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PREVIOUS YEAR PAPER · 2026

OLYMPIAD · STAGE I

NSEA

National Standard Examination in Astronomy

2026

Question paper, answer key and Zigyan solutions

60	216	120 min	41
Questions	Maximum marks	Time	Paper code

Question paper and TENTATIVE answer key: Indian Association of Physics Teachers (IAPT), NSEA 2026, 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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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
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Given in the question paper

Physical constants you may need….

Magnitude of charge on electron $e = 1.60 \times 10^{-19}\,C$	Speed of light in free space $c = 3 \times 10^{8}\,ms^{-1}$
Mass of electron $m_e = 9.11 \times 10^{-31}\,kg$	Speed of sound in dry air at 0°C $v = 332\ ms^{-1}$
Mass of proton $m_p = 1.67 \times 10^{-27}\,kg$	Permittivity of free space $\varepsilon_0 = 8.85 \times 10^{-12}\,C^2/Nm^2$
Mass of neutron $m_n = 1.67 \times 10^{-27}\,kg$	Permeability of free space $\mu_0 = 4\pi \times 10^{-7}\,H/m$
Acceleration due to gravity $g = 9.80\ ms^{-2}$	Planck's constant $h = 6.626 \times 10^{-34}\,Js$
Universal gravitational constant $G = 6.67 \times 10^{-11}\,Nm^2/kg^2$	Rydberg constant $R = 1.097 \times 10^{7}\,m^{-1}$
Universal gas constant $R = 8.31\,J/molK$	Astronomical unit $= 1.50 \times 10^{11}\,m$
Boltzmann constant $k = 1.38 \times 10^{-23}\,J/K$	Radius of Sun $R = 6.96 \times 10^{8}\,m$
Stefan's constant $\sigma = 5.67 \times 10^{-8}\,W/m^2K^4$	Mass of Sun $M = 2.0 \times 10^{30}\,kg$
Avogadro's constant $A = 6.022 \times 10^{23}\,mol^{-1}$	Radius of the Earth = 6371 km
Faraday constant $= 96,500\ C/mol$	Mass of the Earth = $5.97 \times 10^{24}\,kg$

PART A-1 · ONE CORRECT OPTION

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

1. A person claims to have followed this path: She was standing at location 'A' on the Earth. She walked towards the north direction for 100 km. Next, she turned towards east and walked for 100 km. Then she turned towards south and walked for 100 km and reached back the same location 'A'.

(A) Her claim is not possible.

(B) Location A can be only one particular place on the Earth.

(C) Location A can be only at two distinct places on the Earth.

(D) Location A can be anywhere on the Earth.

Solution · Q1 — **As per Zigyan: no option is correct**

East is taken along a circle of latitude.

South Pole as A:

After the first two legs she is still 100 km from the pole, so the last leg brings her back.

Near the North Pole, the walk also closes if the eastward 100 km makes n full circles of radius r.

$$r = \frac{100}{2\pi n}\ km$$

$$\Rightarrow r \approx 15.9/n\ km$$

So A can be any point on these circles around the North Pole, at distance d from it:

$$d \approx (100 + 15.9/n) \text{ km}, n = 1, 2, 3, \ldots$$

$\therefore$ A has infinitely many positions, but it cannot be anywhere on the Earth.

So no option is correct.

Why Zigyan differs from IAPT: besides the South Pole, every point on certain circles near the North Pole also works, so A is not limited to one particular place.

Check: A step-by-step coordinate trace on a sphere of radius 6371 km returns to A for starts 115.9, 108.0 and 105.3 km from the North Pole and at the South Pole, but misses A by about 100 km for a start on the equator.

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

2. For a binary star system with two identical mass stars,

(A) the orbit is always circular.

(B) the centre of mass of the system shows a periodic motion.

(C) the elliptical orbit may appear to be circular to the observer due to certain inclination.

(D) the stars can be always resolved using powerful telescopes.

Solution · Q2 **Answer: (C)**

(A): the orbits may be elliptical.

(B): with no external force, the centre of mass has no periodic motion.

(C): tilt an elliptical orbit about its minor axis through a suitable angle i. It appears circular when

$$a \cos i = b$$

(D): very close or very distant pairs cannot be resolved.

$\therefore$ Only statement (C) is true.

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

3. Two locations on the southern hemisphere of the earth have exactly the same length of day (and night) on any given day, but the times of sunrise and sunset both are offset by twelve hours each. A plane flying between the two locations trying to cover the shortest path will always fly

(A) first southwards and then northwards

(B) first northwards and then southwards

(C) exactly westwards.

(D) exactly eastwards.

Solution · Q3 **Answer: (A)**

Equal day length on every day means the same latitude.

A difference of 12 h in sunrise and sunset gives the difference in longitude:

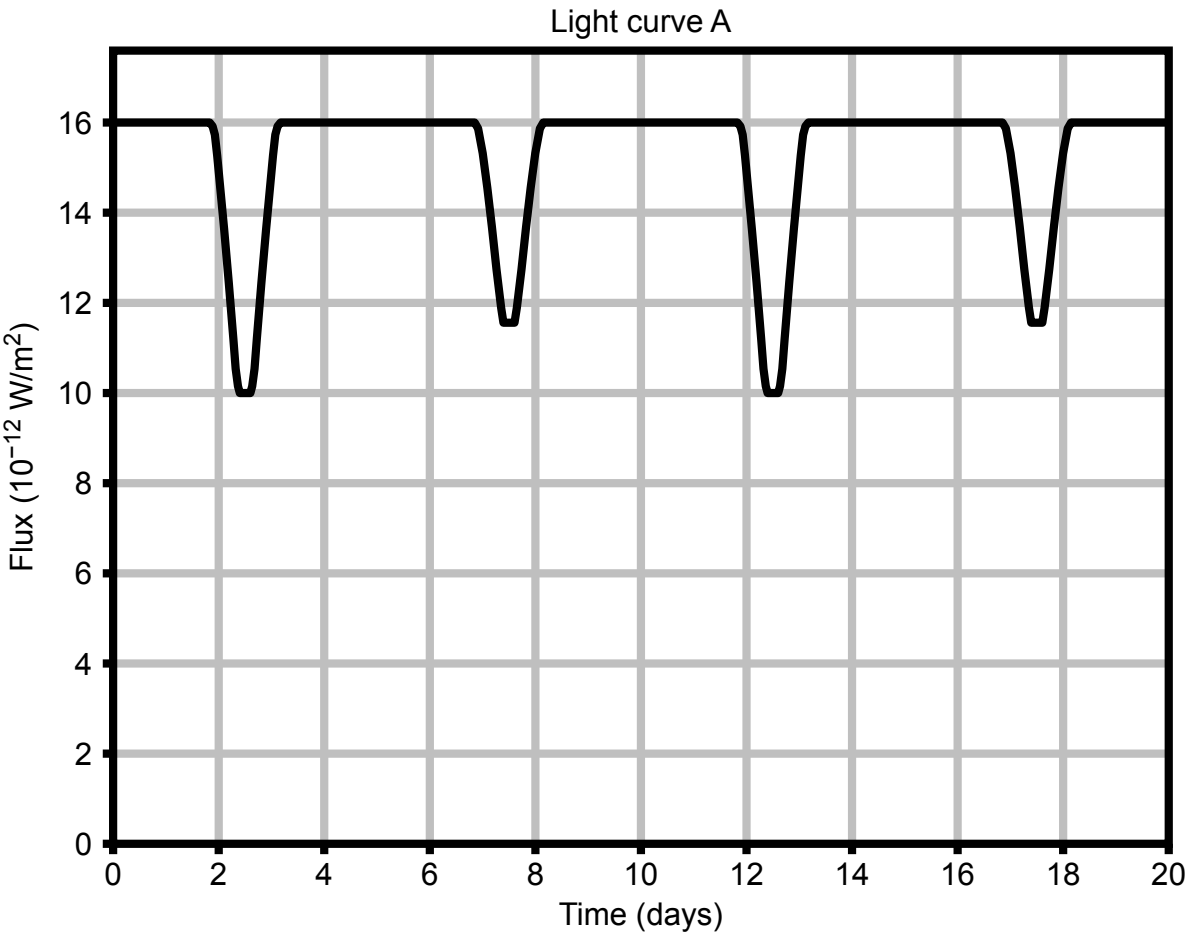
$$\Delta\lambda = 12 \times 15° = 180°$$

The places lie on opposite meridians. The shortest great circle path goes over the nearer pole, which is the South Pole.

$\therefore$ The plane flies first southwards and then northwards.

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

4. The light curve shows a fictional edge-on eclipsing binary system containing star X and star Y. Which of the following is the correct option about the light curve?



(A) Two stars revolve around common centre of mass in necessarily circular orbit.

(B) Both stars are surely not of the same size.

(C) The two stars have their intensities in the ratio of 6 : 5.

(D) Larger dip is when cooler star comes in front of hotter star.

Solution · Q4 **As per Zigyan: (D)**

Flat minima: the smaller disc is wholly in front of, or behind, the larger one.

So both eclipses hide the same area. For dip depth ΔF,

$$\Delta F \propto T^4$$

where T is the temperature of the hidden star.

So the larger dip occurs when the cooler star is in front of the hotter one. (D) is true.

(A): a plot cannot rule out a very small eccentricity, so a circular orbit does not necessarily follow.

(C): the two dip depths are

$$16 - 10 = 6$$

$$16 - 11.6 = 4.4$$

Neither these depths nor the possible star fluxes give 6 : 5.

Reference: OpenStax Astronomy 2e, section 18.3 'Diameters of Stars', Figure 18.10: for a smaller, hotter star, hiding it completely gives the strong dip, and its passage in front of the other star gives the smaller one.

Reference: NCERT Physics Class XI (Part II), Chapter 10 'Thermal Properties of Matter', section 10.9.4 'Blackbody Radiation': a perfect radiator emits power $A\sigma T^4$, so of two equal areas the hotter one gives out more.

Check: An edge-on orbit of eccentricity 0.01, long axis along the line of sight, keeps the dips evenly spaced and makes their widths differ by only about 2 %, too little to see here.

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

5. An astronomical telescope has objective with focal length of 750 mm. When eyepiece of 25 mm is used to observe a binary star, it is barely separated to a normal human eye. The aperture of telescope is 150 mm. The actual angular separation of the binary stars is approximately

(A) 1 arc sec (B) 2 arc sec (C) 1 arc min (D) 2 arc min

Solution · Q5 **Answer: (B)**

Magnification of the telescope:

$$M = \frac{f_o}{f_e}$$

$$\Rightarrow M = \frac{750}{25}$$

$$\Rightarrow M = 30$$

The eye can just separate an angle of about 1 arc min, so the image angle is

$$M\theta = 60 \text{ arc sec}$$

$$\Rightarrow \theta = 2 \text{ arc sec}$$

This is above the diffraction limit of the 150 mm aperture, about 0.9 arc sec.

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

6. An observer is located at latitude of 60° south and he can only see the sky above 10° horizon due to local geography. What percentage of sky will he never see from his location?

(A) 17.1 % (B) 25.0 % (C) 32.9 % (D) 41.3 %

Solution · Q6 **Answer: (C)**

Greatest altitude of a star of declination δ:

$$h = 90° - |\delta + 60°|$$

The star is never seen if h does not exceed 10°. This is so for

$$\delta \geq +20°$$

Fraction of the celestial sphere in this cap:

$$F = \frac{1 - \sin 20°}{2}$$

$$\Rightarrow F \approx 0.329$$

$\therefore$ He never sees 32.9 % of the sky.

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

7. Brightness of stars is given in magnitude. If the flux of energy received from two stars is l_1 and l_2, their magnitudes (m_1 and m_2 respectively) are related as $m_2 - m_1 = -2.5\log\left(\frac{l_2}{l_1}\right)$. A particular star X is seen with magnitude 3.0 from the earth and with magnitude 4.0 from an exoplanet around another star Y. From the Earth, stars X and Y are seen separated by 40° with each other. The distance of the star Y from the Earth is 30 ly. The distance of the star X from the exoplanet is

(A) 23.6 ly (B) 21.5 ly (C) 13.5 ly (D) 9.4 ly

Solution · Q7 **Answer: (B)**

Let d_P and d_E be the distances of X from the exoplanet and the Earth. By the inverse square law,

$$m_P - m_E = 5\log\left(\frac{d_P}{d_E}\right)$$

$$\Rightarrow d_P = 10^{0.2}\, d_E$$

$$\Rightarrow d_P \approx 1.585\, d_E$$

The exoplanet is practically at Y. Cosine rule in the triangle Earth, X, Y:

$$d_P^2 = d_E^2 + 30^2 - 60\, d_E \cos 40°$$

$$\Rightarrow 1.512\, d_E^2 + 45.96\, d_E - 900 = 0$$

$$\Rightarrow d_E \approx 13.55 \text{ ly}$$

$$\Rightarrow d_P \approx 21.5 \text{ ly}$$

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

8. Which of the following constellations has smallest area?

(A) Triangulum (B) Sagitta (C) Scutum (D) Crux

Solution · Q8 **Answer: (D)**

Crux is the smallest of all the 88 constellations.

Approximate areas in square degrees: Crux 68, Sagitta 80, Scutum 109, Triangulum 132.

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

9. A comet is orbiting around the sun with the closest distance as 3.00 AU. If its period of revolution around the Sun is 6.55 years, what is its farthest distance from the Sun?

(A) 3.50 AU (B) 4.00 AU (C) 5.38 AU (D) 8.38 AU

Solution · Q9 **Answer: (B)**

By Kepler's third law, with a in AU and T in years,

$$a^3 = T^2$$

$$\Rightarrow a^3 = (6.55)^2$$

$$\Rightarrow a \approx 3.50 \text{ AU}$$

The closest and farthest distances add up to the major axis:

$$r_{min} + r_{max} = 2a$$

$$\Rightarrow r_{max} = 7.00 - 3.00$$

$$\Rightarrow r_{max} = 4.00 \text{ AU}$$

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

10. Consider two statements A and R.

Statement A: The ion tail of a comet is always seen on the opposite side of the sun.

Statement R: Ion tail has very low density and hence it lags behind the comet approaching the Sun.

Choose the most appropriate option that best describe the above two statements.

(A) Both statements are correct and statement R is correct reason for statement A

(B) Both statements are correct, but statement R is not correct reason for statement A

(C) Statement A is correct, but statement R is wrong.

(D) Statement A is wrong, but statement R is correct.

Solution · Q10 **Answer: (C)**

The solar wind and its magnetic field drive the ions straight away from the Sun. So statement A is correct.

The ion tail does not lag because of its low density. When the comet recedes from the Sun, this tail even leads the comet.

So statement R is wrong.

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

11. It is observed that large number of stars follow $L \propto M^4$ relation between luminosity L and mass M. Similarly large number of stars have $R \propto M^{0.8}$. The surface temperature of stars will have relation $T \propto M^x$. The value of x is

(A) 3.2 (B) 1.7 (C) 0.8 (D) 0.6

Solution · Q11 **Answer: (D)**

By Stefan's law,

$$L = 4\pi R^2 \sigma T^4$$

$$\Rightarrow T^4 \propto \frac{L}{R^2}$$

$$\Rightarrow T^4 \propto \frac{M^4}{M^{1.6}}$$

$$\Rightarrow T^4 \propto M^{2.4}$$

$$\Rightarrow T \propto M^{0.6}$$

$$\therefore x = 0.6$$

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

12. Cosmological redshift

(A) is due to actual motion of galaxies away from the Milky Way.

(B) can be measured due to transverse motion of the sources as seen by the observer.

(C) is due to the cumulative expansion of space along the photon's path from the source to the observer.

(D) is due to slowing down of time near heavy stars and galaxies.

Solution · Q12 **Answer: (C)**

Cosmological redshift arises because space expands while the light travels. The wavelength is stretched all along the path.

In terms of the scale factor a of the universe, at observation and at emission,

$$1 + z = \frac{a_{obs}}{a_{em}}$$

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

13. Planetary scientists are interested in the study of asteroids because asteroids are

(A) numerous and can easily be found anywhere and hence help to study stability of orbits.

(B) chemically undifferentiated due to their smaller mass and hence chemical composition of solar system can be determined.

(C) chemically volatile and reflect lot of light, hence can tell us more about their orbits.

(D) less massive and hence have very stable orbits.

Solution · Q13 **Answer: (B)**

Most asteroids are too small to have melted and separated into layers, so they are chemically undifferentiated.

They therefore preserve the composition of the early solar system.

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

14. In a true scale model of the Solar system, the Earth's size is represented by a one-rupee coin (diameter approximately 2.2 cm). At what average distance can the Jupiter be placed from this one-rupee coin?

Physical constants you may need....

Radius of the Earth = 6371 km

(A) 12.2 km (B) 1.22 km (C) 122 m (D) 12.2 m

Solution · Q14 **Answer: (B)**

Diameter of the Earth:

$$D_E = 2 \times 6371 = 12742 \text{ km}$$

Average distance of Jupiter from the Earth, taken as its orbital radius:

$$r \approx 5.2 \text{ AU} = 7.8 \times 10^8 \text{ km}$$

In the model:

$$d = 2.2 \text{ cm} \times \frac{7.8 \times 10^8}{12742}$$

$$\Rightarrow d \approx 1.35 \text{ km}$$

The nearest option is 1.22 km; the others are far from this value.

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

15. Period of satellite Io around the planet Jupiter is 42.5 hours. It is tidally locked to Jupiter. Period of Jupiter around the Sun is 11.86 years while period of its rotation is 9 h 56 m. An observer located on the Equatorial region of Io, is seeing Jupiter almost overhead while the Sun on the Eastern horizon. In how much minimum time will she see the Sun on her Western horizon?

(A) 4.96 hours (B) 21.25 hours

(C) 5.93 years (D) Sun will not change position in the sky

Solution · Q15 **Answer: (B)**

Io is tidally locked, so it spins once in one orbit and Jupiter stays fixed in its sky.

Period of Jupiter around the Sun:

$$T_J = 11.86\ y \approx 1.04 \times 10^5\ h$$

Solar day T on Io:

$$\frac{1}{T} = \frac{1}{42.5} - \frac{1}{T_J}$$

$$\Rightarrow T \approx 42.5\ h$$

From the eastern to the western horizon, the Sun needs half of this day.

$$\therefore t = \frac{T}{2}$$

$$\Rightarrow t \approx 21.25\ h$$

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

16. Brightness of celestial object is given in magnitude. If the flux of energy received from two objects are l_1 and l_2, then their magnitudes (m_1 and m_2 respectively) are related to fluxes as $m_2 - m_1 = -2.5\log\left(\frac{l_2}{l_1}\right)$. A space probe from a distance of 50 pc is observing transit of Jupiter in front of the Sun. How much will be the change in magnitude when Jupiter's disc is fully in front of the Sun? Assume Sun's disc is uniformly bright. Sun's diameter is 109 times diameter of the Earth and Jupiter's diameter is 11 times that of the Earth.

(A) 0.01 (B) 0.02 (C) 0.04 (D) 0.5

Solution · Q16 **Answer: (A)**

From 50 pc, the Sun and Jupiter are practically equally far, so the fraction of light blocked is the ratio of the disc areas.

$$\frac{l_2}{l_1} = 1 - \left(\frac{11}{109}\right)^2$$

$$\Rightarrow l_2/l_1 = 0.9898$$

Change in magnitude:

$$m_2 - m_1 = -2.5\ \log\ (0.9898)$$

$$\Rightarrow m_2 - m_1 \approx 0.011$$

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

17. A student applies various voltages (V) across a resistor and measures corresponding currents (I). She then plots the graph of I (1cm as 1 mA on Y axis) and V (1 cm as 1 V on X axis). The best fit line makes an angle of 71° ± 1° with voltage axis. The value of resistor can be determined as

(A) 344 ± 5 Ω (B) 344 ± 20 Ω (C) 2.90 ± 0.04 kΩ (D) 2.90 ± 0.16 kΩ

Solution · Q17 **Answer: (B)**

Both axes use 1 cm for one unit (1 mA and 1 V), so the slope of the line gives:

$$I/V = \tan\theta \text{ mA/V}$$

$$\Rightarrow R = \cot\theta \text{ kΩ}$$

$$R = \cot 71° \text{ kΩ} \approx 344 \text{ Ω}$$

Error in R:

$$\Delta R = \text{cosec}^2\theta\,\Delta\theta \text{ kΩ}$$

$$\Delta\theta = \pi/180 \text{ rad}$$

$$\Rightarrow \Delta R = 1.119 \times 0.01745 \text{ kΩ}$$

$$\Rightarrow \Delta R \approx 20 \text{ Ω}$$

$$\therefore R = 344 \pm 20 \text{ Ω}$$

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

18. Weight of a cubical block is measured to be 360 gram force with a spring balance having least count of 20 gram force. Side length of the block, measured with least count of 1 mm, is equal to 13.6 cm. Calculation of pressure developed by the block on a table would have the uncertainty of

(A) 3 % (B) 5 %
(C) 7 % (D) will depend on size of the table

Solution · Q18 **Answer: (C)**

Pressure of the block on the table:

$$P = \frac{W}{a^2}$$

For the maximum error, each least count is taken as the error in that reading.

$$\frac{\Delta P}{P} = \frac{\Delta W}{W} + 2\frac{\Delta a}{a}$$

$$\frac{\Delta P}{P} = \frac{20}{360} + 2 \times \frac{0.1}{13.6}$$

$$\Rightarrow \Delta P/P = 0.0556 + 0.0147$$

$$\Rightarrow \Delta P/P \approx 0.07$$

So the uncertainty is about 7 %.

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

19. A truck of length 17 m is running on a straight highway with uniform speed of 60.0 km/hr. A car of length 3 m is running with zero acceleration on a track parallel to that of the truck. The car takes 3.6 seconds to completely overtake the truck. The speed of the car must be

(A) 20 km/hr (B) 71 km/hr (C) 80 km/hr (D) 82 km/hr

Solution · Q19 **Answer: (C)**

For complete overtaking, the car covers both lengths relative to the truck.

$$d = 17 + 3 = 20 \text{ m}$$

$$v_{rel} = 20/3.6 \text{ m/s}$$

$$\Rightarrow v_{rel} = 20 \text{ km/hr}$$

Both move in the same direction.

$$\therefore v_{car} = 60 + 20 = 80 \text{ km/hr}$$

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

20. A circular loop of radius R has N closely wound turns of a wire carrying current I. It is suspended vertically in a region of horizontal magnetic field of strength B in such a way that its area vector makes an angle of 30° with the magnetic field. Keeping the perimeter of the loop same if it is made into square shape,

(A) If the angle between area vector and B is increased to 60° without changing N, I and B the amount of torque will decrease.

(B) With the same N and I, to get the same amount of torque, angle between area vector and B should be increased without changing the magnitude of B.

(C) With the same N, I and orientation of the loop, torque developed will increase if magnitude of B is decreased.

(D) With the same N and orientation of the loop, to get the same torque developed, current I and magnitude of B should be decreased.

Solution · Q20 **Answer: (B)**

Torque on the loop:

$$\tau = NIAB \sin\theta$$

With the same perimeter $2\pi R$, the side of the square is $\pi R/2$.

$$\frac{A_{square}}{A_{circle}} = \frac{\pi}{4}$$

For the same torque with the same N, I and B:

$$\frac{\pi}{4}\sin\theta = \sin 30^\circ$$

$$\Rightarrow \sin\theta = \frac{2}{\pi}$$

$$\Rightarrow \theta \approx 39.5^\circ$$

So the angle has to be increased, and (B) is true.

(A) is false, because going from 30° to 60° raises $\sin\theta$ and so the torque.

Even when compared with the circular loop at 30°:

$$(\pi/4) \sin 60^\circ \approx 0.68 > \sin 30^\circ$$

For (C) and (D):

$$\tau \propto IB$$

So lowering B or I cannot raise or keep the torque; both are false.

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

21. Consider following statements:

Statement I: During heavy winters ponds freeze from top.

Statement II: Volume of water increases on heating as well as cooling starting at 4 °C.

Which of the following is correct conclusion.

(A) Both the statements are correct and statement II is the correct reason for statement I.

(B) Both the statements are correct but statement II is not the correct reason for statement I.

(C) Only statement I is correct.

(D) Only statement II is correct.

Solution · Q21 **Answer: (A)**

Water has maximum density at 4 °C, so it expands when cooled below 4 °C.

This colder, lighter water stays on top and freezes first.

So both statements are correct, and II explains I.

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

22. A moving coil galvanometer with a coil having resistance R_G, is being used as a current meter, connecting a shunt resistance $R_s << R_G$ parallel to the coil. The galvanometer now works with current sensitivity of 1 rad/microampere. Magnetic field of the MCG is now doubled and a resistance of 100 kΩ $>> R_G$ is connected in series with its coil so that it can be used as a voltmeter. Voltage sensitivity of this voltmeter would be,

(A) 20 rad/mV (B) 2.0 rad/mV (C) 0.20 rad/mV (D) 0.020 rad/mV

Solution · Q22 **As per Zigyan: (D)**

R_s is not given, so 1 rad/μA is taken as the sensitivity of the coil itself, and the shunt is not used in the voltmeter.

Current sensitivity of the coil:

$$\theta/I = NAB/k \propto B$$

With B doubled:

$$\theta/I = 2 \text{ rad}/\mu\text{A} = 2 \times 10^6 \text{ rad/A}$$

The series resistance is much larger than R_G, so the total resistance is nearly 100 kΩ.

Voltage sensitivity:

$$\frac{\theta}{V} = \frac{2 \times 10^6}{10^5} \text{ rad/V}$$

$$\Rightarrow \theta/V = 20 \text{ rad/V}$$

$$\Rightarrow \theta/V = 0.020 \text{ rad/mV}$$

Reference: NCERT Physics Class XII (Part I), Chapter 4 'Moving Charges and Magnetism', section 4.10 'The Moving Coil Galvanometer': current sensitivity NAB/k grows with B; voltage sensitivity is this value divided by the large series resistance.

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

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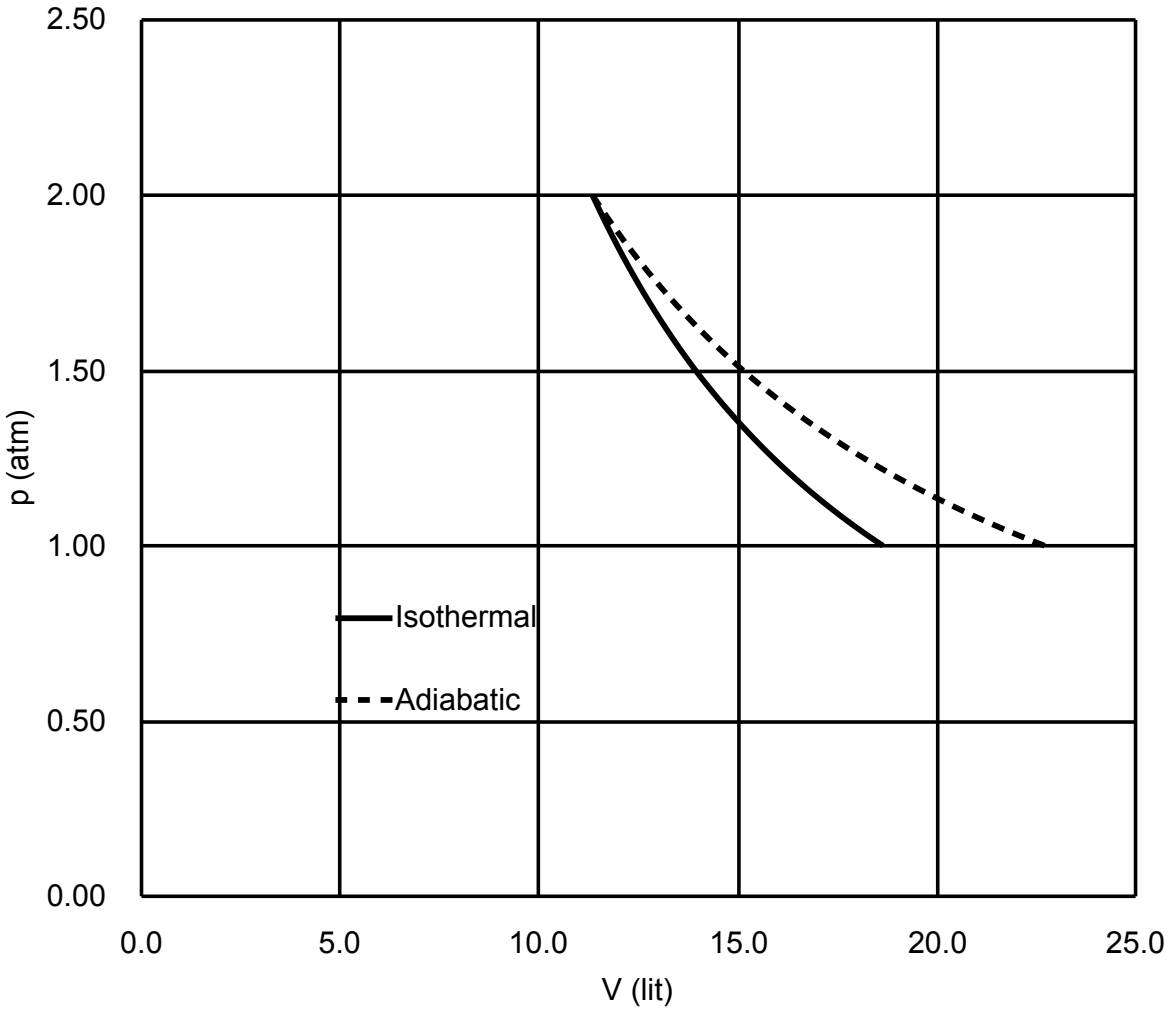
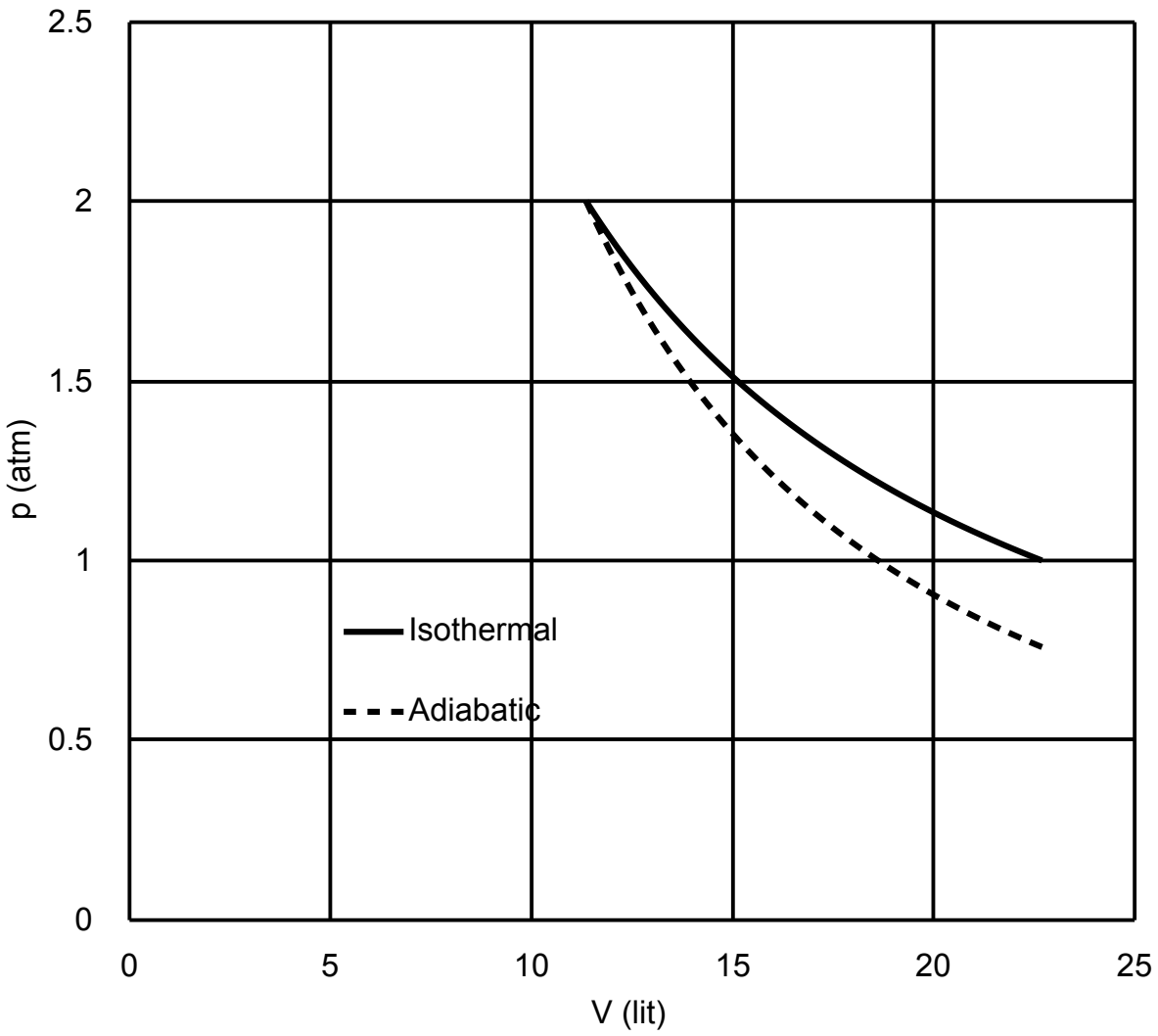
23. A reversible process is an infinitesimally slow process that can be reversed without leaving any change in the system. One mole of air at STP is compressed isothermally and reversibly to one-half of the original volume. It is then expanded adiabatically and reversibly to its original pressure. Which of the following graphs correctly shows these processes?

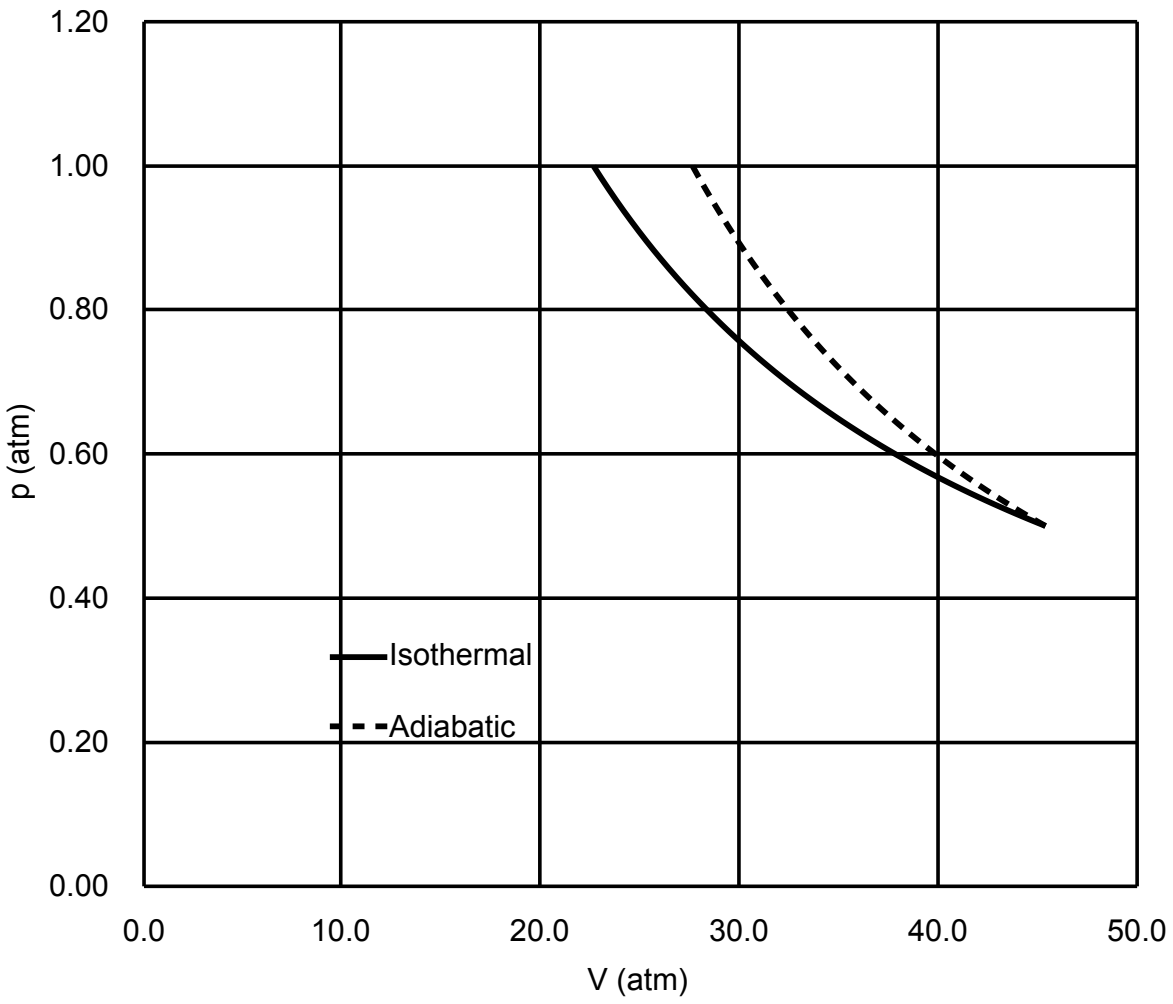
(A)



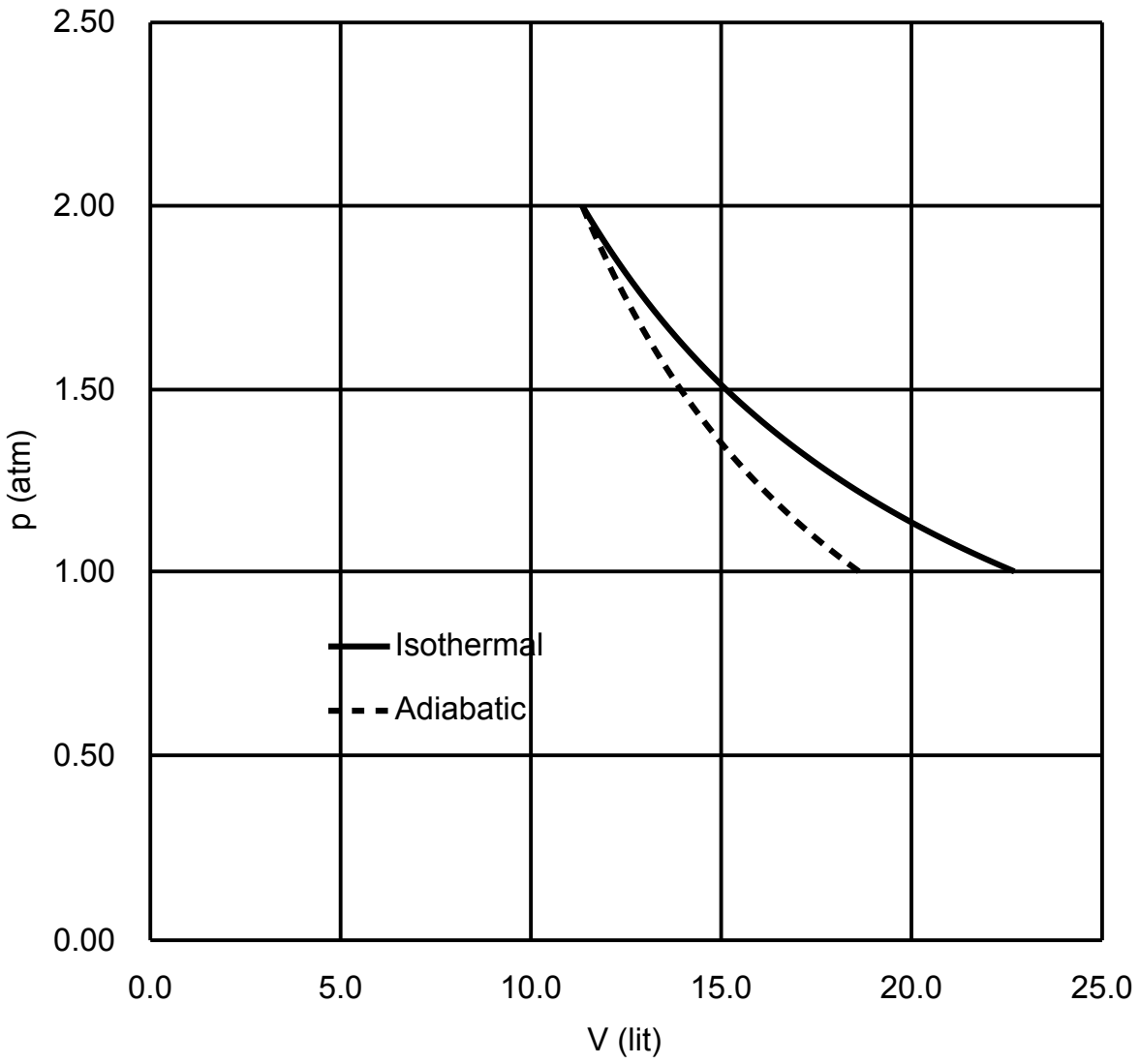
(B)



(C)


1.20
1.00
0.80
0.60
0.40
0.20
0.00
p (atm)
0.0
10.0
20.0
30.0
40.0
50.0
V (atm)
Isothermal
Adiabatic

(D)



Solution · Q23 **Answer: (D)**

Isothermal compression to half the volume:

$(V_0, 1\text{ atm}) \rightarrow (V_0/2, 2\text{ atm})$

The graphs use these values:

$$V_0 = 22.7\text{ L and } V_0/2 = 11.35\text{ L}$$

Adiabatic expansion of air back to 1 atm:

$$\gamma = 1.4$$

$$V = 11.35 \times 2^{1/1.4}\text{ L}$$

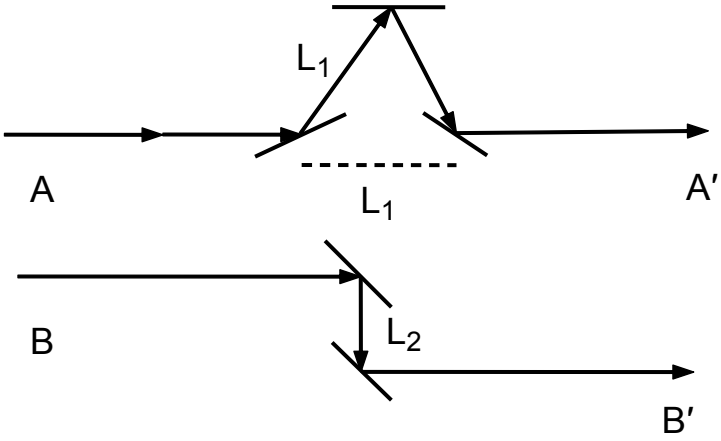
$$\Rightarrow V \approx 18.6\text{ L}$$

The adiabatic curve is also steeper than the isothermal curve.

Graph (D) shows the solid isotherm from 22.7 L to 11.35 L and the dashed adiabat from 11.35 L to 18.6 L.

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

24. Two rays **A** & **B** are light waves of equal wavelength λ and they are in phase. Ray **A** gets reflected at three mirrors and ray **B** at two mirrors as shown in the figure. Distance between consecutive reflecting faces for A is L_1 and that for B is L_2 such that $L_2 = L_1/3$. The smallest value of L_1 giving A′ and B′ in phase is



(A) $\frac{3\lambda}{4}$ (B) $\frac{3\lambda}{5}$

(C) $\frac{3\lambda}{10}$ (D) $\frac{3\lambda}{15}$

Solution · Q24 **Answer: (A)**

Compare both rays between the same incoming and outgoing wavefronts.

From its first to its third mirror, A travels $2L_1$ but moves forward only L_1 (the dashed length).

B travels L_2 between its mirrors without moving forward.

Path difference:

$$\Delta x = (2L_1 - L_1) - L_2$$

$$\Rightarrow \Delta x = 2L_1/3$$

Taking a phase change of π at each reflection, three for A and two for B leave a net π.

So, for the smallest length with A′ and B′ in phase:

$$\frac{2L_1}{3} = \frac{\lambda}{2}$$

$$\Rightarrow L_1 = \frac{3\lambda}{4}$$

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

25. When a person of average height stands on a smooth surface with clear horizons, the approximate distance to the horizon from the person is

Physical constants you may need....

Radius of the Earth = 6371 km

(A) 500 km (B) 50 km (C) 15 km (D) 5 km

Solution · Q25 **Answer: (D)**

For eye height h and radius of the Earth R,

$$(R + h)^2 = R^2 + d^2$$

$$\Rightarrow d \approx \sqrt{2Rh}$$

Taking an average eye height,

$$h \approx 1.6 \text{ m}, R \approx 6.4 \times 10^6 \text{ m}$$

$$\Rightarrow d \approx \sqrt{2 \times 6.4 \times 10^6 \times 1.6} \text{ m}$$

$$\Rightarrow d \approx 4.5 \text{ km} \approx 5 \text{ km}$$

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

26. Imagine a new scale for measuring sound energy is designed. In this scale, 1 μJ energy incident per unit second per square meter, is denoted as 0 sonus. Every increase of 4 sonus increases the sound energy by 100 times. Two identical sound sources of rating 3.2 sonus are played simultaneously. It was observed that one of them has its frequency slightly shifted, so they create beats. What will be the highest level of beats?

(A) 3.2 sonus (B) 3.8 sonus (C) 4.4 sonus (D) 6.4 sonus

Solution · Q26 **Answer: (C)**

Every 4 sonus multiplies the intensity by 100. At L sonus,

$$I = I_0 \times 10^{L/2}$$

For each source,

$$I_1 = I_0 \times 10^{1.6}$$

At a beat maximum the amplitudes add.

$$I_{max} = 4I_1$$

$$\Rightarrow 10^{L/2} = 4 \times 10^{1.6}$$

$$\Rightarrow \frac{L}{2} = 1.6 + \log 4 \approx 2.2$$

$$\Rightarrow L \approx 4.4 \text{ sonus}$$

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

27. A radioactive sample of Na-24 used for irradiation of a patient is prepared exactly 6.0 hrs before it is to be used for a patient. It has half-life of 14.96 hrs. If it is expected to have activity of 40 kBq at the start of the treatment, what should be its mass when it is prepared?

Physical constants you may need....

Avogadro's constant $A = 6.022 \times 10^{23} \text{ mol}^{-1}$

(A) 5.90×10^{-4} μg (B) 2.46×10^{-5} μg (C) 3.94×10^{-6} μg (D) 1.64×10^{-7} μg

Solution · Q27 **Answer: (D)**

Activity at the time of preparation:

$$A_0 = 40 \times 2^{6.0/14.96} \text{ kBq}$$

$$\Rightarrow A_0 \approx 52.8 \text{ kBq}$$

Number of nuclei at that time:

$$N = \frac{A_0 T_{1/2}}{\ln 2} = \frac{52.8 \times 10^3 \times 14.96 \times 3600}{0.693}$$

$$\Rightarrow N \approx 4.10 \times 10^9$$

Mass of these nuclei, at 24 g per mole:

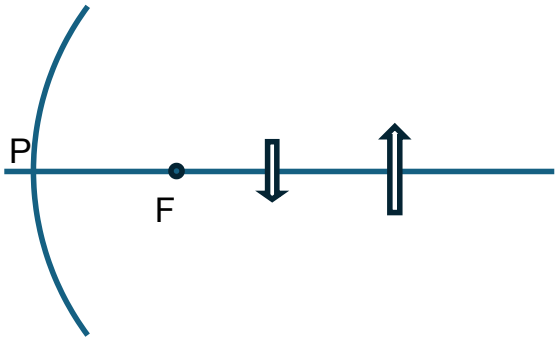
$$m = \frac{4.10 \times 10^9 \times 24}{6.02 \times 10^{23}}\ \text{g}$$

$$\Rightarrow m \approx 1.64 \times 10^{-13}\ \text{g} = 1.64 \times 10^{-7}\ \mu\text{g}$$

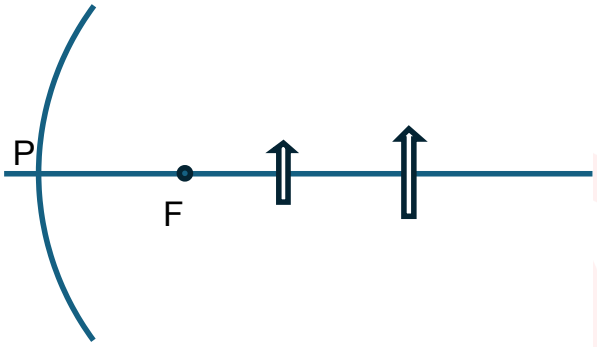
IAPT tentative answer: (D) | **Zigyan answer:** (D)

28. A caterpillar is in front of a concave mirror of focal length f as shown in the diagram. It is located at a distance of 2.5 f from the pole of the mirror and its height, perpendicular to the axis is 1.2 cm. Select the correct image of caterpillar for this situation. Caterpillar is shown with an upright arrow at the same location in all images. The other arrow is the image.

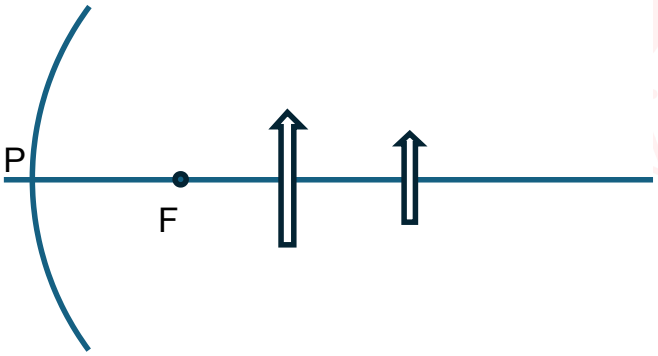
(A)



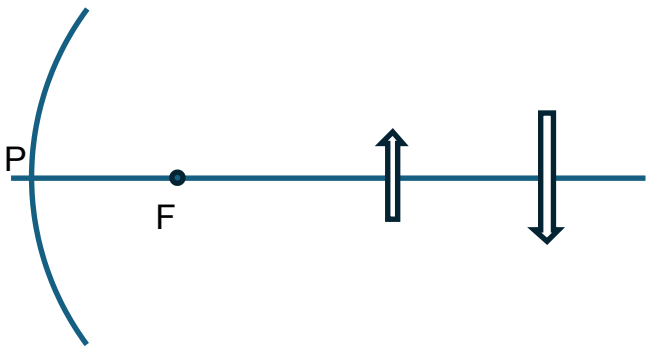
(B)



(C)



(D)



Solution · Q28 **Answer: (A)**

By the mirror formula with sign convention,

$$\frac{1}{v} - \frac{1}{2.5f} = -\frac{1}{f}$$

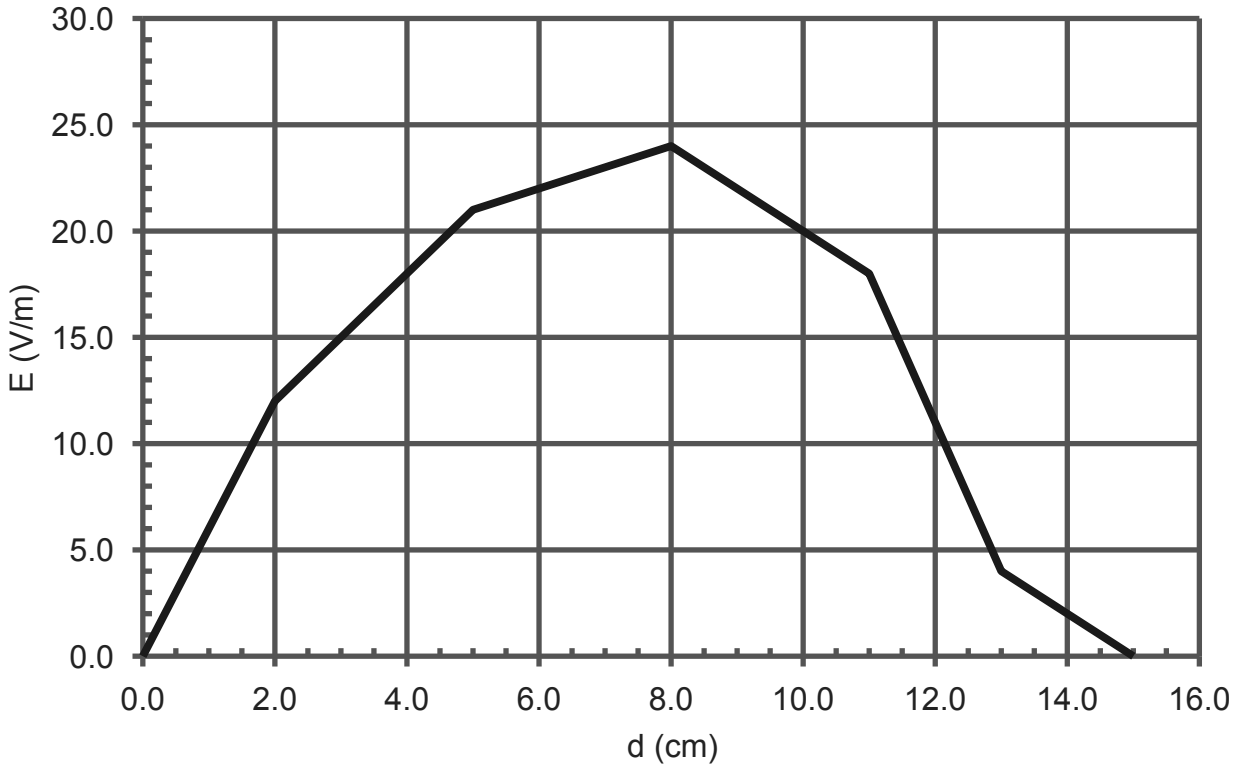
$$\Rightarrow v = -\frac{5f}{3}$$

$$m = -\frac{v}{u} = -\frac{2}{3}$$

So the image is real, inverted and smaller, between F and the object.

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

29. A proton moves in variable electric field as shown in the graph. If original speed of proton is 2.00 km/s, what is its final speed?



(A) 22.4 km/s (B) 20.5 km/s (C) 205 km/s (D) 880 km/s

Solution · Q29 **Answer: (B)**

The field is taken along the motion of the proton.

The potential difference is the area under the E–d graph:

$$\Delta V = (12 + 49.5 + 67.5 + 63 + 22 + 4) \times 10^{-2}\ V$$

$$\Rightarrow \Delta V = 2.18\ V$$

By the work–energy theorem,

$$v^2 = u^2 + \frac{2e\Delta V}{m}$$

$$v^2 = (2000)^2 + \frac{2 \times 1.60 \times 10^{-19} \times 2.18}{1.67 \times 10^{-27}}$$

$$\Rightarrow v^2 \approx 4.22 \times 10^8\ m^2\ s^{-2}$$

$$\Rightarrow v \approx 20.5\ km/s$$

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

30. A compressor designed to compress air is used to compress Helium instead of air near room temperature. Select correct statement regarding the functioning of this compressor with Helium. When the compressor is used for the same gauge reading, it will

(A) be overheated
(B) develop less pressure than that for air
(C) be cooled
(D) compress the gas to smaller volume

Solution · Q30 **Answer: (A)**

Same gauge reading means the same pressure ratio. For nearly adiabatic compression,

$$T_2 = T_1(P_2/P_1)^{(\gamma-1)/\gamma}$$

For helium,

$$\gamma = 5/3$$

$$\Rightarrow (\gamma - 1)/\gamma = 0.40$$

For air,

$$\gamma = 7/5$$

$$\Rightarrow (\gamma - 1)/\gamma \approx 0.29$$

So helium gets much hotter and the compressor is overheated.

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

31. An athlete weighing 60 kg has participated in hammer throw. Weight of the hammer is 4.0 kg. It is connected to a non-stretchable wire. The distance between grip and the hammer head is 1.16 m. At the time of releasing the hammer, athlete stretches her hands such that the grip of the hammer is at 32 cm from the axis of rotation. To achieve the linear velocity of 27 m/s, the centrifugal force on the hammer and the time it should complete each rotation is,

(A) 36496 N, 0.36 s (B) 30512 N, 0.27 s (C) 1970 N, 0.34 s (D) 1906 N, 0.27 s

Solution · Q31 **Answer: (C)**

With the arm and wire in one straight line,

$$r = 0.32\ \text{m} + 1.16\ \text{m} = 1.48\ \text{m}$$

$$F = \frac{mv^2}{r} = \frac{4.0 \times 27^2}{1.48}\ \text{N}$$

$$\Rightarrow F \approx 1970\ \text{N}$$

$$T = \frac{2\pi r}{v} = \frac{2\pi \times 1.48}{27}\ \text{s}$$

$$\Rightarrow T \approx 0.34\ \text{s}$$

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

32. An astronomical telescope with a primary mirror of 600 mm focal length is focussed for distant object using an eyepiece of focal length 15 mm. When a concave lens of 30 mm focal length is introduced between the primary and eyepiece to triple magnification of the system by what distance eyepiece needs to be shifted when focussed for distant object?

(A) 15 mm (B) 30 mm (C) 40 mm (D) 45 mm

Solution · Q32 **Answer: (C)**

To triple the magnification, the concave lens must magnify the primary image 3 times.

Let that image (virtual object) be x beyond the lens. The new image is then 3x beyond it.

$$\frac{1}{3x} - \frac{1}{x} = \frac{1}{-30}$$

$$\Rightarrow x = 20 \text{ mm}$$

The eyepiece moves by the same distance as the image:

$$3x - x = 40 \text{ mm}$$

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

33. If $\alpha, \beta, \gamma \in \left(0, \frac{\pi}{2}\right)$ such that $\tan\alpha + \tan\beta + \tan\gamma = \tan\alpha \tan\beta \tan\gamma$, then the value of $\cos^2\alpha + \cos^2\beta + \cos^2\gamma + 2\cos\alpha\cos\beta\cos\gamma$ is

(A) 0 (B) 1 (C) 2 (D) −1

Solution · Q33 **Answer: (B)**

$$\tan\alpha + \tan\beta + \tan\gamma = \tan\alpha \tan\beta \tan\gamma$$

$$\Rightarrow \tan(\alpha + \beta + \gamma) = 0$$

Each angle is acute, so

$$\alpha + \beta + \gamma = \pi$$

For the angles of a triangle,

$$\cos^2\alpha + \cos^2\beta + \cos^2\gamma + 2\cos\alpha\cos\beta\cos\gamma = 1$$

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

34. If $\begin{vmatrix} 1+x & 1 & 1 \\ 1 & 1+y & 1 \\ 1 & 1 & 1+z \end{vmatrix} = 0$, and $xyz \neq 0$; then

(A) $\frac{1}{x} + \frac{1}{y} + \frac{1}{z} = 1$ (B) $\frac{1}{x} + \frac{1}{y} + \frac{1}{z} = 0$

(C) $\frac{1}{x} + \frac{1}{y} + \frac{1}{z} = -1$ (D) $\frac{1}{x} + \frac{1}{y} + \frac{1}{z} = -2$

Solution · Q34 **Answer: (C)**

Expanding the determinant,

$$(1 + x)(y + z + yz) - z - y = 0$$

$$\Rightarrow xyz + xy + yz + zx = 0$$

Dividing by xyz,

$$\Rightarrow \frac{1}{x}+\frac{1}{y}+\frac{1}{z}=-1$$

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

35. $\sum_{k=1}^{n} \frac{1}{k(k+1)(k+2)} =$

(A) $\frac{1}{4}+\frac{1}{2(n+1)(n+2)}$ (B) $\frac{1}{4}-\frac{1}{2(n+1)(n+2)}$

(C) $\frac{1}{2}-\frac{1}{(n+1)(n+2)}$ (D) $\frac{1}{2(n+1)}$

Solution · Q35 **Answer: (B)**

$$T_k=\frac{1}{2}\left[\frac{1}{k(k+1)}-\frac{1}{(k+1)(k+2)}\right]$$

On adding, the middle terms cancel.

$$S_n=\frac{1}{2}\left[\frac{1}{2}-\frac{1}{(n+1)(n+2)}\right]$$

$$\Rightarrow S_n=\frac{1}{4}-\frac{1}{2(n+1)(n+2)}$$

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

36. The area (in appropriate units) enclosed by $y = x^3 - 4x + 3$ and $y = 3 - x$ is

(A) $\frac{3}{2}$ (B) $\frac{9}{2}$

(C) 6 (D) 9

Solution · Q36 **Answer: (B)**

For the points of intersection,

$$x^3 - 4x + 3 = 3 - x$$

$$\Rightarrow x = 0, \pm\sqrt{3}$$

The two enclosed parts are equal by symmetry.

$$A = 2\int_0^{\sqrt{3}} \left(3x - x^3\right)dx$$

$$\Rightarrow A = 2\left(\frac{9}{2}-\frac{9}{4}\right)=\frac{9}{2}$$

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

37. If $a_n = \frac{1}{\sqrt{n}+\sqrt{n+1}}$, then $\sum_{n=1}^{99} a_n = ?$

(A) 9 (B) 10

(C) $\sqrt{99}-1$ (D) 11

Solution · Q37 **Answer: (A)**

Rationalising each term,

$$a_n = \sqrt{n+1}-\sqrt{n}$$

On adding, the intermediate terms cancel.

$$\sum_{n=1}^{99} a_n = \sqrt{100} - \sqrt{1}$$

$$\therefore \Sigma a_n = 9$$

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

38. If $f(x) = x^x$ then $f'(1) = ?$

(A) 0 (B) 1 (C) 2 (D) e

Solution · Q38 **Answer: (B)**

Taking logarithm of both sides,

$$\ln f(x) = x \ln x$$

On differentiating,

$$f'(x) = x^x(1 + \ln x)$$

$$\therefore f'(1) = 1$$

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

39. The number of 5 digit numbers formed using 1, 2, 3, 4, 5 without repetition and divisible by 6 is

(A) 24 (B) 36 (C) 40 (D) 48

Solution · Q39 **Answer: (D)**

The digit sum is 15, so every such number is divisible by 3.

For divisibility by 2, the last digit must be 2 or 4.

The other four digits can be arranged in 4! ways.

$$\therefore N = 2 \times 4!$$

$$\Rightarrow N = 48$$

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

40. A number is chosen randomly from 1,2,3,...,100. The probability that it is divisible by neither 2 nor 5 is

(A) $\frac{2}{5}$ (B) $\frac{1}{2}$

(C) $\frac{3}{5}$ (D) $\frac{5}{2}$

Solution · Q40 **Answer: (A)**

Let A and B be the sets of multiples of 2 and 5 up to 100.

$$n(A \cup B) = n(A) + n(B) - n(A \cap B)$$

$$\Rightarrow n(A \cup B) = 50 + 20 - 10$$

$$\Rightarrow n(A \cup B) = 60$$

Required probability:

$$P = \frac{100 - 60}{100}$$

$$\Rightarrow P = \frac{2}{5}$$

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

41. If $z + \frac{1}{z} = 2$, $z \neq 0$ and $z \in \mathbb{C}$, then $z^{2026} + \frac{1}{z^{2026}} =$

(A) 0 (B) 1 (C) 2 (D) 2026

Solution · Q41 **Answer: (C)**

Multiplying the given relation by z,

$$(z-1)^2 = 0$$

$$\Rightarrow z = 1$$

$$\therefore z^{2026} + \frac{1}{z^{2026}} = 2$$

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

42. The number of solutions of $\sin x + \sin 2x + \sin 3x = 0$ in $[0, 2\pi)$ is

(A) 4 (B) 5 (C) 6 (D) 7

Solution · Q42 **Answer: (C)**

Combining the first and third terms,

$$2 \sin 2x \cos x + \sin 2x = 0$$

$$\Rightarrow \sin 2x (2 \cos x + 1) = 0$$

First factor:

$$\sin 2x = 0$$

$$\Rightarrow x = 0, \pi/2, \pi, 3\pi/2$$

Second factor:

$$\cos x = -1/2$$

$$\Rightarrow x = 2\pi/3, 4\pi/3$$

Total number of distinct solutions:

$$\therefore 4 + 2 = 6$$

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

43. If an integer n leaves reminder 1, when divided by 2 and 3, then $n^2 - 1$ is always divisible by

(A) 6 (B) 13 (C) 24 (D) 36

Solution · Q43 **As per Zigyan: (C)**

$n - 1$ is divisible by both 2 and 3.

$$\Rightarrow n = 6k + 1$$

$$\Rightarrow n^2 - 1 = 12k(3k + 1)$$

The product $k(3k + 1)$ is always even.

$\therefore n^2 - 1$ is always divisible by 24.

The largest such divisor among the options is taken.

A test value rules out 13 and 36:

$$n = 7,\ n^2 - 1 = 48$$

Check: Without writing n as 6k + 1: n is odd, so n − 1 and n + 1 are consecutive even numbers with product divisible by 8, and 3 divides n − 1; hence 24 always divides $n^2 - 1$.

IAPT tentative answer: (A) or (C) | **Zigyan answer:** (C)

44. Consider $f(x) = \sin^{-1}(\sin x) + \cos^{-1}(\cos x)$ for $x \in [-\pi, 2\pi]$. Which of the following correctly describes f?

(A) $f(x) = 2x$ for all $x \in [-\pi, 2\pi]$.

(B) f is piecewise linear and takes the value π on the interval $\left[\frac{\pi}{2}, \pi\right]$.

(C) $f(x) = 0$ for all $x \in [0, \pi]$.

(D) The range of f on $[-\pi, 2\pi]$ is $[0, 2\pi]$.

Solution · Q44 **Answer: (B)**

Adding the principal values interval by interval,

$$f(x) = -\pi - 2x,\ x \in [-\pi, -\pi/2]$$

$$f(x) = 0,\ x \in [-\pi/2, 0]$$

$$f(x) = 2x,\ x \in [0, \pi/2]$$

$$f(x) = \pi,\ x \in [\pi/2, \pi]$$

$$f(x) = 3\pi - 2x,\ x \in [\pi, 3\pi/2]$$

$$f(x) = 0,\ x \in [3\pi/2, 2\pi]$$

So f is piecewise linear, equals π on $[\pi/2, \pi]$, and has range $[0, \pi]$.

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

45. Bag X contains 3 red and 4 black balls; Bag Y contains 5 red and 3 black balls. One ball is transferred at random from X to Y, and then one ball is drawn at random from Y. The probability that the drawn ball is red equals:

(A) $\frac{38}{63}$ (B) $\frac{5}{9}$

(C) $\frac{37}{63}$ (D) $\frac{17}{28}$

Solution · Q45 **Answer: (A)**

The transferred ball is red or black. By total probability,

$$P(R) = \frac{3}{7} \times \frac{6}{9} + \frac{4}{7} \times \frac{5}{9}$$

$$\Rightarrow P(R) = \frac{38}{63}$$

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

46. The maximum area of a quadrilateral with sides 1.0 cm, 4.0 cm, 7.0 cm, 8.0 cm is

(A) $\sqrt{799}$ cm^2 (B) 3.5 cm^2

(C) 18.0 cm^2 (D) 11.06 cm^2

Solution · Q46 **Answer: (C)**

For fixed sides, the area is maximum when the quadrilateral is cyclic.

Semi-perimeter:

$$s = (1 + 4 + 7 + 8)/2$$

$$\Rightarrow s = 10 \text{ cm}$$

By Brahmagupta's formula,

$$A_{max} = \sqrt{(s-a)(s-b)(s-c)(s-d)}$$

$$\Rightarrow A_{max} = \sqrt{9 \times 6 \times 3 \times 2}$$

$$\Rightarrow A_{max} = 18 \text{ cm}^2$$

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

47. A sequence is defined by $a_1 = 1$, $a_{n+1} = a_n + \frac{1}{a_n^2}$. Choose the correct option from the following.

(A) $\lim_{n \to \infty} a_n = 0$

(B) $\lim_{n \to \infty} a_n$ is a finite number

(C) $a_{3000} > 30$

(D) $a_{3000} < 30$

Solution · Q47 **Answer: (D)**

Cubing the given relation,

$$a_{n+1}^3 = a_n^3 + 3 + \frac{3}{a_n^3} + \frac{1}{a_n^6}$$

The sequence increases from 1, so

$$a_n \geq 1$$

$$\Rightarrow 3 < a_{n+1}{}^3 - a_n{}^3 \leq 7$$

Adding the lower bounds,

$$a_n{}^3 \geq 3n - 2$$

So the sequence has no finite limit.

Adding the upper bounds,

$$a_{3000}{}^3 \leq 1 + 7 \times 2999$$

$$\Rightarrow a_{3000}{}^3 \leq 20994 < 27000$$

$$\therefore a_{3000} < 30$$

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

48. Consider the following functional equation for a real valued function on real numbers

$$f(x + y) + f(x - y) = 2f(x)f(y)$$

and f is not identically zero function.

Choose the correct option from the following:

(A) f is an odd function

(B) f is always differentiable on the set of real numbers

(C) f is always a periodic function

(D) f(0) = 1

Solution · Q48 **Answer: (D)**

Replacing y by zero,

$$2f(x) = 2f(x)f(0)$$

$$\Rightarrow f(x)[1 - f(0)] = 0$$

Since f is not identically zero,

$$\therefore f(0) = 1$$

IAPT tentative 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. A current carrying conductor is kept horizontal along North – South. It carries current from South to North. A small magnetic needle, free to rotate about vertical axis can be held in the neighbourhood of the conductor. If the needle is held

(A) above the conductor, its North pole deflects towards East.

(B) below the conductor, its South pole deflects towards East.

(C) East of the conductor in the same horizontal plane, North pole deflects towards East.

(D) West of the conductor in the same horizontal plane, South pole deflects towards East.

Solution · Q49 **Answer: (A), (B)**

By the right hand thumb rule, the field of the wire is:

East above it and West below it,

downward on its East side and upward on its West side.

The needle's North pole turns along this field, the South pole opposite to it.

(A) North pole turns East. ∴ True.

(B) North pole turns West, so the South pole turns East. ∴ True.

(C), (D) A vertical field gives no torque about the vertical axis. ∴ False.

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

50. A charge given to a solid copper sphere, kept on insulator stand, distributes uniformly on its surface only. Which of the following principles is/are involved in this fact?

(A) Like charges repel each other.

(B) Copper is a good conductor.

(C) Shape of the conductor is sphere.

(D) Every system tries to minimize its potential energy.

Solution · Q50 **Answer: (A), (B), (C), (D)**

(A) Mutual repulsion pushes the charges as far apart as possible. ∴ True.

(B) Charges move freely in copper and reach the surface, leaving zero field inside. ∴ True.

(C) All surface points of a sphere are equivalent, so the surface charge density is uniform. ∴ True.

(D) In equilibrium, this arrangement has the minimum electrostatic potential energy. ∴ True.

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

51. Assume Earth as a sphere with density radially increasing from surface (3 g/cc) to the core (>15 g/cc). Which of the following statements is/are correct statements?

(A) Gravitational field at height h above the surface will never be greater than field on the surface.

(B) Gravitational field at some depth d below the surface can be greater than field on the surface.

(C) Gravitational potential will always decrease as one moves towards the centre from surface.

(D) Gravitational potential near the centre of the Earth can be taken zero for calculations.

Solution · Q51 **Answer: (A), (B), (C), (D)**

(A) Outside the Earth:

$$g = \frac{GM}{(R+h)^2}$$

$$g_{outside} < g_{surface}$$

∴ True.

(B) Inside, for local density ρ and mean density ρ_m within radius r:

$$\frac{dg}{dr} = 4\pi G\left(\rho - \frac{2\rho_m}{3}\right)$$

Near the surface ρ is 3 g/cc, while ρ_m of the Earth is about 5.5 g/cc.

$$\Rightarrow \frac{dg}{dr} < 0$$

So g increases on going down. ∴ True.

(C) The field points towards the centre.

$$\frac{dV}{dr} = g$$

$$\Rightarrow \frac{dV}{dr} > 0$$

V falls on moving inward. ∴ True.

(D) The zero of potential is arbitrary and V is finite at the centre. ∴ True.

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

52. If the Planck's constant increases by 1 order of magnitude and speed of light reduces by one order of magnitude, without changing any other constants, which of the following will hold true?

(A) Energy of hydrogen atoms will reduce by 2 orders of magnitude

(B) Wavelength of hydrogen spectral lines will increase by 2 orders of magnitude

(C) Electron's rest mass energy will reduce by 2 orders of magnitude

(D) Moment of inertia of diatomic molecules will increase by 2 orders of magnitude.

Solution · Q52 **Answer: (A), (B), (C)**

Taking m, e and ε_0 unchanged:

$$E_n = -\frac{me^4}{8\varepsilon_0^2 h^2 n^2}$$

h becomes 10h, so the energy becomes one hundredth. ∴ (A) is true.

$$\lambda = \frac{hc}{\Delta E}$$

$$\Rightarrow \lambda \propto h^3 c$$

$$\Rightarrow \lambda_{new} = 10^3 \times 10^{-1} \times \lambda$$

$$\Rightarrow \lambda_{new} = 100\lambda$$

∴ (B) is true.

$$E_{rest} = mc^2 \propto c^2$$

It becomes one hundredth. ∴ (C) is true.

Bond length r varies as the Bohr radius:

$$a_0 = \frac{\varepsilon_0 h^2}{\pi m e^2}$$

$$I = \mu r^2 \propto h^4$$

So I rises by 4 orders of magnitude. ∴ (D) is false.

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

53. Let $a_n = x^n + \frac{1}{x^n}$, where $x + \frac{1}{x} = 3$. Which of the following are correct?

(A) $a_n = 3a_{n-1} - a_{n-2}$ (B) $a_2 = 7$

(C) $a_4 = 49$ (D) $a_6 = 322$

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

$$3a_{n-1} = \left(x + \frac{1}{x}\right)\left(x^{n-1} + \frac{1}{x^{n-1}}\right)$$

$$\Rightarrow 3a_{n-1} = a_n + a_{n-2}$$

$$\Rightarrow a_n = 3a_{n-1} - a_{n-2}$$

∴ (A) is true.

$$a_0 = 2, a_1 = 3$$

$$\Rightarrow a_2 = 9 - 2 = 7$$

$$\Rightarrow a_3 = 21 - 3 = 18$$

$$\Rightarrow a_4 = 54 - 7 = 47$$

$$\Rightarrow a_5 = 141 - 18 = 123$$

$$\Rightarrow a_6 = 369 - 47 = 322$$

$\therefore$ (B), (D) are true and (C) is false.

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

54. Let $\Delta = \begin{vmatrix} a+b & c & c \\ c+a & b & a \\ b+c & a & b \end{vmatrix}$. Which of the following are correct?

(A) $\Delta = 0$

(B) $a + b + c = 0 \Rightarrow \Delta = 0$

(C) Δ changes sign, if a and b are interchanged

(D) Δ is divisible by $(a - b)$

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

Apply $C_1 \rightarrow C_1 + C_2$ and take out the common factor:

$$\Delta = (a+b+c)\begin{vmatrix} 1 & c & c \\ 1 & b & a \\ 1 & a & b \end{vmatrix}$$

Now use $R_2 \rightarrow R_2 - R_1$ and $R_3 \rightarrow R_3 - R_1$.

$$\Rightarrow \Delta = (a + b + c)[(b - c)^2 - (a - c)^2]$$

$$\Rightarrow \Delta = -(a - b)(a + b + c)(a + b - 2c)$$

(A) Δ is not identically zero. $\therefore$ False.

(B) The factor $(a + b + c)$ is present. $\therefore$ True.

(C) Interchanging a and b reverses only the sign of $(a - b)$. $\therefore$ True.

(D) $(a - b)$ is a factor. $\therefore$ True.

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

55. Let $\vec{a}$, $\vec{b}$ and $\vec{c}$ be the three non-coplanar vectors to define other three vectors $\vec{p}$, $\vec{q}$ and $\vec{r}$ such that $\vec{p} = \dfrac{\vec{b}\times\vec{c}}{\left[\vec{a}\,\vec{b}\,\vec{c}\right]}$, $\vec{q} = \dfrac{\vec{c}\times\vec{a}}{\left[\vec{a}\,\vec{b}\,\vec{c}\right]}$ and $\vec{r} = \dfrac{\vec{a}\times\vec{b}}{\left[\vec{a}\,\vec{b}\,\vec{c}\right]}$.

Which of the following is/are necessarily true?

(A) $\vec{a}\cdot\vec{p} + \vec{b}\cdot\vec{q} + \vec{c}\cdot\vec{r} = 3$

(B) $\vec{a}\cdot\vec{q} = 0$

(C) $\left[\vec{p}\,\vec{q}\,\vec{r}\right] = \dfrac{1}{\left[\vec{a}\,\vec{b}\,\vec{c}\right]}$

(D) $\vec{p}$, $\vec{q}$, $\vec{r}$ are coplanar

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

$$\vec{a}\cdot\vec{p} = \frac{\vec{a}\cdot\left(\vec{b}\times\vec{c}\right)}{\left[\vec{a}\,\vec{b}\,\vec{c}\right]}$$

$$\Rightarrow \vec{a}\cdot\vec{p} = 1$$

Similarly for the other two terms.

$$\vec{a}\cdot\vec{p} + \vec{b}\cdot\vec{q} + \vec{c}\cdot\vec{r} = 3$$

$\therefore$ (A) is true.

$$\vec{a}\cdot\vec{q} = \frac{\vec{a}\cdot\left(\vec{c}\times\vec{a}\right)}{\left[\vec{a}\,\vec{b}\,\vec{c}\right]}$$

$$\Rightarrow \vec{a}\cdot\vec{q} = 0$$

$\therefore$ (B) is true.

$$\vec{q}\times\vec{r} = \frac{\vec{a}}{\left[\vec{a}\,\vec{b}\,\vec{c}\right]}$$

$$\Rightarrow \left[\vec{p}\,\vec{q}\,\vec{r}\right] = \frac{\vec{p}\cdot\vec{a}}{\left[\vec{a}\,\vec{b}\,\vec{c}\right]}$$

$$\Rightarrow \left[\vec{p}\,\vec{q}\,\vec{r}\right] = \frac{1}{\left[\vec{a}\,\vec{b}\,\vec{c}\right]}$$

$\therefore$ (C) is true.

This product is not zero, so (D) is false.

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

56. An ellipse has foci at $F_1(1, 0)$ and $F_2(-1, 0)$ and passes through the point $P\left(1, \frac{1}{\sqrt{2}}\right)$. Which of the following are correct?

(A) $a^2 = 2, b^2 = 1$.

(B) The eccentricity is $e = \frac{1}{\sqrt{2}}$.

(C) The length of the minor axis is 2.

(D) The directrices of the ellipse are $x = \pm 2$.

Solution · Q56 **Answer: (A), (B), (C), (D)**

$$2a = PF_1 + PF_2$$

$$\Rightarrow 2a = \frac{1}{\sqrt{2}} + \frac{3}{\sqrt{2}}$$

$$\Rightarrow a = \sqrt{2}$$

$$ae = 1$$

$$\Rightarrow e = \frac{1}{\sqrt{2}}$$

$$b^2 = a^2 - (ae)^2$$

$$\Rightarrow b^2 = 1 \text{ and } a^2 = 2$$

$$2b = 2$$

Directrices:

$$x = \pm \frac{a}{e}$$

$$\Rightarrow x = \pm 2$$

$\therefore$ All four options are correct.

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

57. Inside the core of star,

(A) the p-p chain of nuclear fusion creates He from H in a solar mass or a less massive star.

(B) the CNO cycle creates the nuclei of elements N and O.

(C) all heavy nuclei till Fe are created if star is massive and evolved.

(D) the triple alpha process creates the nuclei of C.

Solution · Q57 **Answer: (A), (C), (D)**

(A) The p-p chain is the main source of He in stars of solar mass or less. $\therefore$ True.

(B) In the CNO cycle, the N and O nuclei formed on the way do not survive. The net result is only H $\rightarrow$ He. $\therefore$ False.

(C) In massive evolved stars, successive He, C, Ne, O and Si burning builds nuclei up to Fe. $\therefore$ True.

(D) Triple alpha process:

$3\ {}^4He \rightarrow {}^{12}C + \gamma$

$\therefore$ True.

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

58. For an observer located at the equator of the Earth, moving in an elliptical orbit around the Sun,

(A) duration between two sunrises is always the same.

(B) the sun passes over zenith every 24 hours.

(C) a star can rise twice on a particular date.

(D) if two stars rise together, they also set together.

Solution · Q58 **Answer: (C), (D)**

(A) The solar day varies through the year due to the elliptical orbit and the tilted axis. ∴ False.

(B) The Sun's declination keeps changing. At the equator it crosses the zenith only around the equinoxes. ∴ False.

(C) The sidereal day is shorter than the mean solar day:

sidereal day ≈ 23 h 56 min

A star rising just after midnight rises again before the next midnight. ∴ True.

(D) At the equator, every star stays above the horizon for half a sidereal day. So stars rising together set together. ∴ True.

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

59. Two planets, A and B, move around the same star with exactly the same time period. Planet A and planet B will

(A) always be exactly on opposite sides of the star.

(B) sweep out exactly equal areas in equal intervals of time.

(C) always have the same distance of closest approach to the star.

(D) have the same distance of farthest approach from the star.

Solution · Q59 **As per Zigyan: (B)**

By Kepler's third law, both orbits have the same semi-major axis, but their eccentricities may differ.

(A) Their positions are not linked. ∴ False.

(B) is read for each planet separately. By Kepler's second law:

$$\frac{dA}{dt} = \text{constant}$$

So each sweeps equal areas in equal times. ∴ True.

(C), (D) The distances a(1 − e) and a(1 + e) depend on e. ∴ False.

Reference: NCERT Physics Class XI (Part I), Chapter 7 'Gravitation', section 7.2: the law of areas applies to each planet, whose area rate is fixed by its own angular momentum and mass.

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

60. A hypothetical planet-star system, behaves exactly like the Earth-Sun system (rotation and revolution period of the planet are the same as that of Earth), with only one difference – the axis of the rotation of the planet is in the orbital plane.

(A) The star will appear always on the zenith to the observer at north pole.

(B) When the star sets (or rises) for the observer at the poles, the star will be at the zenith at mid-day for the observer at the equator.

(C) The star will always appear at the horizon to the observer at the equator.

(D) An observer on either of the poles of the planet will see the sun rise once and set once in one year cycle.

Solution · Q60 **Answer: (B), (D)**

The axis stays fixed in the orbital plane. So in a year the star's declination δ runs from $-90°$ to $+90°$ and back.

(A) The star is overhead at the north pole at only one point of the orbit. $\therefore$ False.

(B) For the poles, the star rises or sets when:

$$\delta = 0°$$

It then passes through the zenith at noon for the equator. $\therefore$ True.

(C) At the equator, it stays on the horizon all day only near:

$$\delta = \pm 90°$$

$\therefore$ False.

(D) At a pole, the altitude is $\pm\delta$. It changes sign twice a year, giving one sunrise and one sunset. $\therefore$ True.

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

ANSWER KEY

NSEA 2026 · PAPER CODE 41 · IAPT TENTATIVE KEY

60
QUESTIONS · 216 MARKS

IAPT's TENTATIVE answer key for paper code 41; the final key may differ. ★ marks an answer given as per Zigyan.

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

★ Answers as per Zigyan

- **Q1** — As per Zigyan: no option is correct; IAPT tentative key (B).
- **Q4** — As per Zigyan: (D); IAPT tentative key (D).
- **Q22** — As per Zigyan: (D); IAPT tentative key (D).
- **Q43** — As per Zigyan: (C); IAPT tentative key (A) or (C).
- **Q59** — As per Zigyan: (B); IAPT tentative key (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

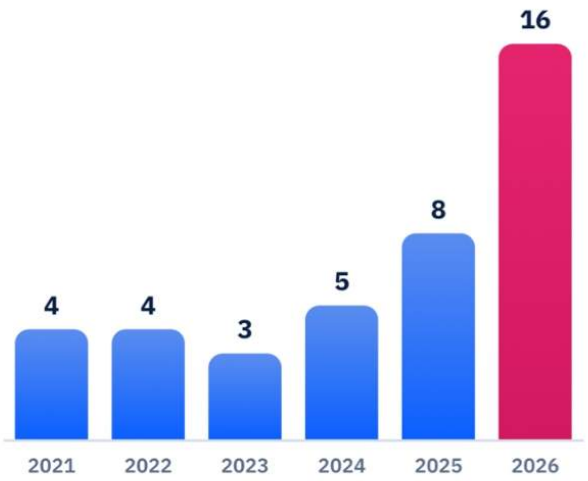
40
JEE Advanced selections in 6 years

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** 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