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PREVIOUS YEAR PAPER · 2020-21

OLYMPIAD · STAGE I

IOQP

Indian Olympiad Qualifier in Physics (Part I)

2020-21

Question paper, answer key and Zigyan solutions

32	120	60 min	61
Questions	Maximum marks	Time	Paper code

Question paper and official answer key: Indian Association of Physics Teachers (IAPT), IOQP 2020-21, paper code 61.
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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OLYMPIAD RESULTS

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

CHEMISTRY

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

PHYSICS

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

ASTRONOMY

- Sulokya Bibhuty — 3 Years Classroom

MATHEMATICS (IOQM)

- Priyanshi — 4 Years Classroom

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

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

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Given in the question paper

Physical constants you may need….

Mass of electron $m_e = 9.10\times10^{-31}$ kg	Magnitude of charge on electron $e = 1.60\times10^{-19}$ C
Mass of proton $m_p = 1.67\times10^{-27}$ kg	Permittivity of free space $\varepsilon_0 = 8.85\times10^{-12}$ $C^2N^{-1}m^{-2}$
Acceleration due to gravity $g = 9.8$ ms^{-2}	Permeability of free space $\mu_0 = 4\pi\times10^{-7}$ Hm^{-1}
Universal gravitational constant $G = 6.67\times10^{-11}$ Nm^2Kg^{-2}	Planck's constant $h = 6.625\times10^{-34}$ Js
Universal gas constant $R = 8.31$ $Jmol^{-1}K^{-1}$	Faraday constant = 96,500 $Cmol^{-1}$
Boltzmann constant $k = 1.38\times10^{-23}$ JK^{-1}	Rydberg constant $R = 1.097\times10^7$ m^{-1}
Stefan's constant $\sigma = 5.67\times10^{-8}$ $Wm^{-2}K^{-4}$	Speed of light in free space $c = 3\times10^8$ ms^{-1}
Avogadro's constant $N_A = 6.023\times10^{23}$ mol^{-1}	

PART A-1 · ONE CORRECT OPTION

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

1. If speed of light c, Planck's constant h and gravitational constant G are chosen as fundamental quantities, dimensions of time in this system of units is

(A) $ch^{3/2}G^{-3/2}$ (B) $c^{-2}G^{1/2}h$

(C) $c^2G^{1/2}h^{5/2}$ (D) $c^{-5/2}G^{1/2}h^{1/2}$

Solution · Q1 **Answer: (D)**

Dimensions of the new base quantities:

$$[c] = LT^{-1}$$

$$[h] = ML^2T^{-1}$$

$$[G] = M^{-1}L^3T^{-2}$$

Let

$$t \propto c^x h^y G^z$$

Comparing the powers of M, L and T,

$$y - z = 0$$

$$x + 2y + 3z = 0$$

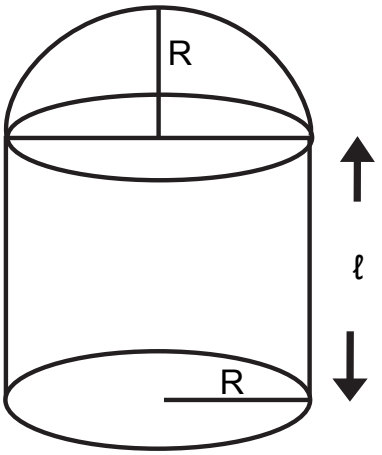
$$-x - y - 2z = 1$$

$$\Rightarrow y = z = \frac{1}{2}, x = -\frac{5}{2}$$

$$\therefore t \propto c^{-5/2}G^{1/2}h^{1/2}$$

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

2. A solid hemisphere is cemented on the flat surface of a solid cylinder of same radius R and same material. The composite body is rotating about the axis of the cylinder of length ℓ with angular speed ω. The radius of gyration K is



(A) $R\sqrt{\frac{2}{5}\left(\frac{15R+8\ell}{3R+2\ell}\right)}$

(B) $R\sqrt{\frac{1}{10}\left(\frac{15\ell+8R}{3\ell+2R}\right)}$

(C) $R\sqrt{\frac{3}{10}\left(\frac{15R+8\ell}{3R+2\ell}\right)}$

(D) $R\sqrt{\frac{1}{10}\left(\frac{3\ell+2R}{15\ell+8R}\right)}$

Solution · Q2 **Answer: (B)**

About the common axis, with density ρ,

$$M_1 = \pi R^2 \ell \rho$$

$$M_2 = \frac{2}{3}\pi R^3 \rho$$

$$I = \frac{1}{2}M_1R^2 + \frac{2}{5}M_2R^2 = \frac{\pi\rho R^4(15\ell+8R)}{30}$$

$$M = M_1 + M_2 = \frac{\pi\rho R^2(3\ell+2R)}{3}$$

$$K^2 = \frac{I}{M}$$

$$\therefore K = R\sqrt{\frac{1}{10}\left(\frac{15\ell+8R}{3\ell+2R}\right)}$$

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

3. The shortest period of rotation of a planet (considered to be a sphere of uniform density ρ) about its own axis, such that any mass m kept on its equator is just to fly off the surface, is

(A) $T = \sqrt{\frac{5\pi}{\rho G}}$

(B) $T = \sqrt{\frac{\pi}{3\rho G}}$

(C) $T = \sqrt{\frac{3\pi}{\rho G}}$

(D) $T = \sqrt{\frac{5\pi}{3\rho G}}$

Solution · Q3 **Answer: (C)**

At the limiting speed, the normal reaction is zero.

$$\frac{GMm}{R^2} = m\omega^2 R$$

Mass of the planet:

$$M = \frac{4}{3}\pi R^3 \rho$$

$$\Rightarrow \omega^2 = \frac{4\pi G\rho}{3}$$

$$\therefore T = \frac{2\pi}{\omega} = \sqrt{\frac{3\pi}{\rho G}}$$

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

4. A body of mass 10 kg at rest explodes into two fragments of masses 3 kg and 7 kg. If the total kinetic energy of two pieces after explosion is 1680 J, the magnitude of their relative velocity in m/s after explosion is:

(A) 40 (B) 50 (C) 70 (D) 80

Solution · Q4 **Answer: (A)**

By conservation of momentum,

$$3v_1 = 7v_2$$

Reduced mass:

$$\mu = \frac{3 \times 7}{3 + 7} = 2.1 \text{ kg}$$

$$1680 = \frac{1}{2} \times 2.1 \times v_{rel}^2$$

$$\therefore v_{rel} = 40 \text{ m s}^{-1}$$

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

5. A shot is fired at an angle α to the horizontal up a hill (Considered to be a long straight incline plane) of inclination β to the horizontal. It will strike the hill horizontally if

(A) $\tan\alpha = 2\tan\beta$ (B) $\sin\alpha = \sin 2\beta$ (C) $\sin\alpha = 2\sin\beta$ (D) $\tan\alpha = 4\tan\beta$

Solution · Q5 **Answer: (A)**

The shot hits the hill horizontally at the highest point of its path.

$$x = \frac{u^2 \sin\alpha\cos\alpha}{g}$$

$$y = \frac{u^2 \sin^2\alpha}{2g}$$

This point lies on the incline.

$$\tan\beta = \frac{y}{x} = \frac{\tan\alpha}{2}$$

$$\therefore \tan\alpha = 2\tan\beta$$

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

6. A particle is executing Simple Harmonic Motion of time period $T = 4\pi^2$ in a straight line. Starting from rest, it travels a distance 'a' in the first second and distance 'b' in the next second travelling in the same direction. The amplitude of SHM is

(A) $\frac{2a^2}{3a-b}$ (B) $\frac{3a^2}{3a-2b}$

(C) $\frac{2a^2}{2a-b}$ (D) none of these

Solution · Q6 **Answer: (A)**

The particle starts from rest at an extreme. T (no unit printed) is long compared with 2 s, so the direction does not change. The distances covered in one and two seconds satisfy

$$a = A(1-\cos\omega)$$

$$a+b = A(1-\cos 2\omega)$$

$$1-\cos 2\omega = 2(1-\cos\omega)(1+\cos\omega)$$

$$\Rightarrow a+b = 2a(1+\cos\omega)$$

$$\cos\omega = 1-\frac{a}{A}$$

$$\Rightarrow a+b = 4a-\frac{2a^2}{A}$$

$$\therefore A = \frac{2a^2}{3a-b}$$

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

7. The kinetic energy of a particle moving along a circle of radius R depends upon the distance covered 's' as $KE = as^2$ where a is a constant. The magnitude of the force acting on the particle as a function of 's' is

(A) $\frac{2as^2}{R}$ (B) $\frac{2as^2}{m}$

(C) 2as (D) $2as\sqrt{1+\left(\frac{s}{R}\right)^2}$

Solution · Q7 **Answer: (D)**

$$\frac{1}{2}mv^2 = as^2$$

Centripetal force:

$$F_c = \frac{mv^2}{R} = \frac{2as^2}{R}$$

Tangential force:

$$F_t = \frac{d(as^2)}{ds} = 2as$$

$$F = \sqrt{F_t^2+F_c^2}$$

$$\therefore F = 2as\sqrt{1+\left(\frac{s}{R}\right)^2}$$

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

8. The flow of water in a horizontal pipe is stream line flow. Along the pipe, at a point, where cross - sectional area is 10 cm^2, the velocity of water flow is 1.00 ms^{-1} and the pressure is 2000 Pa. The pressure of water at another point where cross - sectional area is 5 cm^2 is

(A) 2000 Pa (B) 1500 Pa (C) 3500 Pa (D) 500 Pa

Solution · Q8 **Answer: (D)**

Take non-viscous flow and water of density 1000 kg m^{-3}. By the equation of continuity,

$$v_2 = \frac{10 \times 1.00}{5} = 2.00 \text{ m s}^{-1}$$

By Bernoulli's equation for a horizontal pipe,

$$P_2 = P_1 + \frac{1}{2}\rho\left(v_1^2 - v_2^2\right)$$

$$\Rightarrow P_2 = 2000 + \frac{1}{2} \times 1000 \times (1.00 - 4.00)$$

$$\therefore P_2 = 500 \text{ Pa}$$

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

9. Three containers A, B and C are filled with water at different temperature. When 1 litre of water from A is mixed with 2 litre of water from B, the resulting temperature of mixture is 52^0 C. When 1 litre of water from B is mixed with 2 litre of water from C, the resulting temperature of mixture is 40^0 C. Similarly when 1 litre of water from C is mixed with 2 litre of water from A, the resulting temperature of mixture is 34^0 C. Temperature of mixture when one litre of water from each container is mixed (neglect the water equivalent of container) is

(A) 40^0 C (B) 42^0 C (C) 38^0 C (D) 45^0 C

Solution · Q9 **Answer: (B)**

Taking equal mass per litre, let the temperatures (in °C) of the water in A, B and C be θ_A, θ_B and θ_C.

$$\theta_A + 2\theta_B = 156$$

$$\theta_B + 2\theta_C = 120$$

$$\theta_C + 2\theta_A = 102$$

Adding,

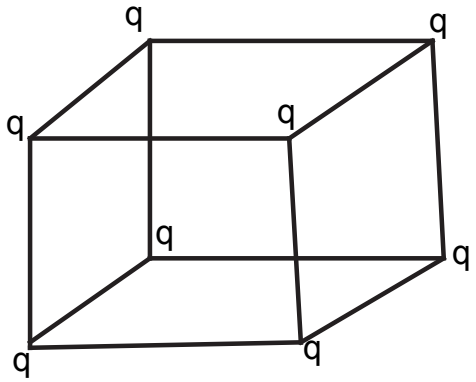
$$\theta_A + \theta_B + \theta_C = 126$$

$$\theta = \frac{126}{3}$$

$$\therefore \theta = 42 \text{ °C}$$

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

10. Point charge q is kept at each corner of a cube of edge length ℓ. The resultant force of repulsion on any one of the charges due to all others is expressed as



(A) $\dfrac{\left(1+\frac{1}{2\sqrt{2}}+\frac{1}{3\sqrt{3}}\right)q^2}{\pi\varepsilon_0\ell^2}$

(B) $\dfrac{\left(\frac{1}{2\sqrt{2}}-1+\frac{1}{3\sqrt{3}}\right)q^2}{\pi\varepsilon_0\ell^2}$

(C) $\dfrac{(1-0.1775)\,q^2}{\pi\varepsilon_0\ell^2}$

(D) none of these

Solution · Q10 **Answer: (C)**

By symmetry, the resultant is along the body diagonal. With

$$k=\frac{1}{4\pi\varepsilon_0}$$

add the x-components from edge, face-diagonal and body-diagonal charges.

$$F_x=\frac{kq^2}{\ell^2}\left(1+\frac{1}{\sqrt{2}}+\frac{1}{3\sqrt{3}}\right)$$

$$\Rightarrow F=\sqrt{3}\;F_x\approx 3.290\frac{kq^2}{\ell^2}$$

$$\therefore F=\frac{(1-0.1775)\,q^2}{\pi\varepsilon_0\ell^2}$$

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

11. In an experiment with potentiometer, the balancing length is 250 cm for a cell. When the cell is shunted by a resistance of 7.5 Ω, balancing point is shifted by 25 cm. If the cell is shunted by a resistance of 20 Ω, the balancing length will be nearly

(A) 240 cm (B) 236 cm (C) 232 cm (D) 230 cm

Solution · Q11 **Answer: (A)**

Balancing length with the 7.5 Ω shunt:

$$250\text{ cm}-25\text{ cm}=225\text{ cm}$$

$$\frac{\ell}{\ell_0}=\frac{R}{R+r}$$

$$\Rightarrow r=7.5\left(\frac{250}{225}-1\right)=\frac{5}{6}\,\Omega$$

With the 20 Ω shunt,

$$\ell_2=250\times\frac{20}{20+5/6}\text{ cm}$$

$$\therefore \ell_2 = 240 \text{ cm}$$

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

12. One mole of a gas with $\gamma = \frac{5}{3}$ is mixed with two moles of another non-interacting gas with $\gamma = \frac{7}{5}$ The ratio of specific heats $\gamma = \frac{C_P}{C_V}$ of mixture is approximately

(A) 1.50 (B) 1.46 (C) 1.49 (D) 1.53

Solution · Q12 **Answer: (B)**

For each gas,

$$C_V = \frac{R}{\gamma - 1}$$

So the molar heat capacities are

$$\frac{3R}{2} \text{ and } \frac{5R}{2}$$

For the mixture,

$$C_V = \frac{1 \times \frac{3}{2}R + 2 \times \frac{5}{2}R}{1+2} = \frac{13R}{6}$$

$$\Rightarrow C_P = C_V + R = \frac{19R}{6}$$

$$\therefore \gamma = \frac{19}{13} \approx 1.46$$

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

13. An ideal gas is expanding such that PT^3 = constant. The coefficient of volume expansion of the gas is

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

(C) $\frac{3}{T}$ (D) $\frac{4}{T}$

Solution · Q13 **Answer: (D)**

For an ideal gas,

$$P = \frac{nRT}{V}$$

Along the process the product PT^3 stays constant. So, with k a constant,

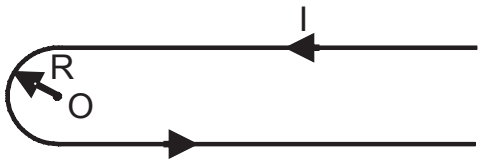
$$V = kT^4$$

$$\gamma = \frac{1}{V}\frac{dV}{dT} = \frac{4kT^3}{kT^4}$$

$$\therefore \gamma = \frac{4}{T}$$

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

14. What is the magnetic induction B at the centre O of the semicircular arc if a current carrying wire has shape of an hair pin as shown in figure? The radius of the curved part of the wire is R, the linear parts are assumed to be very long.



(A) $B = \frac{\mu_0 I}{4\pi R}(2+\pi)$

(B) $B = \frac{\mu_0 I}{4R}(2+\pi)$

(C) $B = \frac{3\mu_0 I}{4R}(2+\pi)$

(D) $B = \frac{\mu_0}{4\pi}\frac{2I}{R}$

Solution · Q14 **Answer: (A)**

Field of each long straight part at O:

$$B_1 = \frac{\mu_0 I}{4\pi R}$$

Field of the semicircular arc at O:

$$B_2 = \frac{\mu_0 I}{4R}$$

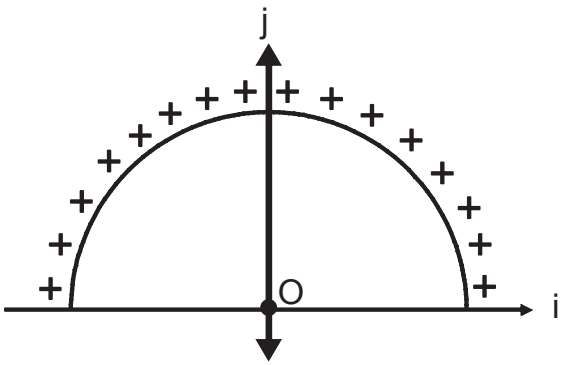
All three fields point out of the page.

$$B = 2B_1 + B_2$$

$$\therefore B = \frac{\mu_0 I}{4\pi R}(2+\pi)$$

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

15. A thin semi-circular metal ring of radius R has a positive charge q distributed uniformly over its curved length. The resultant electric field $\vec{E}$ at the center O is



(A) $-\hat{j}\frac{q}{2\pi^2\varepsilon_0 R^2}$

(B) $+\hat{j}\frac{q}{2\pi^2\varepsilon_0 R^2}$

(C) $+\hat{j}\frac{q}{4\pi^2\varepsilon_0 R^2}$

(D) $-\hat{j}\frac{q}{4\pi^2\varepsilon_0 R^2}$

Solution · Q15 **Answer: (A)**

$$\lambda = \frac{q}{\pi R}$$

By symmetry, the components along the x-axis cancel.

$$E = \frac{\lambda}{4\pi\varepsilon_0 R}\int_0^{\pi} \sin\theta d\theta = \frac{\lambda}{2\pi\varepsilon_0 R}$$

$$\therefore \vec{E} = -\hat{j}\frac{q}{2\pi^2\varepsilon_0 R^2}$$

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

16. An Alternating Current is expressed as $i = i_1 \cos\omega t + i_2 \sin\omega t$. The RMS value of current is

(A) $\sqrt{\frac{(i_1 + i_2)^2}{2}}$ (B) $\sqrt{\frac{i_1 i_2}{2}}$

(C) $\sqrt{\frac{(i_1^2 + i_2^2)}{2}}$ (D) $\sqrt{\frac{(i_1 - i_2)^2}{2}}$

Solution · Q16 **Answer: (C)**

$$i^2 = {i_1}^2 \cos^2\omega t + {i_2}^2 \sin^2\omega t + 2i_1 i_2 \sin\omega t \cos\omega t$$

Over a period, the squared cosine and sine each average to one half, and the cross term averages to zero.

$$\therefore i_{rms} = \sqrt{\frac{i_1^2 + i_2^2}{2}}$$

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

17. A charge + q is placed at each of the points $x = x_0$, $x = 3x_0$, $x = 5x_0$, $x = 7x_0$ .....∞ on the x-axis and a charge −q is placed at each of the points $x = 2x_0$, $x = 4x_0$, $x = 6x_0$, $x = 8x_0$ .....∞ here x_0 is a positive constant. Take the electric potential at a point due to a charge q at a distance r from it to be $V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r}$. The electric potential at the origin due to the above system of charges is

(A) zero (B) $\frac{1}{4\pi\varepsilon_0}\frac{q}{x_0}\ln 2$

(C) $\frac{1}{4\pi\varepsilon_0}\frac{q}{x_0}2\ln 2$ (D) infinite

Solution · Q17 **Answer: (B)**

$$V = \frac{q}{4\pi\varepsilon_0 x_0}\left(1 - \frac{1}{2} + \frac{1}{3} - \frac{1}{4} + \ \ldots\right)$$

The series in the bracket equals ln 2.

$$\therefore V = \frac{1}{4\pi\varepsilon_0}\frac{q}{x_0}\ln 2$$

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

18. The Nucleus ${}^{23}_{10}Ne$ decays by β − emission through the reaction ${}^{23}_{10}Ne \rightarrow {}^{23}_{11}Na + {}^{0}_{-1}\beta + \bar{\upsilon}$ + energy The atomic masses are ${}^{23}_{10}Ne$ = 22.994466 u and ${}^{23}_{11}Na$ = 22.989770 u, ${}^{0}_{-1}\beta$ = 0.000549 u. The maximum kinetic energy that the emitted electron can ever have is

(A) 4.374 MeV (B) 3.862 MeV (C) 2.187 MeV (D) 1.931 MeV

Solution · Q18 **Answer: (A)**

Using atomic masses and neglecting electron binding energies, the electron masses cancel.

$$Q = [M(Ne) - M(Na)]c^2$$

$$\Rightarrow Q = (22.994466 - 22.989770) \times 931.5 \text{ MeV}$$

$$\Rightarrow Q \approx 4.374 \text{ MeV}$$

Neglecting the tiny recoil, the electron has its maximum energy when the antineutrino takes almost none.

$$\therefore K_{max} \approx 4.374 \text{ MeV}$$

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

19. The distance between two slits in Young's double slits experiment is d = 2.5 mm and the distance of the screen from the plane of slits is D = 120 cm. The slits are illuminated with coherent beam of light of wavelength λ = 600 nm. The minimum distance (from the central maximum) of a point where the intensity reduces to 25% of maximum intensity is

(A) 24 μm (B) 48 μm (C) 96 μm (D) 120 μm

Solution · Q19 **Answer: (C)**

The slits are taken as identical.

$$I = I_{max}\cos^2\left(\frac{\varphi}{2}\right)$$

$$\cos^2\left(\frac{\varphi}{2}\right) = \frac{1}{4}$$

$$\Rightarrow \phi = 120°$$

The path difference is one third of a wavelength.

$$\frac{yd}{D} = \frac{\lambda}{3}$$

$$\Rightarrow y = \frac{600 \times 10^{-9} \times 1.20}{3 \times 2.5 \times 10^{-3}} \text{ m}$$

$$\therefore y = 96 \text{ μm}$$

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

20. What amount of heat will be generated in a coil of resistance R (ohm) due to a total charge Q (coulomb) passing through it if the current in the coil decreases down to zero halving its value every Δt second?

(A) $\frac{1}{2}\frac{Q^2R}{\Delta t}$ (B) $\frac{Q^2R}{\Delta t}\ln 2$

(C) $\frac{1}{2}\frac{Q^2R}{\Delta t}\ln 2$ (D) $\frac{1}{4}\frac{Q^2R}{\Delta t}$

Solution · Q20 **Answer: (C)**

The current decays exponentially.

$$i = i_0 e^{-kt}$$

$$k = \frac{\ln 2}{\Delta t}$$

$$Q = \int_0^\infty i dt = \frac{i_0}{k}$$

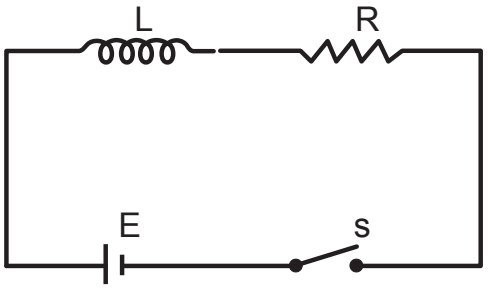
$$H = \int_0^\infty i^2 R dt = \frac{i_0^2 R}{2k}$$

$$\Rightarrow H = \frac{Q^2 R k}{2}$$

$$\therefore H = \frac{1}{2}\frac{Q^2 R}{\Delta t}\ln 2$$

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

21. In the L R circuit shown in figure, switch S is closed at time t = 0, the charge that passes through the battery of emf E in one time constant is (e being the base of natural logarithm).



(A) $\frac{EL}{eR^2}$

(B) $\frac{EL}{eR}$

(C) $\frac{eER^2}{L}$

(D) $\frac{EL}{R}$

Solution · Q21 **Answer: (A)**

For the LR circuit,

$$i = \frac{E}{R}\left(1 - e^{-t/\tau}\right)$$

$$\tau = \frac{L}{R}$$

Charge in one time constant:

$$q = \int_0^{\tau} i\,dt = \frac{E\tau}{eR}$$

$$\therefore q = \frac{EL}{eR^2}$$

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

22. Natural Uranium is a mixture of $^{238}_{92}U$ and $^{235}_{92}U$ with a relative mass abundance of 140 : 1. The ratio of radioactivity contributed by the two isotopes of natural uranium, if their half-lives are 4.5×10^9 years and 7.0×10^8 years respectively is

(A) 99.3 : 0.7

(B) 50.3 : 49.7

(C) 95.6 : 04.4

(D) cannot be estimated

Solution · Q22 **Answer: (C)**

Activity is given by

$$A = \lambda N$$

For uranium-238 (1) and uranium-235 (2),

$$\frac{A_1}{A_2} = \frac{m_1}{m_2} \times \frac{M_2}{M_1} \times \frac{T_2}{T_1}$$

$$\Rightarrow \frac{A_1}{A_2} = 140 \times \frac{235}{238} \times \frac{7.0 \times 10^8}{4.5 \times 10^9} \approx 21.5$$

Share of uranium-238:

$$\frac{21.5}{22.5} \times 100 \approx 95.6$$

$\therefore$ The ratio is 95.6 : 4.4.

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

23. A cylinder of length $\ell > 1$m filled with water ($\mu = \frac{4}{3}$) up to the brim, kept on a horizontal table is covered at its top by an equiconvex glass ($\mu = 1.5$) lens of focal length 25 cm when in air. At mid day, 12.00 noon, Sun is just overhead and light rays comes parallel to the principal axis of the lens. The sun rays will be focused

(A) 25 cm behind the lens in the water
(B) 37.5 cm behind the lens in the water
(C) 50 cm behind the lens in the water
(D) 100 cm behind the lens in the water

Solution · Q23 **Answer: (C)**

Using the focal length of the lens in air, each face has radius 25 cm. Upper face (air to glass), with parallel rays:

$$\frac{1.5}{v_1} - 0 = \frac{1.5 - 1}{25}$$

$$\Rightarrow v_1 = 75 \text{ cm}$$

Lower face (glass to water):

$$\frac{4}{3v} - \frac{1.5}{75} = \frac{4/3 - 1.5}{-25}$$

$$\Rightarrow \frac{4}{3v} = \frac{1}{50} + \frac{1}{150} = \frac{2}{75}$$

$$\therefore v = 50 \text{ cm}$$

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

24. Even the radiation of highest wave length in the ultraviolet region of hydrogen spectrum is just able to eject photoelectrons from a metal. The value of threshold frequency for the given metal is

(A) 3.83×10^{15} Hz (B) 4.33×10^{14} Hz (C) 2.46×10^{15} Hz (D) 7.83×10^{14} Hz

Solution · Q24 **Answer: (C)**

The ultraviolet series is taken as the Lyman series. Its longest wavelength is for the jump from the second orbit to the first.

$$\frac{1}{\lambda} = R\left(\frac{1}{1^2} - \frac{1}{2^2}\right) = \frac{3R}{4}$$

$$\Rightarrow \nu_0 = \frac{c}{\lambda} = \frac{3Rc}{4}$$

$$\Rightarrow \nu_0 = 0.75 \times 1.097 \times 10^7 \times 3 \times 10^8 \text{ Hz}$$

$$\Rightarrow \nu_0 \approx 2.47 \times 10^{15} \text{ Hz}$$

The nearest option is (C); the small difference comes from rounding of constants.

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

PART A-2 · ONE OR MORE CORRECT OPTIONS

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

25. A parallel plate capacitor of plate area A and plate separation d is charged to potential V. Then the battery is disconnected. A slab of dielectric constant k is then inserted between the plates of the capacitor so as to fill the space between the plates completely. If Q, E and W denote respectively, the magnitude of charge on each plate, the electric field between the plates (after the slab is inserted) and work done on the system, in question, in the process of inserting the slab, then

(A) $Q = k\varepsilon_0 AE$

(B) $Q = \dfrac{\varepsilon_0 kAV}{d}$

(C) $E = \dfrac{V}{kd}$

(D) $W = \dfrac{\varepsilon_0 AV^2}{2d}\left(1 - \dfrac{1}{k}\right)$

Solution · Q25 **Answer: (A), (C)**

The charge stays constant after the battery is removed.

$$Q = \frac{\varepsilon_0 AV}{d}$$

$$\text{(A) } E = \frac{Q}{k\varepsilon_0 A}$$

$$\Rightarrow Q = k\varepsilon_0 AE$$

So (A) is true and (B) is false.

$$\text{(C) } E = \frac{V}{kd}$$

So (C) is true.

(D) For slow insertion, work done on the system equals the change in stored energy.

$$W = U_f - U_i = -\frac{\varepsilon_0 AV^2}{2d}\left(1 - \frac{1}{k}\right)$$

The printed value has the wrong sign, so (D) is false.

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

26. The magnitudes of the gravitational field at distances r_1 and r_2 from the centre of a uniform solid sphere of radius R and mass M are F (r_1) and F (r_2) respectively. Such that

(A) $\dfrac{F(r_1)}{F(r_2)} = \dfrac{r_1}{r_2}$ if $r_1 \le R$ and $r_2 \le R$

(B) $\dfrac{F(r_1)}{F(r_2)} = \dfrac{r_2^2}{r_1^2}$ if $r_1 \ge R$ and $r_2 \ge R$

(C) $\dfrac{F(r_1)}{F(r_2)} = \dfrac{r_1}{r_2}$ if $r_1 \ge R$ and $r_2 \ge R$

(D) $\dfrac{F(r_1)}{F(r_2)} = \dfrac{r_1^2}{r_2^2}$ if $r_1 \le R$ and $r_2 \le R$

Solution · Q26 **Answer: (A), (B)**

Inside the sphere:

$$F(r) = \frac{GMr}{R^3}$$

$$\Rightarrow \frac{F(r_1)}{F(r_2)} = \frac{r_1}{r_2}$$

So (A) is true and (D) is false.

Outside the sphere:

$$F(r) = \frac{GM}{r^2}$$

$$\Rightarrow \frac{F(r_1)}{F(r_2)} = \frac{r_2^2}{r_1^2}$$

∴ (B) is true and (C) is false.

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

27. The intensity of sound at a point P is I_0, when the sounds reach this point directly and in same phase from two identical sources S_1 and S_2. The power of S_1 is now reduced by 64 % and the phase difference (ϕ) between S_1 and S_2 is varied continuously. The maximum and minimum intensities recorded at P are now I_{max} and I_{min} such that

(A) $I_{max} = 0.64\ I_0$

(B) $I_{min} = 0.36\ I_0$

(C) $\frac{I_{max}}{I_{min}} = 16$

(D) $\frac{I_{max}}{I_{min}} = \frac{16}{9}$

Solution · Q27 **Answer: (A), (C)**

Initially, with equal intensity I from each source,

$$I_0 = 4I$$

After the power cut, the intensities of the two sources at P are $0.09I_0$ and $0.25I_0$

$$I = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\varphi$$

$$\Rightarrow I = I_0(0.34 + 0.30\cos\phi)$$

$$\Rightarrow I_{max} = 0.64 I_0$$

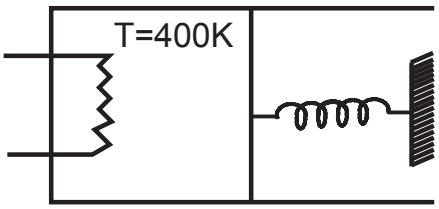
$$I_{min} = 0.04 I_0$$

$$\Rightarrow \frac{I_{max}}{I_{min}} = 16$$

∴ (A) and (C) are true.

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

28. An ideal monatomic gas is confined within a cylinder by a spring loaded piston of cross-sectional area 4×10^{-3} m^2. Initially the gas is at 400 K and occupies a volume 2×10^{-3} m^3 and the spring is in its relaxed position. The gas is heated by an electric heater for some time. During this time the gas expands and the piston moves out by a distance 0.1 m. The spring connected to the rigid wall is massless and frictionless. The force constant of the spring is 2000 Nm^{-1} and atmospheric pressure is 10^5 Nm^{-2} then



(A) The final temperature of the gas is 720 K.

(B) The work done by gas in expanding is 50 J

(C) The heat supplied by heater is 190 J

(D) The heat supplied by heater is 290 J

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

The gas is heated slowly, so the piston stays in equilibrium. Initial pressure, with the spring relaxed:

$$P_1 = 10^5 \text{ N m}^{-2}$$

Final volume and pressure:

$$V_2 = V_1 + Ax = 2.4 \times 10^{-3} \text{ m}^3$$

$$P_2 = 10^5 + \frac{2000 \times 0.1}{4 \times 10^{-3}} = 1.5 \times 10^5 \text{ N m}^{-2}$$

$$\text{(A) } T_2 = 400 \times \frac{1.5 \times 2.4}{1 \times 2} = 720 \text{ K}$$

So (A) is true.

$$\text{(B) } W = P_0 \Delta V + \frac{1}{2} kx^2$$

$$\Rightarrow W = 40 \text{ J} + 10 \text{ J} = 50 \text{ J}$$

So (B) is true.

Heat supplied, assumed to go wholly into the gas:

$$\Delta U = \frac{3}{2}(P_2V_2 - P_1V_1) = 240 \text{ J}$$

$$\Rightarrow Q = \Delta U + W = 290 \text{ J}$$

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

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

29. A particle of mass m is located in a one dimensional potential field U (x) = U_0 (1 – cos ax); U_0 and a are constants. Which of the following statement/s is/are correct?

(A) The particle will execute Simple Harmonic Motion for small displacements.

(B) The stable equilibrium condition is x = 0

(C) The time period of small oscillations is $\frac{2\pi}{a}\sqrt{\frac{m}{U_0}}$

(D) The angular frequency for small oscillations is $\omega = a\sqrt{\frac{U_0}{m}}$

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

Taking both constants as positive,

$$F = -\frac{dU}{dx} = -U_0 a \sin ax$$

For small x,

$$F \approx -U_0 a^2 x$$

So the motion is simple harmonic, and (A) is true.

(B) At the origin,

$$\frac{d^2U}{dx^2} = U_0 a^2 > 0$$

So (B) is true.

$$\text{(D) } \omega = a\sqrt{\frac{U_0}{m}}$$

So (D) is true.

$$\text{(C) } T = \frac{2\pi}{\omega} = \frac{2\pi}{a}\sqrt{\frac{m}{U_0}}$$

∴ (C) is true.

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

30. A ray of light is incident on an equilateral prism made of flint glass (refractive index 1.6) placed in air.

(A) The ray suffers a minimum deviation if it is incident at angle 53^0.

(B) The minimum angle of deviation suffered by the ray is 46^0.

(C) If prism is immersed in water ($\mu = \frac{4}{3}$) the minimum deviation produced by the prism is 14^0.

(D) The minimum deviation produced by the prism is 23.6^0 if it is immersed in a liquid of refractive index μ = 1.2

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

At minimum deviation, with relative index n,

$$r = 30°$$

$$\sin i = n \sin 30°$$

$$\delta_m = 2i - 60°$$

(A) In air,

$$\sin i = 0.8$$

$$\Rightarrow i \approx 53°$$

So (A) is true.

$$(B)\ \delta_m \approx 46°$$

So (B) is true.

(C) In water,

$$n = \frac{1.6}{4/3} = 1.2$$

$$\Rightarrow \sin i = 0.6$$

$$\Rightarrow \delta_m \approx 14°$$

So (C) is true.

(D) In the liquid,

$$\sin i = \frac{1.6}{1.2} \times \frac{1}{2} = \frac{2}{3}$$

$$\Rightarrow \delta_m \approx 23.6°$$

$\therefore$ (D) is true.

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

31. In a p-n junction diode, the current (i) varies with applied biasing voltage (V) and can be expressed as $i = i_0 (e^{qV/kT} - 1)$ where $i_0 = 5 \times 10^{-12}$ A is reverse saturation current, k is Boltzmann constant and q is the charge on the electron

At Absolute Temperature T = 300K

(A) The forward current is approximately 59.5 mA for a forward bias of 0.6 volt

(B) The current increases approximately by 2.75A if the biasing voltage changes from 0.6 V to 0.7 V

(C) The dynamic resistance of p-n junction is approximately 435 mΩ at the biasing voltage of 0.6 V

(D) The change in reverse bias current when biasing voltage change from −1 volt to −2 volt happens to be practically zero.

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

$$\frac{kT}{q} = \frac{1.38 \times 10^{-23} \times 300}{1.60 \times 10^{-19}} \approx 0.025875\ V$$

(A) At 0.6 V,

$$i \approx 58.8\ mA$$

With the exponent rounded to 23.2,

$$i \approx 59.5\ mA$$

So (A) is true as an approximate value.

(B) At 0.7 V,

$$i \approx 2.81\ A$$

$$\Rightarrow \Delta i = 2.81\ A - 0.06\ A \approx 2.75\ A$$

So (B) is true.

$$(C)\ r_d = \frac{dV}{di} \approx \frac{kT}{qi}$$

Taking the current of (A) as 59.5 mA,

$$r_d \approx 435\ \text{m}\Omega$$

So (C) is true.

(D) In reverse bias,

$$i \approx -i_0$$

The current is practically unchanged, so (D) is true.

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

32. A charged oil (density 880 kg m^{-3}) drop is held stationary between two parallel horizontal metal plates 6.0 mm apart when a potential difference of V = 103 volt is applied between the two plates. When the electric field is switched off, the drop falls. At a certain time the drop is seen to fall a distance of 2.0 mm in 35.7 s and next 1.2 mm in 21.4 s. (The upper plate in the experiment is at higher potential).

Given that the viscosity of air = 1.80×10^{-5} Nsm^{-2} and density of air = 1.29 kg m^{-3}

(A) The radius of the drop is a = 7.25×10^{-7}m

(B) The charge on the drop is q = 8.0×10^{-19}C

(C) The terminal velocity of the oil drop, under its free fall, is 5.6×10^{-5} ms^{-1}

(D) The oil drop carries 5 excess electrons

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

(C) Terminal speed:

$$v = \frac{2.0 \times 10^{-3}}{35.7} \approx 5.60 \times 10^{-5}\ \text{m s}^{-1}$$

So (C) is true.

(A) Stokes drag balances weight less buoyancy.

$$a = \sqrt{\frac{9\eta v}{2(\rho - \sigma)g}} \approx 7.26 \times 10^{-7}\ \text{m}$$

So (A) is true.

(B) With the drop at rest,

$$|q|E = 6\pi\eta a v$$

$$E = \frac{103}{6.0 \times 10^{-3}}\ \text{V m}^{-1}$$

$$\Rightarrow |q| \approx 8.0 \times 10^{-19}\ \text{C}$$

The upper plate is positive, so the charge is negative. Hence (B) is false.

(D) $$n = \frac{8.03 \times 10^{-19}}{1.60 \times 10^{-19}} \approx 5$$

$\therefore$ (D) is true.

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

ANSWER KEY

IOQP 2020-21 · PAPER CODE 61

32
QUESTIONS · 120 MARKS

IAPT final answer key for paper code 61. ★ marks an answer given as per Zigyan.

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

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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

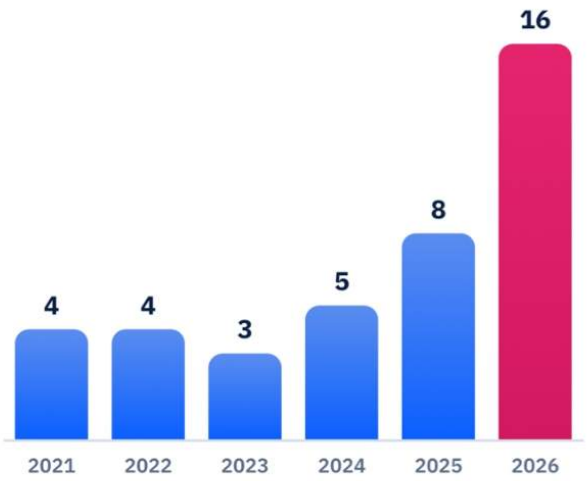
40
JEE Advanced selections in 6 years

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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