT key (B).
- **Q9** — As per Zigyan: (B); IAPT key (A) or (B).
- **Q11** — As per Zigyan: no option is correct; dropped by IAPT.
- **Q12** — As per Zigyan: no option is correct; dropped by IAPT.
- **Q26** — As per Zigyan: (A), (B), (D); IAPT key (A), (B), (C) or (A), (B), (D).
- **Q27** — As per Zigyan: (A), (B); IAPT key (A), (B).

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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

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RESULTS · 2021 – 2026

# Our toppers, year by year

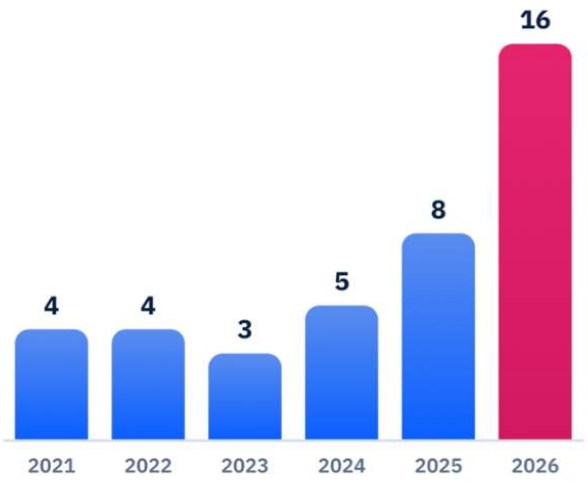
**40**
JEE Advanced selections in 6 years

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