NSEA 2026

Held On 21 November, Saturday 2026	TIME : 2 : 30 PM to 4 : 30 PM

ASTRONOMY

PART A-1

Q1 Part A-1

A person claims to have followed this path: She was standing at location 'A' on the Earth. She walked towards the north 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.

Answer: No single key (note - see method).

Method: The eastward leg stays on one latitude circle. The walk closes only if the 100 km eastward leg covers a whole number n of laps of that latitude circle, so the circle must have circumference 100/n km. Such circles exist near the North Pole, one for each n = 1, 2, 3, ..., and every point on each of those circles works, so there are infinitely many valid starting points. The South Pole works too: every meridian meets there, so walking 100 km south brings her back to it. That is neither 'only one place', nor 'only two places', nor 'anywhere'. **Note:** Aakash marks (d), but its own solution proves infinitely many valid points, not every point on Earth, so no option is strictly correct. Check the official IAPT key for this question.

Q2 Part A-1

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.

Answer: (C)

Correct option: C. **Method:** Two identical-mass stars orbit their common centre of mass, which lies midway between them. (a) is false: identical masses do not force a circular orbit, the orbit can be an ellipse. (b) is false: with no external force the centre of mass stays at rest or moves uniformly, it shows no periodic motion. (c) is true: an elliptical orbit seen at an inclination is a projection, and the projection of an ellipse can look like a circle. (d) is false: resolving the stars depends on their angular separation and the telescope's resolution, so very close or very distant binaries cannot always be resolved.

Q3 Part A-1

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.

Answer: (A)

Correct option: A. **Method:** Same day length on the same date, both in the southern hemisphere, means both places are at the same latitude, since day length depends only on latitude and date. Sunrise and sunset differing by 12 hours means the longitudes differ by 180 degrees, since local solar time changes by 1 hour per 15 degrees of longitude. Two points at the same latitude and 180 degrees apart in longitude lie on a common meridian circle through both poles. For latitude φ (south), the path via the South Pole is 2(90 degrees - |φ|) long and the path via the North Pole is 2(90 degrees + |φ|) long, so the south route is shorter. The plane flies first southwards, towards the South Pole, then northwards.

Q4 Part A-1

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? *Figure: Light curve A plots flux in units of 10^{-12} W/m^2 against time in days from 0 to 20. The flux stays at 16 units except for four dips: two deeper dips down to 10 units (around day 2.5 and day 12.5) and two shallower dips down to about 11.5 units (around day 7.5 and day 17.5).*

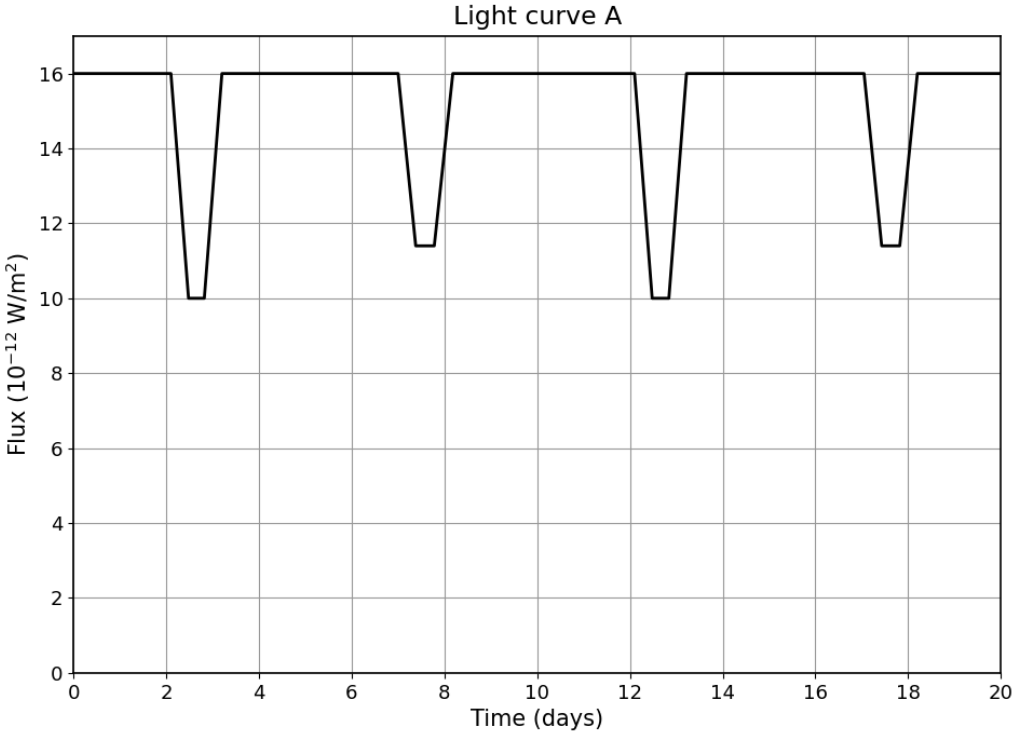


Figure for Q4.

(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.

Answer: (D)

Correct option: D. **Method:** The depth of a dip is proportional to the area blocked and the intensity of the star being blocked. The area blocked is the same in both dips, so the deeper dip (depth 6, from 16 down to 10) is the hotter star being blocked, which happens when the cooler star passes in front of the hotter star. (a) is wrong because the orbit is not necessarily circular. (b) cannot be inferred from the curve. (c) is wrong because the two depths are 6 and about 4.5, a ratio of 4:3, not 6:5.

Q5 Part A-1

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

Answer: (B)

Correct option: B. **Method:** Magnification M = f_o/f_e = 750/25 = 30. A normal human eye barely separates 1 arc min = 60 arc sec. So the actual separation = 60/30 = 2 arc sec.

Q6 Part A-1

An observer is located at latitude of 60 degrees south and he can only see the sky above 10 degrees 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%

Answer: (C)

Correct option: C. **Method:** A star's maximum altitude is h_{max} = 90 degrees - |φ - δ| = 90 degrees - |δ + 60 degrees|. It can be seen only if h_{max} > 10 degrees, which gives δ < +20 degrees. So the unseen part is the spherical cap with δ > +20 degrees, whose fraction of the celestial sphere is (1 - sin 20 degrees)/2 = (1 - 0.342)/2 = 0.329, that is 32.9%.

Q7 Part A-1

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 $m_2 - m_1 = -2.5 \log (l_2/l_1)$. 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 degrees 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

Answer: (B)

Correct option: B. **Method:** Let d_1 be the Earth to X distance and d_2 the exoplanet to X distance. Since flux goes as $1/d^2$, $m_2 - m_1 = 1$ gives $1 = -5 \log (d_1/d_2)$, so $d_2/d_1 = 10^{0.2} = 1.585$. By the cosine rule with the 40 degree separation and Y at 30 ly, $d_2^2 = d_1^2 + 30^2 - 2 \times 30 \times d_1 \times \cos 40$ degrees, which gives $1.512\, d_1^2 + 45.96\, d_1 - 900 = 0$, so d_1 = 13.5 ly and $d_2 = 1.585 \times 13.5 = 21.5$ ly. Note that 13.5 ly, option (c), is the Earth to X distance, not the distance asked.

Q8 Part A-1

Which of the following constellations has smallest area?

(a) Triangulum (b) Sagitta (c) Scutum (d) Crux

Answer: (D)

Correct option: D. **Method:** Crux is the smallest of the 88 constellations, covering only 68 square degrees.

Q9 Part A-1

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

Answer: (B)

Correct option: B. **Method:** Kepler's third law, $T^2 = a^3$, gives $a^3 = 6.55^2$, so a = 3.5 AU. The farthest distance (aphelion) = 2a - perihelion = 2 x 3.5 - 3.00 = 4.00 AU.

Q10 Part A-1

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.

Answer: (C)

Correct option: C. **Method:** Statement A is correct: the ion tail points away from the Sun. Statement R is wrong: the ion tail is pushed back by the solar wind. It is the dust tail that lags behind the comet.

Q11 Part A-1

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

Answer: (D)

Correct option: D. **Method:** Luminosity $L \propto R^2T^4$. With $L \propto M^4$ and $R \propto M^{0.8}$, we get $R^2 \propto M^{1.6}$, so $M^4 \propto M^{1.6}T^4$, giving $T^4 \propto M^{2.4}$ and $T \propto M^{0.6}$. So x = 0.6.

Q12 Part A-1

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.

Answer: (C)

Correct option: C. **Method:** Cosmological redshift comes from the expansion of space itself, which stretches the photon's wavelength as it travels from the source to the observer. It is not an ordinary Doppler shift from motion through space, and it is not a gravitational time dilation effect.

Q13 Part A-1

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.

Answer: (B)

Correct option: B. **Method:** Asteroids are small, so their chemical composition has not changed much since formation. They preserve the early Solar System composition, so studying them helps determine the composition of the Solar System.

Q14 Part A-1

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?

(a) 12.2 km (b) 1.22 km (c) 122 m (d) 12.2 m

Answer: (B)

Correct option: B. **Method:** Earth's diameter is 12742 km, represented by 2.2 cm, so the scale factor is 2.2×10^{-5} km / 12742 km. Jupiter is 5.2 AU from the Sun, about 7.78×10^{8} km. The model distance is $7.78 \times 10^{8} \times 2.2 \times 10^{-5}$ / 12742, about 1.3 km, so option (b) 1.22 km is the intended answer, far closer than any other option.

Q15 Part A-1

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

Answer: (B)

Correct option: B. **Method:** Io is tidally locked, so Jupiter stays almost fixed in its sky. The Sun's apparent motion as seen from Io repeats with the synodic period T_s, where $1/T_s = 1/T_{Io} - 1/T_J = 1/42.5 - 1/103965$, giving $T_s = 42.5$ hours. The Sun moves from the eastern horizon to the western horizon in half a synodic day, 42.5/2 = 21.25 hours.

Q16 Part A-1

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 $m_2 - m_1 = -2.5 \log (l_2/l_1)$. 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

Answer: (A)

Correct option: A. **Method:** The fraction of the Sun's disc blocked is the area ratio $(D_{Jupiter}/D_{Sun})^2 = (11/109)^2 = 0.01018$. So the flux falls to $l_2/l_1 = 1 - 0.01018 = 0.98982$. The magnitude change is $m_2 - m_1 = -2.5 \log_{10}(0.98982) = -2.5 \times (-0.00444) = 0.011$, about 0.01.

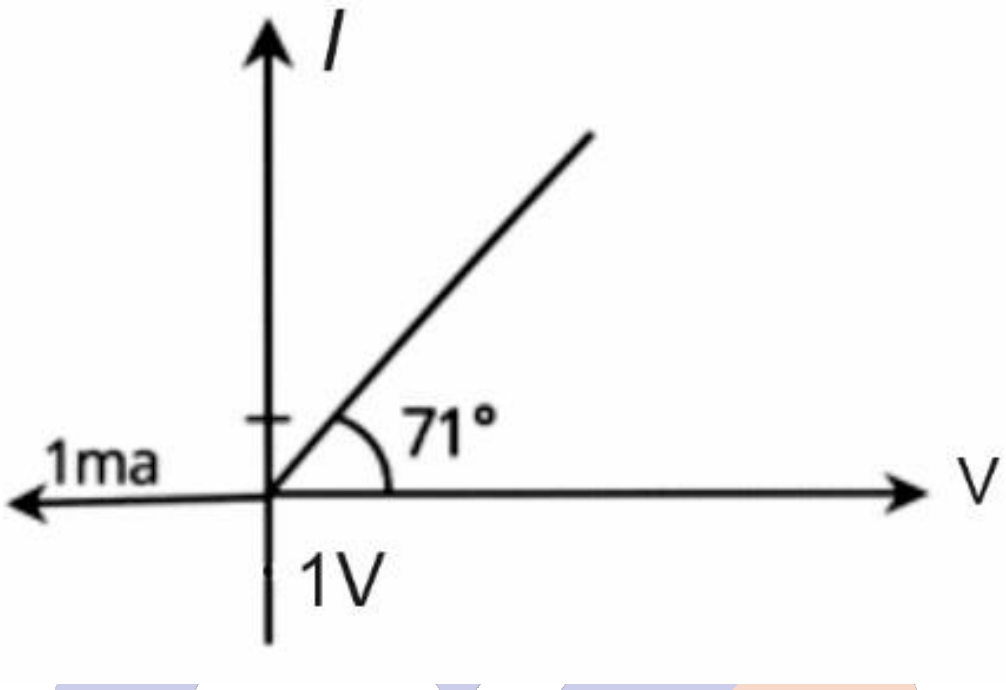
Q17 Part A-1

A student applies various voltages (V) across a resistor and measures corresponding currents (I). She then plots the graph of I (1 cm 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 degrees ± 1 degree 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

Answer: (B)

Correct option: B. **Method:** The slope I/V = tan 71 degrees. With 1 cm = 1 mA on the current axis and 1 cm = 1 V on the voltage axis, V/I = 10^3/tan 71 degrees = 10^3/2.904 = 344.35 Ω. The uncertainty comes from the angle: R = 1000 cot θ, so dR = 1000 cosec^2 θ x (π/180) = 1000/$(0.9455)^2$ x π/180 = 19.5 Ω. So R = 344 ± 20 Ω.



Solution figure for Q17.

Q18 Part A-1

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

Answer: (C)

Correct option: C. **Method:** Pressure P = F/A = F/l^2, so the fractional uncertainty is ΔP/P = ΔF/F + 2Δl/l = 20/360 + 2 x 1/136 = 5.55% + 1.47% = 7.02%, about 7%.

Q19 Part A-1

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

Answer: (C)

Correct option: C. **Method:** To overtake completely, the car must cover the truck's length plus its own length relative to the truck, 17 + 3 = 20 m, in 3.6 s. So the relative speed is 20/3.6 = 5.56 m/s = 20 km/hr. The car's speed is 60 + 20 = 80 km/hr.

Q20 Part A-1

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 degrees 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 degrees 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.

Answer: (B)

Correct option: B. **Method:** With the same perimeter, the square has side a = π R/2 and area $A_2 = \pi^2R^2/4$, which is less than the circle's area $A_1 = \pi R^2$. Torque is tau = NIAB sin θ. With the smaller area, sin θ must be larger to get the same torque, so the angle between the area vector and B must be increased. (a) is wrong because at 60 degrees the torque on the square is larger, not smaller, than the circle's torque at 30 degrees. (c) and (d) are wrong because decreasing B or I decreases the torque.

Q21 Part A-1

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 degrees 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.

Answer: (A)

Correct option: A. **Method:** Water has maximum density at 4 degrees C, so statement II is correct: water expands both on heating above 4 degrees C and on cooling below it. Below 4 degrees C the colder water becomes lighter and rises to the top, so the pond freezes from the top first. Statement II is the correct reason for statement I.

Q22 Part A-1

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,

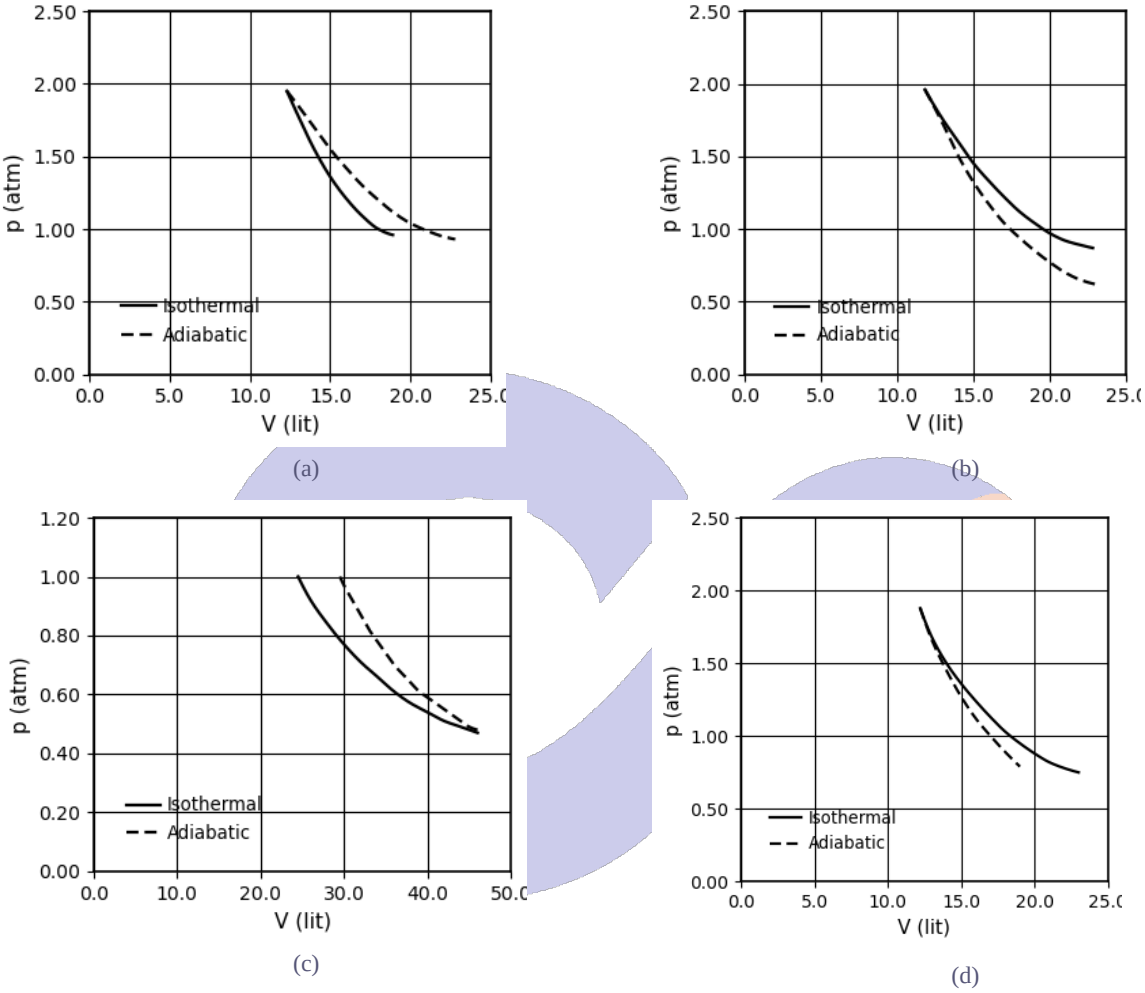
(a) 20 rad/mV (b) 2.0 rad/mV (c) 0.20 rad/mV (d) 0.020 rad/mV

Answer: (D)

Correct option: D. **Method:** Current sensitivity φ/i = NAB/k = 1 rad per microampere = 10^6 rad/A. Doubling B doubles the deflection per unit current, and with the series resistance R = 100 kΩ the voltage sensitivity is $\varphi/V = 2 \times 10^6 / (100 \times 10^3) = 20$ rad/V = 0.02 rad/mV.

Q23 Part A-1

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? *Figure: Four p-V graphs labelled (a) to (d). In each, pressure in atm is on the vertical axis and volume in litres on the horizontal axis, with a solid isothermal curve and a dashed adiabatic curve through the compressed state.*



Figures for Q23, options (a) to (d).

(a) Graph (a) (b) Graph (b) (c) Graph (c) (d) Graph (d)

Answer: (D)

Correct option: D. **Method:** At STP the gas starts at 1 atm and 22.4 litres. Isothermal compression to half the volume takes it to 11.2 litres and 2 atm, along the isotherm. Adiabatic expansion back to the original pressure of 1 atm ends at $V = 2^{(1-\gamma)/\gamma} \times 22.4 = 18.4$ litres, below the starting volume, and the adiabat is steeper than the isotherm. Only graph (d) shows the steeper adiabatic curve returning to 1 atm at a volume below the starting volume.

Q24 Part A-1

Two rays A and 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 *Figure: Ray A enters from the left and zigzags through three mirrors before leaving as A', with the distance between one reflecting face and the next equal to L_1. Ray B reflects off two mirrors and leaves as B', with face spacing $L_2 = L_1/3$.*

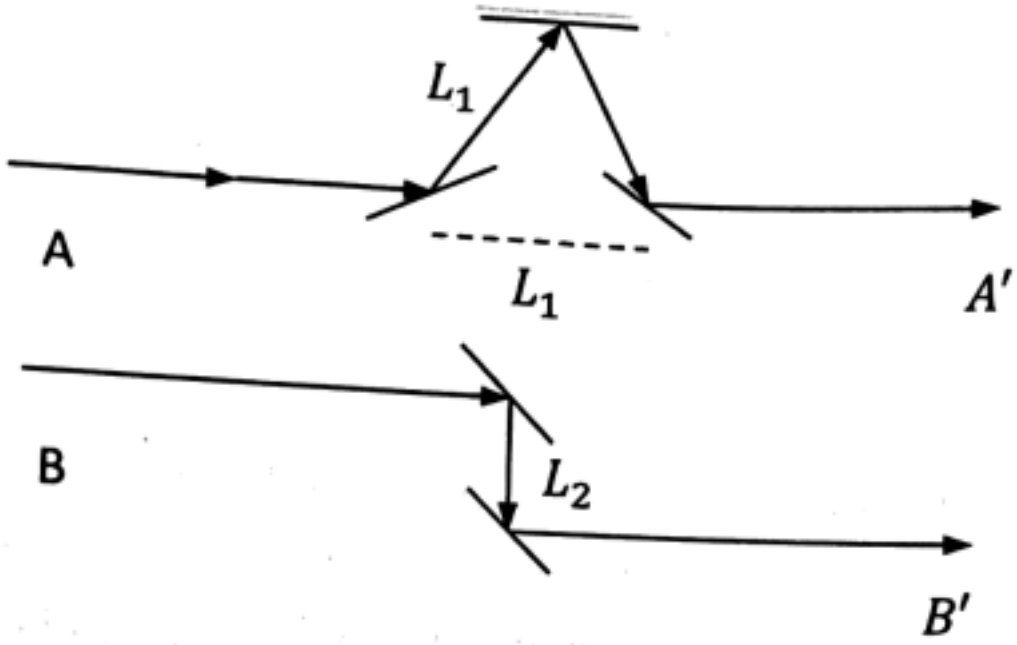


Figure for Q24.

(a) 3λ/4 (b) 3λ/5 (c) 3λ/10 (d) 3λ/15

Answer: (A)

Correct option: A. **Method:** Each reflection adds a half-wavelength phase change. The path difference between A' and B' is $\Delta x = 2L_1 + 3\lambda/2 - (L_1 + \lambda/2 + L_2) = L_1 - L_2 + \lambda/2$. With $L_2 = L_1/3$, this is $(2/3)L_1 + \lambda/2$. For A' and B' to be in phase, $\Delta x = n\lambda$. The smallest positive L_1 comes from n = 1: $(2/3)L_1 = \lambda/2$, so $L_1 = 3\lambda/4$.

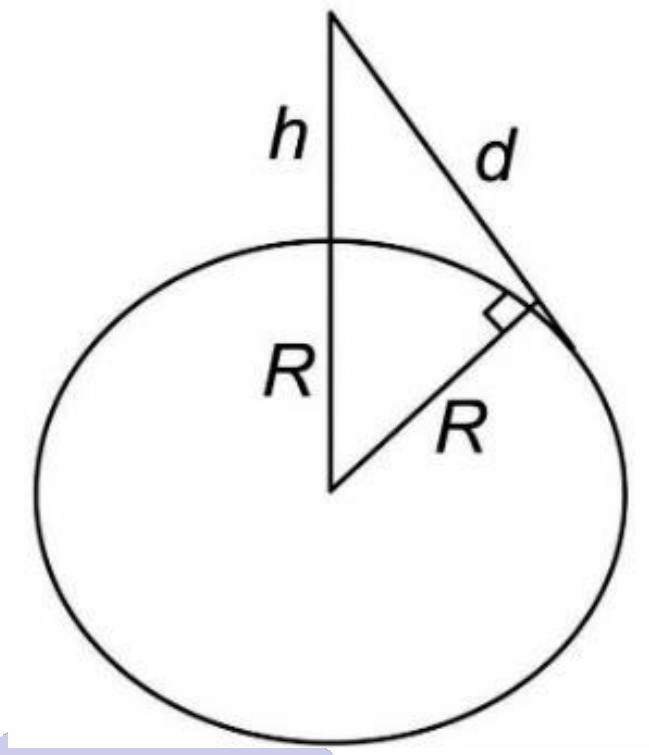
Q25 Part A-1

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

(a) 500 km (b) 50 km (c) 15 km (d) 5 km

Answer: (D)

Correct option: D. **Method:** From the right triangle with the Earth's radius R, the observer's height h and the horizon distance d, $(R + h)^2 = R^2 + d^2$, so $d = \sqrt{(2Rh)}$ for h much smaller than R. With $R = 6.4 \times 10^6$ m and h = 1.5 m, $d = \sqrt{(2 \times 6.4 \times 10^6 \times 1.5)} = 4.4$ km, about 5 km.



Solution figure for Q25.

Q26 Part A-1

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

Answer: (C)

Correct option: C. **Method:** The scale is exponential: 4 sonus means 100 times the energy, so the intensity in these units is $I = 10^{n/2}$, where n is the sonus value. One source has $I_0 = 10^{3.2/2} = 10^{1.6}$. In beats the maximum intensity is $4I_0$, so $10^{n'/2} = 4 \times 10^{1.6}$, giving $n'/2 = 1.6 + \log_{10} 4 = 1.6 + 0.602 = 2.202$, so $n' = 4.4$ sonus.

Q27 Part A-1

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?

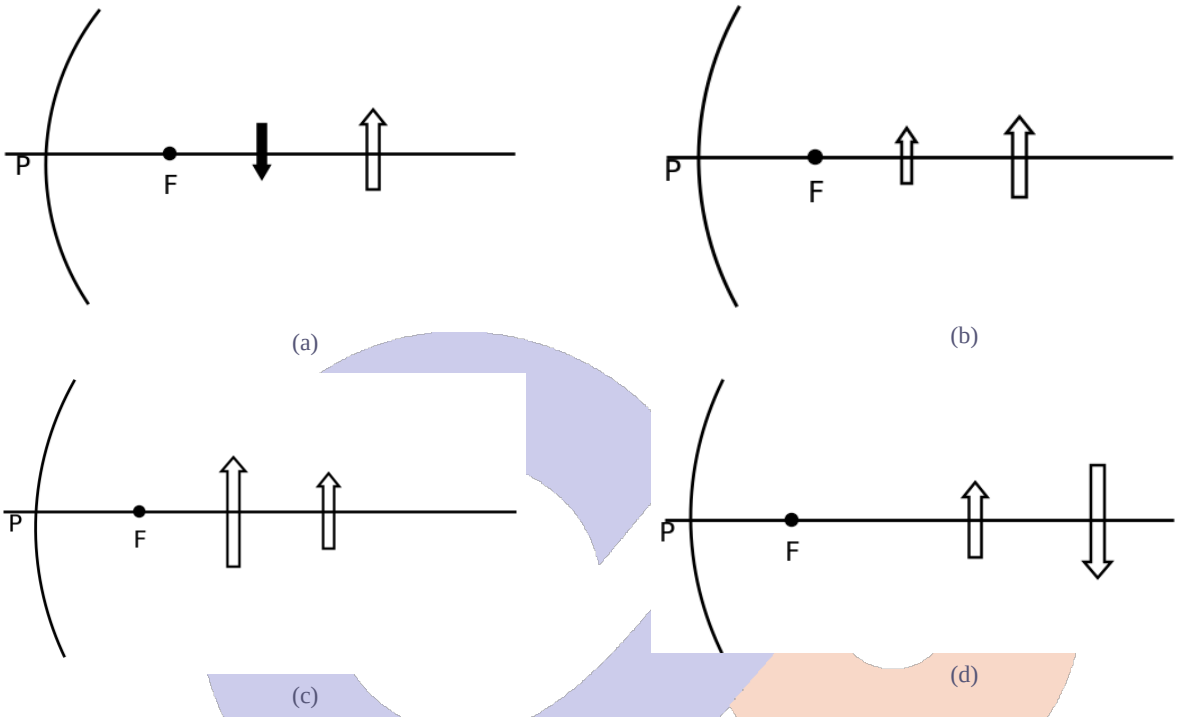
(a) 5.90×10^{-4} μg (b) 2.46×10^{-5} μg (c) 3.94×10^{-6} μg (d) 1.64×10^{-7} μg

Answer: (D)

Correct option: D. **Method:** Activity falls as $A = A_0 e^{-\lambda t}$, so the activity at preparation must be $A_0 = A e^{\lambda t}$ with $\lambda = \ln 2 / 14.96$ h and t = 6 h, giving $A_0 = 40 \times e^{0.278} = 52.8$ kBq. The number of atoms is $N_0 = A_0/\lambda = 52.8 \times 10^3 \times 14.96 \times 3600 / \ln 2 = 4.1 \times 10^9$. Mass = $N_0 \times 24 \times 1.66 \times 10^{-27}$ kg = 1.64×10^{-7} μg.

Q28 Part A-1

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. *Figure: Four panels (a) to (d). Each shows the concave mirror with pole P, focus F marked on the axis, the tall upright object arrow on the right, and a second arrow for the image. In (a) the second arrow is short and inverted, between F and the object. In (b) both arrows are upright. In (c) both arrows are tall and upright. In (d) the object arrow is upright and the second arrow is tall and inverted, far to the right.*



Figures for Q28, options (a) to (d).

(a) Panel (a): short inverted arrow between F and the object
(b) Panel (b): two upright arrows
(c) Panel (c): two tall upright arrows
(d) Panel (d): tall inverted arrow far to the right

Answer: (A)

Correct option: A. **Method:** The object is at 2.5f, beyond the centre of curvature R = 2f. So the image is real, inverted and smaller than the object, and it forms between f and R. Only panel (a) shows a short inverted arrow between F and the object.

Q29 Part A-1

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? *Figure: Graph of electric field E in V/m (vertical axis, 0 to 30.0) against distance d in cm (horizontal axis, 0.0 to 16.0). E rises from 0 at d = 0 to about 12 at d = 2 cm, about 21 at d = 6 cm, peaks near 24 V/m at d = 8 cm, then falls to about 19 at d = 11 cm, about 6 at d = 13 cm, and back to 0 near d = 14.5 cm.*

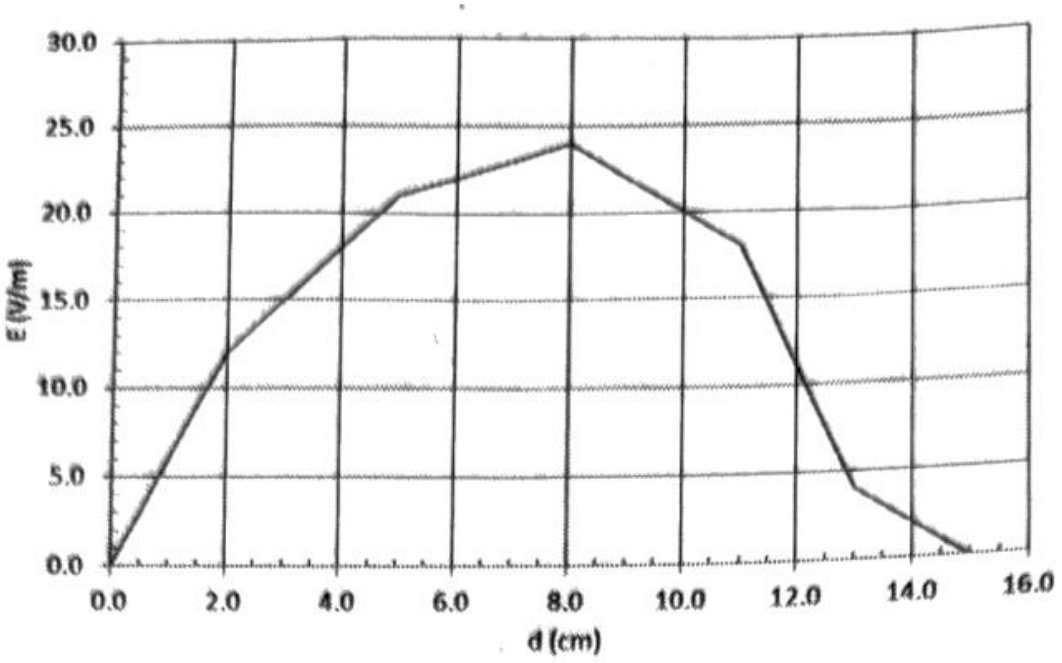


Figure for Q29.

(a) 22.4 km/s (b) 20.5 km/s (c) 205 km/s (d) 880 km/s

Answer: (B)

Correct option: B. **Method:** The potential difference is the area under the E-d graph, about 2.2 V (E in V/m times d in cm gives about 220 x 0.01 = 2.2 V). The work done is e x ΔV, so $mv^2/2 - mu^2/2 = e\Delta V$, giving $v^2 = u^2 + 2e\Delta V/m = (2 \times 10^3)^2 + 2 \times 1.6 \times 10^{-19} \times 2.2 / (1.67 \times 10^{-27}) = 4.25 \times 10^8$, so v = 20.5 km/s.

Q30 Part A-1

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

Answer: (A)

Correct option: A. **Method:** For an adiabatic compression, $T \propto P^{(\gamma-1)/\gamma}$. Helium has γ = 1.66, so the exponent is (1.66 - 1)/1.66 = 0.39, while air has γ = 1.4 and exponent (1.4 - 1)/1.4 = 0.28. For the same pressure rise, helium heats up more than air, so the compressor will be overheated.

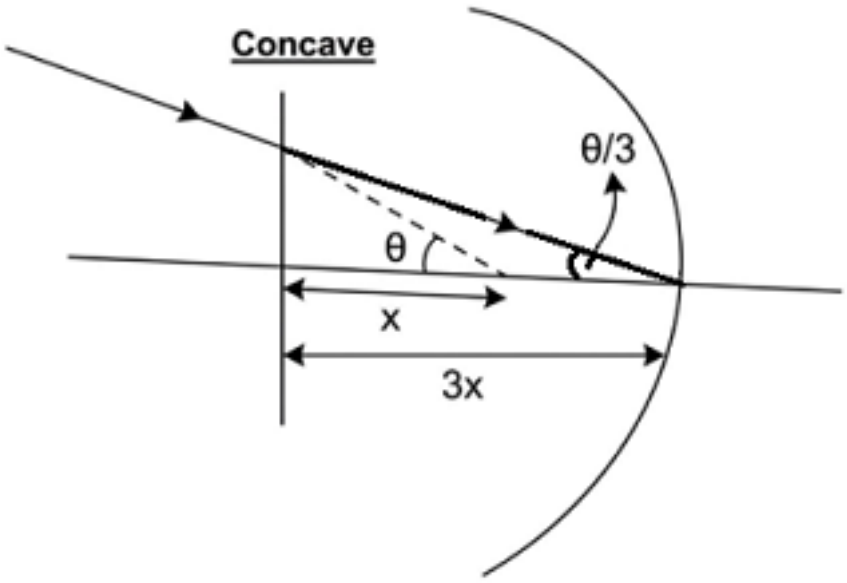
Q31 Part A-1

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

Answer: (C)

Correct option: C. **Method:** The radius of rotation is R = 1.16 + 0.32 = 1.48 m. The centrifugal force is $F = mv^2/R = 4 \times 27 \times 27 / 1.48 = 1970$ N. The time for one rotation is $t = 2\pi R / v = 2\pi \times 1.48 / 27 = 0.34$ s.



Solution figure for Q31.

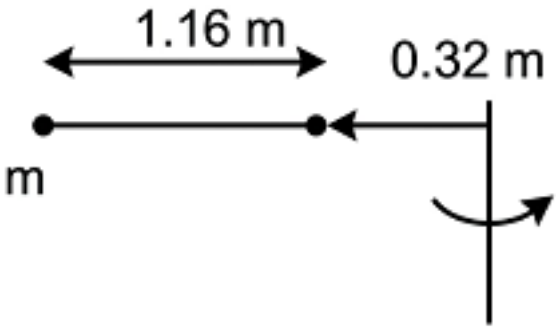
Q32 Part A-1

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

Answer: (C)

Correct option: C. **Method:** The concave lens has f = -30 mm. If the lens is placed x mm before the focus formed by the primary, the lens equation 1/v - 1/u = 1/f with v = 3x (for triple magnification) and u = x gives 1/(3x) - 1/x = -1/30, so -2/(3x) = -1/30 and x = 20 mm. The new image forms 3x = 60 mm beyond the lens instead of 20 mm, so the eyepiece must be shifted by 2x = 40 mm.



Solution figure for Q32.

Q33 Part A-1

If $\alpha, \beta, \gamma \in (0, \pi/2)$ 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

Answer: (B)

Correct option: B. **Method:** The tangent addition formula gives tan(α + β + γ) = (tan α + tan β + tan γ - tan α tan β tan γ) / (1 - sum of pairwise products) = 0, so α + β + γ = π. For any angles with sum π, the identity $\cos^2 \alpha + \cos^2 \beta + \cos^2 \gamma + 2 \cos \alpha \cos \beta \cos \gamma = 1$ holds. Substituting γ = π - (α + β) and expanding confirms it.

Q34 Part A-1

If the determinant | 1+x 1 1 ; 1 1+y 1 ; 1 1 1+z | = 0, and xyz ≠ 0; then 1/x + 1/y + 1/z equals

(a) 1 (b) 0 (c) -1 (d) -2

Answer: (C)

Correct option: C. **Method:** Expanding the determinant along the first row gives (1 + x)[(1 + y)(1 + z) - 1] - [(1 + z) - 1] + [1 - (1 + y)] = 0, which simplifies to xy + yz + zx + xyz = 0. Dividing by xyz (non-zero) gives 1/z + 1/x + 1/y + 1 = 0, so 1/x + 1/y + 1/z = -1.

Q35 Part A-1

The sum from k = 1 to n of 1 / [k (k + 1)(k + 2)] equals

(a) 1/4 + 1 / [2 (n + 1)(n + 2)] (b) 1/4 - 1 / [2 (n + 1)(n + 2)] (c) 1/2 - 1 / [(n + 1)(n + 2)] (d) 1 / [2 (n + 1)]

Answer: (B)

Correct option: B. **Method:** By partial fractions, 1/[k(k+1)(k+2)] = (1/2)[1/(k(k+1)) - 1/((k+1)(k+2))]. Summing from k = 1 to n telescopes: all intermediate terms cancel, leaving (1/2)[1/2 - 1/((n+1)(n+2))] = 1/4 - 1/[2(n+1)(n+2)].

Q36 Part A-1

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

(a) 3/2 (b) 9/2 (c) 6 (d) 9

Answer: (B)

Correct option: B. **Method:** The curves meet where $x^3 - 4x + 3 = 3 - x$, that is $x^3 - 3x = 0$, so x = 0, ± √(3). The area is the integral of $|x^3 - 3x|$ from -√(3) to √(3). Since $x^3 - 3x$ is odd, this is 2 times the integral of $(3x - x^3)$ from 0 to √(3), which is $2[3x^2/2 - x^4/4]$ from 0 to √(3) = 2(9/2 - 9/4) = 9/2.

Q37 Part A-1

If $a_n = 1 / (\sqrt{n} + \sqrt{n+1})$, then the sum of a_n from n = 1 to 99 equals

(a) 9 (b) 10 (c) √(99) - 1 (d) 11

Answer: (A)

Correct option: A. **Method:** Rationalise the denominator: $a_n = (\sqrt{n+1} - \sqrt{n}) / ((\sqrt{n+1} + \sqrt{n})(\sqrt{n+1} - \sqrt{n})) = \sqrt{n+1} - \sqrt{n}$. The sum telescopes: (√(2) - 1) + (√(3) - √(2)) + ... + (√(100) - √(99)) = √(100) - 1 = 10 - 1 = 9.

Q38 Part A-1

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

(a) 0 (b) 1 (c) 2 (d) e

Answer: (B)

Correct option: B. **Method:** Take logs: ln f(x) = x ln x. Differentiating gives f'(x)/f(x) = ln x + 1, so $f'(x) = x^x(\ln x + 1)$. At x = 1, $f'(1) = 1^1(\ln 1 + 1) = 1 \times 1 = 1$.

Q39 Part A-1

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

Answer: (D)

Correct option: D. **Method:** A number is divisible by 6 if it is divisible by both 2 and 3. The digit sum is 1 + 2 + 3 + 4 + 5 = 15, divisible by 3, so every permutation is divisible by 3. For divisibility by 2 the last digit must be even: 2 or 4. With last digit 2, the other four digits arrange in 4! = 24 ways; with last digit 4, another 24 ways. Total = 24 + 24 = 48.

Q40 Part A-1

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

(a) 2/5 (b) 1/2 (c) 3/5 (d) 5/2

Answer: (A)

Correct option: A. **Method:** Numbers divisible by 2: 50. Divisible by 5: 20. Divisible by both, that is by 10: 10. By inclusion-exclusion, divisible by 2 or 5: 50 + 20 - 10 = 60. Divisible by neither: 100 - 60 = 40. Probability = 40/100 = 2/5.

Q41 Part A-1

If $z + 1/z = 2$, $z \neq 0$ and $z \in C$, then $z^{2026} + 1/z^{2026}$ equals

(a) 0 (b) 1 (c) 2 (d) 2026

Answer: (C)

Correct option: C. **Method:** Multiply $z + 1/z = 2$ by z: $z^2 + 1 = 2z$, so $z^2 - 2z + 1 = 0$, that is $(z - 1)^2 = 0$, so $z = 1$. Then $z^{2026} + 1/z^{2026} = 1 + 1 = 2$.

Q42 Part A-1

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

Answer: (D)

Correct option: D. **Method:** Group the terms: $\sin x + \sin 3x = 2 \sin 2x \cos x$, so the equation becomes $2 \sin 2x \cos x + \sin 2x = \sin 2x (2 \cos x + 1) = 0$. Case 1: $\sin 2x = 0$ gives $x = k\pi/2$, and in the closed interval $[0, 2\pi]$ that is $x = 0, \pi/2, \pi, 3\pi/2, 2\pi$, five solutions. Case 2: $\cos x = -1/2$ gives $x = 2\pi/3, 4\pi/3$, two solutions. Total = 5 + 2 = 7. **Note:** Aakash marks (c) 6 because its solution counts solutions in $[0, 2\pi)$, dropping $x = 2\pi$, but the question states the closed interval $[0, 2\pi]$ and $x = 2\pi$ satisfies $\sin 2\pi + \sin 4\pi + \sin 6\pi = 0$. The correct answer is 7.

Q43 Part A-1

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

(a) 6 (b) 13 (c) 24 (d) 36

Answer: No single key (note - see method).

Method: Since n - 1 is divisible by both 2 and 3, and gcd(2, 3) = 1, n - 1 is divisible by 6, so $n = 6k + 1$ for some integer k. Then $n^2 - 1 = (6k + 1)^2 - 1 = 36k^2 + 12k = 12k(3k + 1)$. If k is even, 12k is divisible by 24. If k is odd, 3k + 1 is even, so again $12k(3k + 1)$ is divisible by 24. So $n^2 - 1$ is always divisible by 24, and therefore also by 6. **Note:** Aakash itself states "(a and c) Both are correct", but Part A-1 is a single-correct section, so this question has two correct options and no single key. The official IAPT key should be checked for this question.

Q44 Part A-1

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 $x \in [-\pi, 2\pi]$.

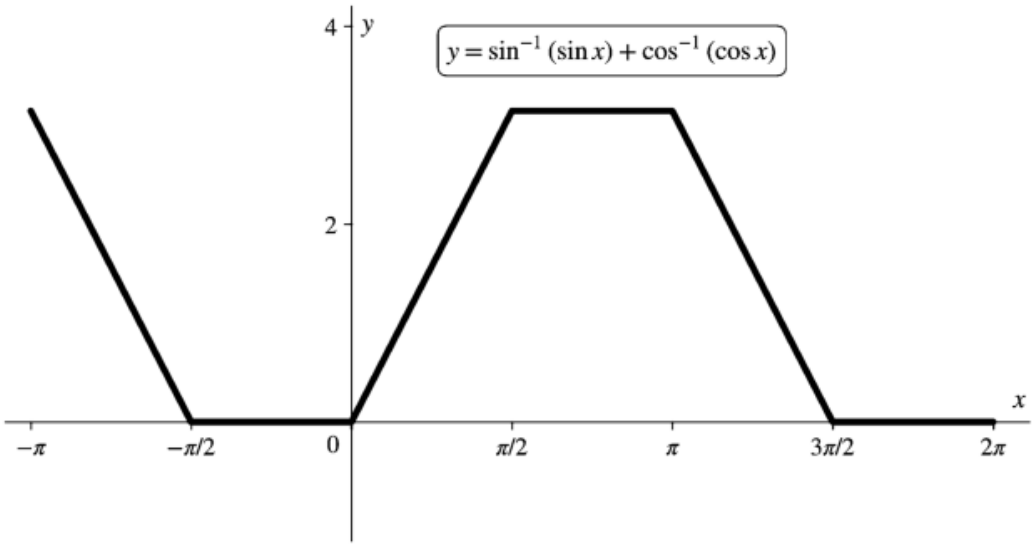
(b) f is piecewise linear and takes the value π on the interval $[\pi/2, \pi]$.

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

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

Answer: (B)

Correct option: B. **Method:** Work interval by interval. For x in $[-\pi, -\pi/2]$: $\sin^{-1}(\sin x) = -\pi - x$ and $\cos^{-1}(\cos x) = -x$, so $f(x) = -\pi - 2x$. For x in $[-\pi/2, 0]$: $f(x) = x + (-x) = 0$. For x in $[0, \pi/2]$: $f(x) = x + x = 2x$. For x in $[\pi/2, \pi]$: $f(x) = (\pi - x) + x = \pi$. So f is piecewise linear and takes the constant value π on $[\pi/2, \pi]$. The range is $[0, \pi]$, not $[0, 2\pi]$, so (d) is false, and (a) and (c) fail on most of the domain.



Solution figure for Q44.

Q45 Part A-1

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) 38/63 (b) 5/9 (c) 37/63 (d) 17/28

Answer: (A)

Correct option: A. **Method:** By the law of total probability. The transferred ball is red with probability 3/7, after which Y has 6 red and 3 black, so the drawn ball is red with probability 6/9. The transferred ball is black with probability 4/7, after which Y has 5 red and 4 black, so the drawn ball is red with probability 5/9. Total $P = (3/7)(6/9) + (4/7)(5/9) = 18/63 + 20/63 = 38/63$.

Q46 Part A-1

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

Answer: (C)

Correct option: C. **Method:** The area of a quadrilateral with given sides is maximised when it is cyclic. By Brahmagupta's formula, with semi-perimeter $s = (1 + 4 + 7 + 8)/2 = 10$, the maximum area is $\sqrt{((s - a)(s - b)(s - c)(s - d))} = \sqrt{(9 \times 6 \times 3 \times 2)} = \sqrt{(324)} = 18.0$ cm^2.

Q47 Part A-1

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

(a) $\lim a_n = 0$ as n tends to infinity

(b) $\lim a_n$ is a finite number as n tends to infinity

(c) $a_{3000} > 30$

(d) $a_{3000} < 30$

Answer: (D)

Correct option: D. **Method:** The sequence is strictly increasing since $a_{n+1} - a_n = 1/a_n^2 > 0$, so it cannot tend to 0, and (a) is false. Cubing the recurrence gives $a_{n+1}^3 = a_n^3 + 3 + 3/a_n^3 + 1/a_n^6$. Since $a_n >= 1$, the increase in the cube is at most 3 + 3 + 1 = 7. Summing gives $a_{3000}^3 <= 1 + 7 \times 2999 = 20994 < 27000 = 30^3$, so $a_{3000} < 30$.

Q48 Part A-1

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) $f(0) = 1$

Answer: (D)

Correct option: D. **Method:** Put $x = y = 0$: $f(0) + f(0) = 2f(0)f(0)$, so $2f(0) = 2f(0)^2$, giving $f(0) = 0$ or $f(0) = 1$. If $f(0) = 0$, putting $y = 0$ in the equation gives $f(x) + f(x) = 2f(x)f(0) = 0$, so $f(x) = 0$ for all x, contradicting the condition that f is not identically zero. Hence $f(0) = 1$. The other options fail: cos x satisfies the equation and is even, not odd; cosh x satisfies it and is not periodic; and differentiability does not follow without extra regularity.

Q49 Part A-2

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

PART A-2

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

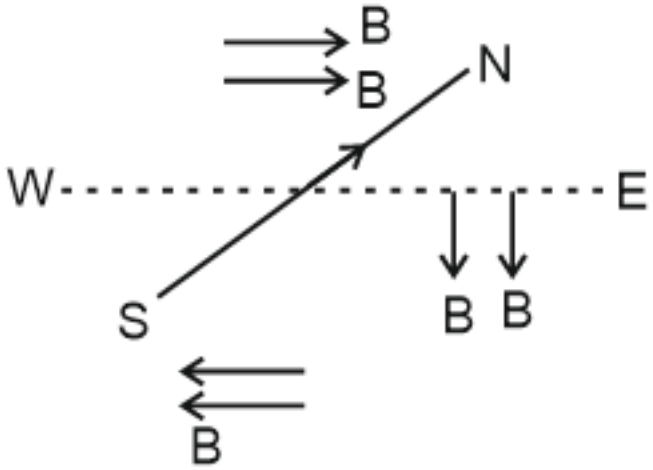
(b) below the conductor, its South pole deflects towards East.

(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.

Answer: (A, B)

Correct options: A, B. **Method:** A north pole deflects in the direction of the magnetic field and a south pole in the opposite direction. By the right-hand rule, with current flowing south to north, the field above the conductor points east, so the north pole deflects east and (a) is correct. Below the conductor the field points west, so the south pole deflects east and (b) is correct. East or west of the conductor in the same horizontal plane, the field is vertical, so a needle free to rotate about a vertical axis shows no horizontal deflection, and (c) and (d) are wrong.



Solution figure for Q49.

Q50 Part A-2

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.

Answer: (A, B, C, D)

Correct options: A, B, C, D. **Method:** (a) Like charges repel each other and move as far apart as they can, to the surface. (b) Copper is a good conductor, so charges can move freely to the surface. (c) Every point on a sphere is equivalent by symmetry, so the surface distribution is uniform. (d) Charges settle in the arrangement that minimises the potential energy of the system.

Q51 Part A-2

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.

Answer: (A, B, C, D)

Correct options: A, B, C, D. **Method:** (a) Outside the Earth, $g = GM/r^2$ falls with distance, so it never exceeds the surface value. (b) Inside, $g(r) = Gm(r)/r^2$, and with density rising inward the enclosed mass grows fast enough that g can exceed the surface value; for a linear density model the maximum is at $r = 5R/6$. (c) Potential decreases in the direction of the field, so it falls as one moves inward. (d) The zero of potential is a free choice of reference and may be taken at the centre.

Q52 Part A-2

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.

Answer: (A, B, C)

Correct options: A, B, C. **Method:** Write h → 10h and c → c/10. (a) Hydrogen energy $E \propto 1/h^2$, so it falls by 100 times, 2 orders of magnitude. (b) Wavelength $\lambda = hc/\Delta E$ with $\Delta E \propto 1/h^2$, so $\lambda \propto h^3 c$, which changes by $10^3 \times 10^{-1} = 100$ times, 2 orders larger. (c) Rest energy mc^2 falls by 100 times since c falls by 10 times. (d) The Bohr radius $r \propto h^2$ grows 100 times, so $I = mr^2$ grows by 10^4 times, 4 orders, not 2, so (d) is false.

Q53 Part A-2

Let $a_n = x^n + 1/x^n$, where $x + 1/x = 3$. Which of the following are correct?

(a) $a_n = 3a_{n-1} - a_{n-2}$ (b) $a_2 = 7$ (c) $a_4 = 49$ (d) $a_6 = 322$

Answer: (A, B, D)

Correct options: A, B, D. **Method:** Multiplying $(x^{n-1} + 1/x^{n-1})(x + 1/x) = 3a_{n-1}$ gives $a_n + a_{n-2} = 3a_{n-1}$, so $a_n = 3a_{n-1} - a_{n-2}$ and (a) is correct. $a_2 = (x + 1/x)^2 - 2 = 9 - 2 = 7$, so (b) is correct. Then $a_3 = 3 \times 7 - 3 = 18$, $a_4 = 3 \times 18 - 7 = 47$, not 49, so (c) is wrong. $a_5 = 3 \times 47 - 18 = 123$ and $a_6 = 3 \times 123 - 47 = 322$, so (d) is correct.

Q54 Part A-2

Let Δ be the determinant | a+b c c ; c+a b a ; b+c a b |. Which of the following are correct?

(a) Δ = 0

(b) a + b + c = 0 implies Δ = 0

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

(d) Δ is divisible by (a - b)

Answer: (B, C, D)

Correct options: B, C, D. **Method:** Adding the second and third columns to the first and simplifying gives Δ = (a + b + c)(a - b)(2c - a - b). (a) is false since Δ is not zero in general. (b) is true because a + b + c = 0 makes the first factor zero. (c) is true because swapping a and b flips the sign of (a - b) while the other factors stay the same. (d) is true because (a - b) is a factor of Δ.

Q55 Part A-2

Let a, b and c be the three non-coplanar vectors to define other three vectors p, q and r such that p = (b x c)/[a b c], q = (c x a)/[a b c] and r = (a x b)/[a b c], where [a b c] is the scalar triple product. Which of the following is/are necessarily true?

(a) a . p + b . q + c . r = 3 (b) a . q = 0 (c) [p q r] = 1/[a b c] (d) p, q, r are coplanar

Answer: (A, B, C)

Correct options: A, B, C. **Method:** These are the reciprocal vectors. (a) a . p = (a . (b x c))/[a b c] = 1, and likewise b . q = 1 and c . r = 1, so the sum is 3. (b) a . q = (a . (c x a))/[a b c] = 0, since c x a is perpendicular to a. (c) [p q r] = 1/[a b c], the standard reciprocal triple product. (d) is false because [p q r] is non-zero, so p, q, r are not coplanar.

Q56 Part A-2

An ellipse has foci at F_1 (1, 0) and F_2 (-1, 0) and passes through the point P (1, 1/√(2)). Which of the following are correct?

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

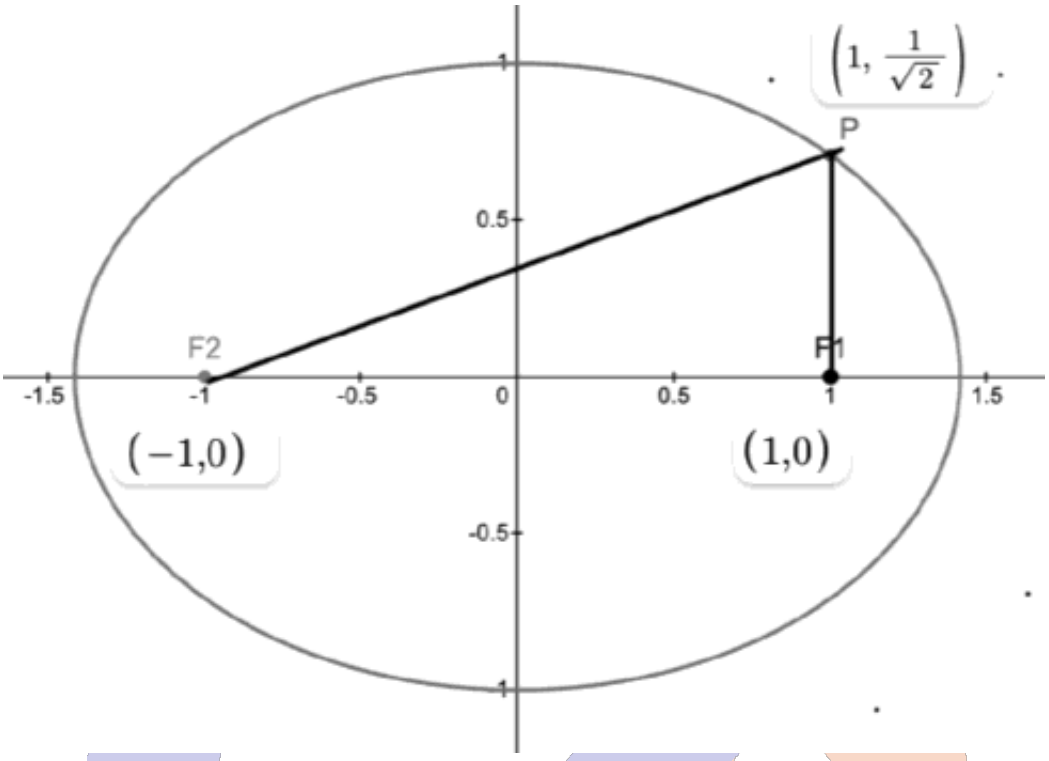
(b) The eccentricity is e = 1/√(2)

(c) The length of the minor axis is 2

(d) The directrices of the ellipse are x = ±2

Answer: (A, B, C, D)

Correct options: A, B, C, D. **Method:** The distance between the foci is 2, so 2ae = 2 and ae = 1. $PF_1 = 1/\sqrt{(2)}$ and $PF_2 = 3/\sqrt{(2)}$, so $PF_1 + PF_2 = 2\sqrt{(2)} = 2a$, giving $a = \sqrt{(2)}$ and $a^2 = 2$. Then $e = 1/a = 1/\sqrt{(2)}$. $b^2 = a^2(1 - e^2) = 2(1 - 1/2) = 1$, so the minor axis is 2b = 2. The directrices are $x = \pm a/e = \pm 2$. **Note:** the point is $P(1, 1/\sqrt{(2)})$; the plain-text extraction lost the square root, but the PDF page and the solution both show $1/\sqrt{(2)}$.



Solution figure for Q56.

Q57 Part A-2

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 α process creates the nuclei of C

Answer: (A, C, D)

Correct options: A, C, D. **Method:** (a) In stars with mass up to about 1.3 solar masses the p-p chain dominates, converting H into He. (b) The CNO cycle uses carbon, nitrogen and oxygen isotopes as catalysts to produce He from H; it does not net-create N and O nuclei, so (b) is false. (c) Massive stars (8 solar masses or more) reach the temperatures and pressures for carbon, neon, oxygen and silicon burning, synthesising nuclei up to Fe. (d) The triple α process produces carbon. **Note:** Aakash's answer line lists (a, b, c, d), but its own solution marks (b) False, so the correct key is (a, c, d).

Q58 Part A-2

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

Answer: (C, D)

Correct options: C, D. **Method:** (a) is false: the length of the solar day varies through the year because the Earth's orbit is elliptical and its axis is tilted. (b) is false: the Sun is at the zenith at the equator only at the equinoxes. (c) is true: the sidereal day is 23 h 56 m, so a star rising just after 00:00 hours can rise again around 23:56 hours on the same date. (d) is true: at the equator the time from rising to setting is nearly half a sidereal day, about 12 hours, for every star, so two stars rising together set together.

Q59 Part A-2

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

Answer: (B)

Correct option: B. **Method:** The same time period means the same semi-major axis by Kepler's third law, but the two planets can have different eccentricities, so they need not stay on opposite sides of the star, and their closest and farthest approaches a(1 - e) and a(1 + e) can differ. By Kepler's second law each planet sweeps out equal areas in equal intervals of time, so (b) is the intended answer.

Q60 Part A-2

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

Answer: (B, D)

Correct options: B, D. **Method:** With the rotation axis in the orbital plane, the star's declination swings between +90 degrees and -90 degrees over the year. (a) is false: the star is at the pole's zenith only at certain times. (b) is true: when the star is on the horizon at the poles its declination is 0, so it is at the equator's zenith at midday. (c) is false: the star is on the equator's horizon all day only when the declination is ± 90 degrees. (d) is true: at each pole the star stays up for half the year, so it rises once and sets once in a year.