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PREVIOUS YEAR PAPER · 2020-21

OLYMPIAD · STAGE I

IOQA

Indian Olympiad Qualifier in Astronomy (Part I)

2020-21

Question paper, answer key and Zigyan solutions

32	120	60 min	41
Questions	Maximum marks	Time	Paper code

Question paper and official answer key: Indian Association of Physics Teachers (IAPT), IOQA 2020-21, paper code 41.
Solutions and notes: Zigyan. This booklet is not an IAPT publication.

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AIR 168	AIR 811
	99.95 percentile



Sulokya Bibhuty

3 YEARS CLASSROOM

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

Physical constants you may need....

CONSTANT	MAGNITUDE	UNIT
Charge of electron	1.60×10^{-19}	C
Mass of electron	9.10×10^{-31}	kg
Mass pf proton	1.67×10^{-27}	kg
Universal Gravitational Constant	6.67×10^{-11}	$Nm^{-2}kg^{-2}$
Boltzmann constant	1.38×10^{-23}	JK^{-1}
Stefan's constant	5.67×10^{-8}	$Wm^{-2}K^{-4}$
Avogadro's Constant	6.02×10^{23}	mol^{-1}
Speed of light in vacuum	3.00×10^{8}	ms^{-1}
Rydberg's constant	1.10×10^{7}	m^{-1}
Density of water	1.00×10^{3}	kgm^{-3}
Plank's constant	6.63×10^{-34}	Js
Faraday's constant	9.65×10^{4}	$Cmol^{-1}$
permeability of free space	8.85×10^{-12}	$C^{-}N^{-1}m^{-2}$
Light year	9.46×10^{15}	m
Earth - Sun Distance	1.50×10^{11}	m
Diameter of the Sun	1.39×10^{9}	m
Permeability of free space	$4\pi\times10^{-7}$	Hm^{-1}
Universal Gas Constant	8.31	$Jmol^{-1}K^{-1}$
Acceleration due to gravity	9.81	ms^{-2}
Parsec	3.26	light year

PART A-1 · ONE CORRECT OPTION

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

1. The value of $\tan^{-1}\left[\frac{\cos x}{1-\sin x}\right]$ is equal to

(A) $\frac{x}{2}$ (B) $\frac{x}{2}-\frac{\pi}{2}$

(C) $\frac{x}{2}-\frac{\pi}{4}$ (D) $\frac{x}{2}+\frac{\pi}{4}$

Solution · Q1 **Answer: (D)**

Using half angles:

$$\frac{\cos x}{1-\sin x}=\frac{\cos^2(x/2)-\sin^2(x/2)}{(\cos(x/2)-\sin(x/2))^2}$$

$$\Rightarrow \frac{\cos x}{1-\sin x}=\frac{1+\tan(x/2)}{1-\tan(x/2)}$$

$$\Rightarrow \frac{\cos x}{1-\sin x}=\tan\left(\frac{\pi}{4}+\frac{x}{2}\right)$$

Principal value range:

$$-3\pi/2 < x < \pi/2$$

$$\therefore \tan^{-1}\left[\frac{\cos x}{1-\sin x}\right]=\frac{\pi}{4}+\frac{x}{2}$$

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

2. The determinant $\begin{vmatrix} 1 & 1 & -1 \\ -1 & 1 & 1 \\ 1 & 1 & x \end{vmatrix} = 0$ The value of x is

(A) x = 0 or 1 (B) x = ±1 (C) x = −1 (D) x = 1

Solution · Q2 **Answer: (C)**

Expanding along the first row:

$$1(x - 1) - 1(-x - 1) - 1(-1 - 1) = 0$$

$$\Rightarrow 2x + 2 = 0$$

$$\therefore x = -1$$

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

3. The value of the given integral

$$\int_{\pi/3}^{\pi/4} \frac{dx}{\sin^2 x \cdot \cos^2 x}$$

is

(A) $\frac{\pi}{4} - \frac{\pi}{3}$ (B) 0

(C) $\frac{1}{\sqrt{3}}$ (D) $-\frac{2}{\sqrt{3}}$

Solution · Q3 **Answer: (D)**

Splitting the integrand:

$$\frac{1}{\sin^2 x \cos^2 x} = \frac{1}{\cos^2 x} + \frac{1}{\sin^2 x}$$

$$I = [\tan x - \cot x]_{\pi/3}^{\pi/4}$$

$$\Rightarrow I = (1 - 1) - \left(\sqrt{3} - \frac{1}{\sqrt{3}}\right)$$

$$\therefore I = -\frac{2}{\sqrt{3}}$$

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

4. Consider the four points A, B, C, D forming a regular tetrahedron with sides each of length L. The coordinates (x, y, z) of A, B and C are A (0,0,0), B (L,O,O) & C $\left(\frac{L}{2}, \frac{L\sqrt{3}}{2}, 0\right)$ The possible coordinates of D are

(A) $\left(\frac{L}{2}, \frac{L}{2}, \pm\frac{L}{\sqrt{2}}\right)$ (B) $\left(\frac{L}{2}, \frac{L}{2\sqrt{3}}, \pm\frac{L\sqrt{2}}{\sqrt{3}}\right)$

(C) $\left(\frac{L}{\sqrt{2}}, \frac{L}{\sqrt{3}}, \pm\frac{L}{\sqrt{3}}\right)$ (D) $\left(\frac{L}{\sqrt{2}}, \frac{L}{\sqrt{3}}, \pm\frac{L\sqrt{5}}{\sqrt{12}}\right)$

Solution · Q4 **Answer: (B)**

D is equidistant from A, B and C, so it lies above or below the centroid G of triangle ABC.

$$G = \left(\frac{L}{2}, \frac{L}{2\sqrt{3}}, 0\right)$$

$$AG = \frac{L}{\sqrt{3}}$$

In right triangle AGD:

$$DG^2 = L^2 - \frac{L^2}{3}$$

$$\Rightarrow DG = \frac{L\sqrt{2}}{\sqrt{3}}$$

$$\therefore D = \left(\frac{L}{2}, \frac{L}{2\sqrt{3}}, \pm\frac{L\sqrt{2}}{\sqrt{3}}\right)$$

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

5. The argument of the complex number $z = \frac{1+i}{1-i\sqrt{3}}$ is

(A) π (B) $\frac{7\pi}{12}$

(C) $-\frac{5\pi}{12}$ (D) $+\frac{5\pi}{12}$

Solution · Q5 **Answer: (B)**

Arguments of the numerator and the denominator:

$$\arg(1+i) = \frac{\pi}{4}$$

$$\arg\left(1-i\sqrt{3}\right) = -\frac{\pi}{3}$$

$$\therefore \arg z = \frac{\pi}{4} + \frac{\pi}{3}$$

$$\Rightarrow \arg z = \frac{7\pi}{12}$$

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

6. Consider the two curves $y_1 = \frac{4x^2}{\pi^2}$ and $y_2 = \sin x$ in the region $0 < x < \pi$. The angle made by the curves at the point of intersection is

(A) $\tan^{-1}\left(\frac{1}{\pi}\right)$ (B) $\tan^{-1}\left(\frac{4}{\pi}\right)$

(C) $\tan^{-1}\infty$ (D) $\tan^{-1} 0$

Solution · Q6 **Answer: (B)**

At the point of intersection:

$$\frac{4x^2}{\pi^2} = \sin x$$

$$\Rightarrow x = \frac{\pi}{2}$$

Slopes of the two curves at this point:

$$m_1 = \frac{8x}{\pi^2}$$

$$\Rightarrow m_1 = \frac{4}{\pi}$$

$$m_2 = \cos x$$

$$\Rightarrow m_2 = 0$$

$$\tan\theta = \left|\frac{m_1 - m_2}{1 + m_1 m_2}\right|$$

$$\therefore \theta = \tan^{-1}\left(\frac{4}{\pi}\right)$$

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

7. The three points (2, 3, – 4), (1, –2, 3) and (3, 8, r) are collinear. The value of r is

(A) 0 (B) –10 (C) –11 (D) 10

Solution · Q7 **Answer: (C)**

Direction ratios of the lines from (2, 3, –4):

To (1, –2, 3): –1, –5, 7

To (3, 8, r): 1, 5, r + 4

The points are collinear, so these are proportional with ratio –1.

$$r + 4 = -7$$

$$\therefore r = -11$$

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

8. The time period of a simple pendulum is theoretically π seconds. In an experiment to measure this time period, a stop clock having least count of one-hundredth of a second is used and the time taken for 'n' oscillations is measured. The percentage error in the calculation of the time period will be

(A) $(n\pi)^{-1}\%$ (B) $\pi\%$ (C) 2% (D) $2(n\pi)^{-1}\%$

Solution · Q8 **Answer: (A)**

Time for n oscillations and its error (least count):

$$t = n\pi \text{ s}, \Delta t = 0.01 \text{ s}$$

As T is t divided by n:

$$\frac{\Delta T}{T} \times 100 = \frac{\Delta t}{t} \times 100$$

$$\Rightarrow \frac{\Delta T}{T} \times 100 = \frac{0.01 \times 100}{n\pi}$$

$\therefore$ the percentage error is $(n\pi)^{-1}\%$.

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

9. A large sphere A of 20 kg being accelerated at 5.0 ms^{-2} strikes another sphere B of mass 8.0 kg. At the moment of impact, the acceleration of B is 12 ms^{-2} . The force on B at the moment of impact is

(A) 40N (B) 96N (C) 240N (D) 100N

Solution · Q9 **Answer: (B)**

By Newton's second law, for sphere B:

$$F = m_B a_B$$

$$\Rightarrow F = 8.0 \times 12$$

$$\therefore F = 96 \text{ N}$$

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

10. Consider that in space with no air resistance and negligible gravity, a ball of mass 250 g, initially at rest, is projected with a force of 30N giving it a speed of 20 ms^{-1}. The ball travels a distance of 1000 m before it strikes a space ship. The original energy, E (in Joule) with which the ball was projected is

(A) 30,000 (B) 50 (C) 50< E < 30,000 (D) none of these

Solution · Q10 **Answer: (B)**

The 30 N force acts only while the ball is being projected. In flight no force acts, so the speed stays constant and the 1000 m distance does not matter.

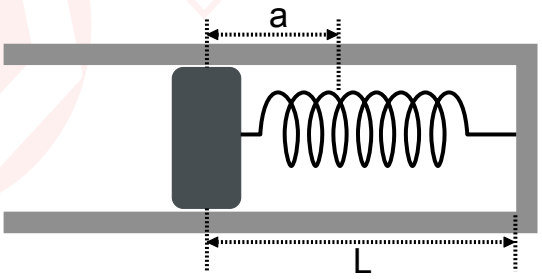
The energy given to the ball is its kinetic energy:

$$E = \frac{1}{2} \times 0.25 \times 20^2$$

$$\Rightarrow E = 50 \text{ J}$$

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

11. The diagram shows a mass m free to slide inside a long frictionless tube along the x axis. It is attached to a spring of spring constant k whose unscratched length is L. Initially the mass is pushed to a position x = a (< L) and released from rest. Let there be a certain position x = x_m at which the maximum power, P_{max}, is generated due to kinetic energy. The values x_m and P_{max} are respectively



(A) $\frac{a}{2}$ & $\left(\frac{3ka^2}{2}\sqrt{\frac{k}{m}}\right)$ (B) 0 & $\left(ka^2\sqrt{\frac{k}{m}}\right)$

(C) $\frac{a}{\sqrt{2}}$ & $\left(\frac{ka^2}{2}\sqrt{\frac{k}{m}}\right)$ (D) $\frac{3a}{4}$ & $\left(2ka^2\sqrt{\frac{k}{m}}\right)$

Solution · Q11 **Answer: (C)**

Measured from the natural length position, the amplitude is a. The speed at x is:

$$v = \omega\sqrt{a^2 - x^2}$$

$$\omega = \sqrt{\frac{k}{m}}$$

Magnitude of the rate of change of kinetic energy (spring force times speed):

$$P = kxv$$

$$\Rightarrow P = k\omega x\sqrt{a^2 - x^2}$$

P is maximum when the following product is maximum:

$x^2(a^2 - x^2)$

$$\therefore x_m = \frac{a}{\sqrt{2}}$$

$$P_{max} = \frac{ka^2}{2}\sqrt{\frac{k}{m}}$$

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

12. Consider a cube with one of its 6 faces open. A charge q is placed at the center of the open face. The total electric flux through the rest of the 5 faces will be nearly equal to

(A) zero

(B) $\frac{q}{\varepsilon_0}$

(C) $\frac{q}{2\varepsilon_0}$

(D) $\frac{5q}{6\varepsilon_0}$

Solution · Q12 **Answer: (C)**

Place an identical cube against the open face.

The charge is now at the centre of a closed cuboid.

By Gauss's law, the total flux through the cuboid is

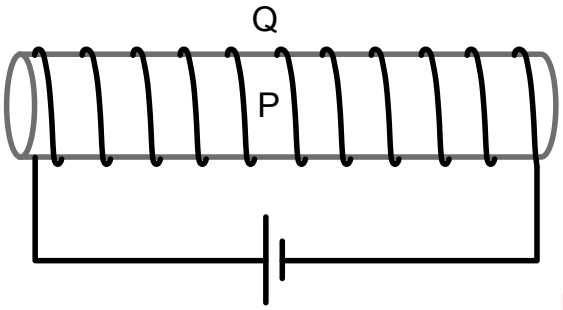
$$\varphi_{total} = \frac{q}{\varepsilon_0}$$

By symmetry, each cube takes half of it.

$$\therefore \varphi = \frac{q}{2\varepsilon_0}$$

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

13. In the diagram of solenoid shown, point P is inside the solenoid and point Q is just outside the solenoid. Which of the following is true for Magnetic Fields $\vec{B}_p$ and $\vec{B}_Q$ at point P and Q respectively?



(A) $\vec{B}_p \neq 0$ & $\vec{B}_Q \approx 0$
(B) $\vec{B}_p \approx 0$ & $\vec{B}_Q \neq 0$
(C) $\vec{B}_p \neq 0$ & $\vec{B}_Q = \vec{B}_p$
(D) $\vec{B}_p = 0$ & $\vec{B}_Q \neq 0$

Solution · Q13 **Answer: (A)**

For a long current-carrying solenoid, the field inside is strong and uniform.

$$B_p = \mu_0 n I$$

$\therefore B_p \neq 0$

Just outside, away from the ends, the field is negligible.

$$\therefore B_Q \approx 0$$

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

14. A 156 Ω non-inductive resistor is connected to an AC source which generates an emf which is given by $e = 312\sin\left(100\pi t + \pi\sqrt{2}\right)$ V. The value of current flowing through the resistor as measured by a millimeter (in A) will be

(A) $2\sqrt{2}$
(B) 2
(C) $\sqrt{2}$
(D) 1

Solution · Q14 **Answer: (C)**

An a.c. milliammeter reads the r.m.s. current. The phase of the emf does not affect it.

Peak current:

$$I_0 = 312/156$$

$$\Rightarrow I_0 = 2 \text{ A}$$

R.m.s. current:

$$I_{rms} = \frac{I_0}{\sqrt{2}}$$

$$\Rightarrow I_{rms} = \sqrt{2} \text{ A}$$

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

15. Consider an atom of mass m in an excited state, moving with a speed v, (v << c) along the x axis. It makes a transition to the ground state by emitting a photon along the y axis. If ΔE is the energy difference between the excited state and the ground state, the frequency of the emitted photon is

(A) $\frac{\Delta E}{h}$

(B) $\frac{\Delta E}{h}\left[1-\frac{\Delta E}{mc^2}\right]$

(C) $\frac{mc^2}{h}\left[\left(\sqrt{1+2\frac{\Delta E}{mc^2}}\right)-1\right]$

(D) not determinable

Solution · Q15 **Answer: (C)**

Take the mass of the atom as m before and after emission.

The photon has no momentum along x, so the x-momentum of the atom stays mv.

Recoil momentum of the atom along y:

$$p_y = hf/c$$

By conservation of energy,

$$\Delta E + \frac{mv^2}{2} = hf + \frac{mv^2}{2} + \frac{p_y^{\,2}}{2m}$$

$$\Rightarrow \Delta E = hf + \frac{(hf)^2}{2mc^2}$$

$$\Rightarrow (hf)^2 + 2mc^2(hf) - 2mc^2\Delta E = 0$$

Taking the positive root,

$$f = \frac{mc^2}{h}\left[\sqrt{1+\frac{2\Delta E}{mc^2}}-1\right]$$

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

16. Messier Object M1 is

(A) Andromeda Nebula (B) Crab Nebula (C) Orion Nebula (D) Horsehead Nebula

Solution · Q16 **Answer: (B)**

M1, the first object in Messier's catalogue, is the Crab Nebula.

It is a supernova remnant in Taurus.

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

17. The right ascension of winter solstice is

(A) 18 hours

(B) 12 hours

(C) 6 hours

(D) depends on the time of the year

Solution · Q17 **Answer: (A)**

Right ascension is measured eastward from the March equinox.

The winter (December) solstice point lies three quarters of the way round.

$$\alpha = \frac{3}{4} \times 24\ h$$

$$\Rightarrow \alpha = 18\ h$$

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

18. The latitude and longitude of the two cities A and B are at (13.0^0N, 77.6^0E) and (28.7^0N, 77.6^0E) respectively. On 15th December 2021,

(A) The Sun will rise earlier and set later in A compared to B.

(B) The Sun will rise earlier and set earlier in A compared to B.

(C) The Sun will rise later and set earlier in A compared to B.

(D) The Sun will rise later and set later in A compared to B.

Solution · Q18 **Answer: (A)**

Both cities are on the same longitude, so local noon is at the same instant.

For the hour angle H of sunset (half the day length),

$$\cos H = -\tan \phi \tan \delta$$

On 15 December the declination δ of the Sun is negative.

So a smaller northern latitude ϕ gives a longer day.

A is at the smaller latitude. Hence the Sun rises earlier and sets later in A.

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

19. In the Period - Luminosity relationship of Cepheid variables, type I Cepheid has 4 times the luminosity than that of type II Cepheid for the same period. The distance to Andromeda Galaxy was determined by assuming a Cepheid located in it as type I. If it had been assumed to be a type II Cepheid, the distance would

(A) increase by a factor of 4

(B) increase by a factor of 2

(C) decrease by a factor of 4

(D) decrease by a factor of 2

Solution · Q19 **Answer: (D)**

For the same observed brightness b,

$$b = \frac{L}{4\pi d^2}$$

$$\Rightarrow d \propto \sqrt{L}$$

$$\frac{d_{II}}{d_I} = \sqrt{\frac{L_{II}}{L_I}}$$

$$\Rightarrow \frac{d_{II}}{d_I} = \sqrt{\frac{1}{4}}$$

$$\Rightarrow d_{II} = d_I/2$$

So the distance decreases by a factor of 2.

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

20. The energy emitted by the Sun is due to fusion reaction $4\,{}_1H^1 \rightarrow {}_2He^4 + 2\,{}_1\beta^0 + 2\nu_e$ (ν_e are neutrinos) with a release of 27 MeV. Assume the solar constant i.e, the energy received per second per meter^2 on the surface of Earth is 1.4 k Wm^{-2} The neutrino flux on the Earth (in $m^{-2}\,s^{-1}$) is approximately (assume that the neutrinos do not interact with anything on their way to the Earth)

Physical constants you may need....

Charge of electron 1.60×10^{-19} C

(A) 6.5×10^{14} (B) 6.5×10^{10} (C) 6.5×10^{18} (D) 6.5×10^{22}

Solution · Q20 **Answer: (A)**

Energy released in one reaction:

$$E = 27 \times 1.60 \times 10^{-13}\ J$$

$$\Rightarrow E = 4.32 \times 10^{-12}\ J$$

Number of reactions needed for 1 m^2 in 1 s:

$$n = \frac{1.4 \times 10^3}{4.32 \times 10^{-12}}$$

$$\Rightarrow n \approx 3.24 \times 10^{14}$$

Each reaction gives 2 neutrinos.

$$\Phi = 2n$$

$$\Rightarrow \Phi \approx 6.5 \times 10^{14}\ m^{-2}\,s^{-1}$$

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

21. A large cluster of radius R has N stars each having a mass M. The stars are moving in the cluster such that the average kinetic energy of a star equals the magnitude of the average gravitational potential energy between two neighbouring stars. Assume the average gravitational potential energy of a star due to a neighbouring star is proportional to $\left(-\frac{GM^2}{r}\right)$, where r is the average distance between two stars. Then the average speed of the star is proportional to

(A) $\sqrt{\left[\frac{GMN^{1/3}}{R}\right]}$ (B) $\sqrt{\left[\frac{GMN^{2/3}}{R}\right]}$

(C) $\sqrt{\left[\frac{GMN}{R}\right]}$ (D) $\sqrt{\left[\frac{GMN^{4/3}}{R}\right]}$

Solution · Q21 **Answer: (A)**

Taking the stars as spread uniformly, the volume per star gives

$$r^3 \propto \frac{R^3}{N}$$

$$\Rightarrow r \propto RN^{-1/3}$$

Average kinetic energy equals the magnitude of the potential energy.

$$\frac{1}{2}Mv^2 \propto \frac{GM^2}{r}$$

$$\Rightarrow v \propto \sqrt{\frac{GMN^{1/3}}{R}}$$

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

22. The distance to Venus from Earth at a particular time is 9.00×10^{10} m. Assume the orbits of Venus and Earth around the Sun to be circular with radii 1.10×10^{11} m and 1.50×10^{11} m respectively. The angle between Sun and Venus as viewed from the Earth is approximately

(A) 20^0 (B) 47^0 (C) 60^0 (D) 80^0

Solution · Q22 **Answer: (B)**

In the triangle of the Sun S, Earth E and Venus V, take the sides in units of 10^{10} m.

$$SE = 15,\ EV = 9 \text{ and } SV = 11$$

By the cosine rule at E,

$$\cos E = \frac{15^2 + 9^2 - 11^2}{2 \times 15 \times 9}$$

$$\Rightarrow \cos E = \frac{185}{270}$$

$$\Rightarrow \cos E \approx 0.685$$

$$\therefore E \approx 47°$$

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

23. As viewed from a place on the Earth, a star makes an angle of 10^0 with the north pole and is just circumpolar. The latitude of the place is

(A) 10^0N (B) 80^0N (C) 10^0S (D) 80^0S

Solution · Q23 **Answer: (A)**

The star circles the north celestial pole at an angular distance of 10°.

At latitude ϕ north, its altitude at the lowest point of this circle is:

$$h_{min} = \phi - 10°$$

Just circumpolar means it only touches the horizon there.

$$\Rightarrow \phi - 10° = 0$$

$$\therefore \phi = 10° \text{ N}$$

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

24. The Moon makes hour angle of 40^0 at 6 pm on a particular day when the Sun is about to set. The hour angle of the Moon at the same time next day is approximately

(A) 70^0 (B) 40^0 (C) -40^0 (D) 27^0

Solution · Q24 **Answer: (D)**

The Moon moves eastward relative to the Sun, completing a round in about 29.5 days.

Daily shift relative to the Sun:

$$\frac{360^\circ}{29.5} \approx 12.2^\circ$$

At the same clock time next day, the Sun's hour angle is practically unchanged. Hour angle is measured westward, so the Moon's value decreases.

$$H \approx 40^\circ - 12.2^\circ$$

$$\Rightarrow H \approx 27.8^\circ$$

The nearest option is 27°.

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. If a and b are real numbers, the equation $a(x + 3)^2 + b(y + 4)^2 = 1$ represents

(A) An ellipse or a circle if $a > 0$ and $b > 0$

(B) An ellipse or a circle if $a < 0$ and $b < 0$

(C) A hyperbola if $a > 0$ and $b < 0$ or $a < 0$ and $b > 0$

(D) A parabola if $a > 0$ and $b = 0$

Solution · Q25 **Answer: (A), (C)**

(A) With a and b both positive, the curve is an ellipse, and a circle when they are equal. ∴ true.

(B) With a and b both negative:

$$a(x + 3)^2 + b(y + 4)^2 \le 0$$

The right side is 1, so no real point exists. ∴ false.

(C) With a and b of opposite signs, one squared term is subtracted from the other, giving a hyperbola. ∴ true.

(D) With b zero and a positive:

$$x = -3 \pm \frac{1}{\sqrt{a}}$$

These are two parallel straight lines, not a parabola. ∴ false.

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

26. If $\tan\theta = \cot\left(\frac{\pi}{3}\right)$ then θ can be

(A) $\frac{\pi}{6}$ (B) $\frac{7\pi}{6}$

(C) $\frac{13\pi}{6}$ (D) $\frac{5\pi}{6}$

Solution · Q26 **Answer: (A), (B), (C)**

$$\cot\left(\frac{\pi}{3}\right) = \tan\left(\frac{\pi}{6}\right)$$

$$\Rightarrow \tan\theta = \tan\left(\frac{\pi}{6}\right)$$

$$\Rightarrow \theta = n\pi + \frac{\pi}{6}$$

Here n is any integer. Taking n as 0, 1 and 2:

$$\theta = \frac{\pi}{6}, \frac{7\pi}{6}, \frac{13\pi}{6}$$

The fourth angle, 5π/6, has a negative tangent.

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

27. The critical velocity of a flowing liquid depends on

(A) Coefficient of viscosity
(B) Reynold number
(C) Density of the liquid
(D) Diameter of the tube

Solution · Q27 **Answer: (A), (B), (C), (D)**

For flow in a tube, the critical velocity is:

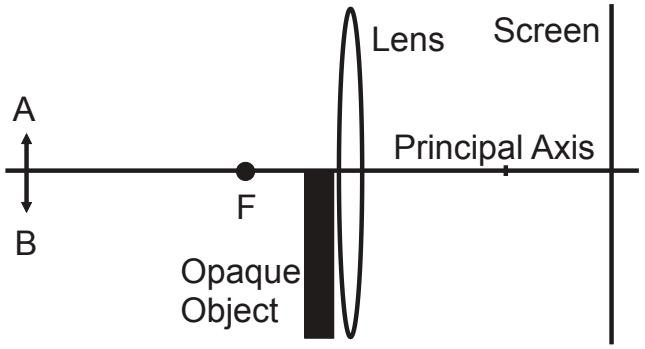
$$v_c = \frac{R_e \eta}{\rho D}$$

Here R_e is the critical Reynolds number, η the coefficient of viscosity, ρ the density and D the tube diameter.

∴ It depends on all four.

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

28. Consider the situation as shown in the diagram where a symmetric biconvex lens is half covered with an opaque object. Given that the object shown AB is symmetric about the principal axis, which of the following is true about the image seen on the screen?



(A) Full image of AB is formed
(B) Intensity of the image is reduced
(C) Full image of AB is formed and the intensity is reduced.
(D) Only half of AB is visible

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

Each point of AB sends light to every part of the lens. The uncovered upper half alone still forms the image of every point.

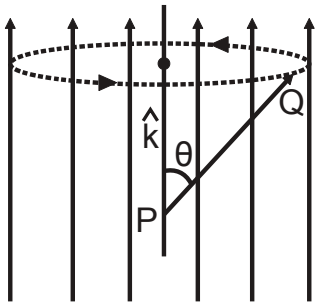
∴ The full image of AB is formed.

The covered half passes no light, so less light reaches the image and its intensity is reduced.

∴ (A), (B) and (C) are true; (D) is false.

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

29. A uniform magnetic field $\vec{B} = B_0\hat{k}$ exists over a certain region of space as shown in figure. A metal rod PQ of length L is fixed at P and PQ makes a constant angle of θ with $\hat{k}$ as it rotates about $\hat{k}$ with a constant angular velocity ω.



(A) The velocity of point Q is $\vec{v} = \vec{\omega} \times \vec{L}$

(B) The magnitude of induced electric field along the rod at a distance r from P is $E = r\omega B_0 \sin^2\theta$

(C) The magnitude of emf developed between P and Q is $= 0.5L^2\omega B_0 \sin 2\theta$

(D) The magnitude of emf developed between P and Q is $= 0.5L^2\omega B_0 \sin^2\theta$

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

(A) Q moves in a circle about the axis through P. Taking L from P to Q:

$$\vec{v} = \vec{\omega} \times \vec{L}$$

∴ true.

(B) Speed of the rod's point at distance r from P:

$$v = r\omega \sin\theta$$

The motional force per unit charge points radially away from the axis, with magnitude:

$$vB_0 = r\omega B_0 \sin\theta$$

Taking its component along the rod:

$$E = (r\omega B_0 \sin\theta)\sin\theta$$

$$\Rightarrow E = r\omega B_0 \sin^2\theta$$

∴ true.

For the emf between P and Q:

$$\varepsilon = \int_0^L r\omega B_0 \sin^2\theta \, dr$$

$$\Rightarrow \varepsilon = 0.5L^2\omega B_0 \sin^2\theta$$

∴ (D) is true and (C) is false.

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

30. Spectroscopic analysis of light from stars gives us information about

(A) The abundance of elements in the stars
(B) Parallax of stars
(C) The radial velocity of stars
(D) Proper motion of stars

Solution · Q30 **Answer: (A), (C)**

(A) The wavelengths of the spectral lines identify elements, and line strengths give their amounts. ∴ true.

(C) The Doppler shift of the lines gives the velocity along the line of sight. ∴ true.

(B), (D) Parallax and proper motion are changes in a star's position on the sky, found by measuring positions.

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

31. Which of the following terms refer to a variable star?

(A) White dwarf (B) RR Lyrae (C) Black hole (D) Eclipsing binary

Solution · Q31 **Answer: (B), (D)**

A variable star is a star whose observed brightness changes with time.

(B) RR Lyrae stars are pulsating variables. ∴ true.

(D) An eclipsing binary dims when one star passes in front of the other; it is classed as a variable star. ∴ true.

White dwarf and black hole are names of compact objects, not of kinds of variable star.

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

32. Which of the statement(s) about Globular cluster(s) is / are true?

(A) They are in the outer regions of the Milky Way
(B) They comprise of variable stars
(C) They comprise of young stars
(D) They are receding from us at very high speed

Solution · Q32 **As per Zigyan: (A)**

(A) Most globular clusters lie in the halo surrounding the disc of the Milky Way. ∴ true.

(B) "Comprise of" means they are made up of variable stars. A globular cluster has some variable stars, but it is not made up of them. ∴ false.

(C) Their stars are very old. ∴ false.

(D) Some globular clusters are approaching us while others are receding. ∴ false.

Reference: OpenStax Astronomy 2e, section 22.2 'Star Clusters': most globular clusters lie in a spherical halo around the Galaxy's disk, and they hold only very old stars.

Reference: W. E. Harris, catalogue of Milky Way globular clusters (McMaster University), radial velocities in km/s: M13 −244.2 (approaching), NGC 3201 +494.0 (receding).

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

ANSWER KEY

IOQA 2020-21 · PAPER CODE 41

32
QUESTIONS · 120 MARKS

IAPT final answer key for paper code 41. ★ marks an answer given as per Zigyan.

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

★ Answers as per Zigyan

- **Q32** — As per Zigyan: (A); IAPT key (A).

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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.

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RESULTS · 2021 – 2026

Our toppers, year by year

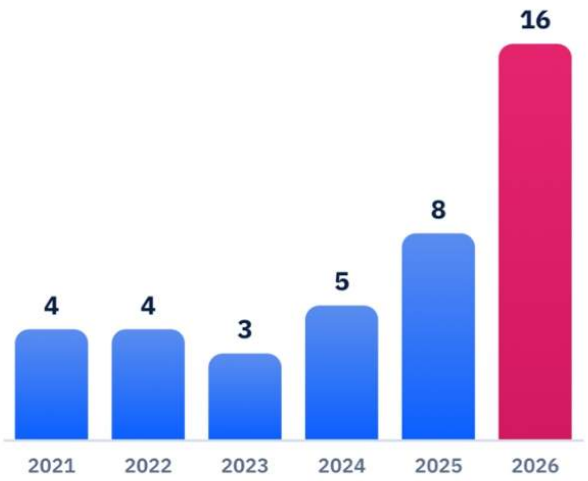
40
JEE Advanced selections in 6 years

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** 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.

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