INDIAN ASSOCIATION OF PHYSICS TEACHERS

National Standard Examination in Astronomy - 2026

Date of Examination: November 21, 2026

Time: 2:30 PM to 4:30 PM

Question Paper Code: 41

Student's Roll No:											

Write the Question Paper code (mentioned above) on YOUR OMR Answer Sheet (in the space provided), otherwise your Answer Sheet will NOT be evaluated. Note that the same Question Paper Code appears on each page of the Question Paper.

Instructions to Candidates:

1. Use of mobile phone, smart watch, iPad and devices like ear pod etc during exam is STRICTLY **PROHIBITED.**
2. In addition to this Question Paper, you are given OMR Answer Sheet along with candidate's copy.
3. On the Answer Sheet, make all the entries carefully in the space provided **ONLY** in **BLOCK CAPITALS** as well as by properly darkening the appropriate bubbles.
   Incomplete/ incorrect/ carelessly filled information may disqualify your candidature.
4. On the OMR Answer Sheet, use only **BLUE or BLACK BALL POINT PEN** for making entries and filling the bubbles.
5. Your **Eleven-digit roll number and date of birth** entered on the OMR Answer Sheet shall remain your login credentials (means login id and password respectively) for accessing your performance / result in National Standard Examination in Astronomy – 2026.
6. Question paper has two parts. In part A-1 (Q. No.1 to 48) each question has four alternatives, out of which **only one** is correct. Choose the correct alternative and fill the appropriate bubble, as shown.

Q.No.22 

In part A-2 (Q. No. 49 to 60) each question has four alternatives out of which any number of alternative(s) (1, 2, 3, or 4) may be correct. You have to choose **all** correct alternative(s) and fill the appropriate bubble(s), as shown

Q.No.54 

7. Attempt all sixty questions. For **Part A-1,** each correct answer carries 3 marks whereas 1 mark will be deducted for each wrong answer. In **Part A-2,** you get 6 marks if all the correct alternatives are marked. No negative marks in this part.
8. Rough work may be done in the space provided. There are **13** printed pages in this question paper
9. Use of **non - programmable scientific** calculator is allowed.
10. No candidate should leave the examination hall before the completion of the examination.
11. After submitting Answer Paper, take away the Question Paper & candidate's copy of OMR sheet for your future reference.

Please DO NOT make any mark other than filling the appropriate bubbles properly in the space provided on the OMR Answer Sheet.

Answer Sheets are evaluated using machine, hence CHANGE OF ENTRY IS NOT ALLOWED. Scratching or overwriting may result in wrong score.

DO NOT WRITE ON THE BACK OF THE ANSWER SHEET.

Instructions to Candidates (Continued) :
You may read the following instructions after submitting the Answer Sheet.

12. **Comments/Inquiries/Grievances regarding this Question Paper, if any, can be shared on the Inquiry/Grievance column on www.iapt.org.in on the specified format till December 1, 2026**

13. **The answers/solutions to this Question Paper will be available on the website: www.iapt.org.in by November 29, 2026.** The score card may be downloaded after Dec 24, 2026

14. **CERTIFICATES and AWARDS:**
Following certificates shall be awarded by IAPT to the students, successful in the NATIONAL STANDARD EXAMINATION IN ASTRONOMY – 2026
(i) "CENTRE TOP 10 %" to be downloaded from iapt.org.in after 30.01.27
(ii) "STATE TOP 1 %" will be dispatched to the examinee
(iii) "NATIONAL TOP 1 %" will be dispatched to the examinee
(iv) "GOLD MEDAL & MERIT CERTIFICATE" to all students who attend OCSC – 2027 at HBCSE-TIFR Mumbai
Certificate for centre toppers shall be uploaded on iapt.org.in

15. List of students (with centre number and roll number only) having a score equal and above **Minimum Admissible Score (MAS)** will be displayed on the website: **www.iapt.org.in** by **December 25, 2026. See the MAS clause** on the Student's brochure on the web.

16. List of students eligible to appear for Indian National Astronomy Olympiad (INAO – 2027) shall be displayed on **www.iapt.org.in** by December 30, 2026.

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 = 5.97×10^{24} kg

INDIAN ASSOCIATION OF PHYSICS TEACHERS
NATIONAL STANDARD EXAMINATION IN ASTRONOMY
(NSEA - 2026)

Time: 120 minute **Max. Marks: 216**

Attempt All Sixty Questions

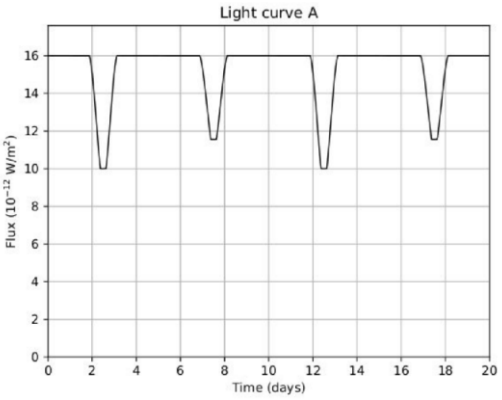
A – 1
ONLY ONE OUT OF THE FOUR OPTIONS IS CORRECT. BUBBLE THE CORRECT OPTION.

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.

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.

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.

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.



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

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 %

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

8. Which of the following constellations has smallest area?
   (a) Triangulum (b) Sagitta (c) Scutum (d) Crux

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

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.

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

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.

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.

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

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

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

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) $344 \pm 5\,\Omega$ (b) $344 \pm 20\,\Omega$ (c) $2.90 \pm 0.04\,\text{k}\Omega$ (d) $2.90 \pm 0.16\,\text{k}\Omega$

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

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

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.

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.

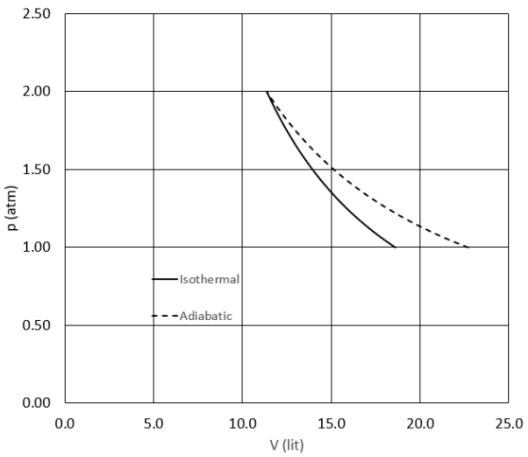
(a) Both the statements are correct and statement II is the correct reason for statement I.
(b) Both the statements are correct but statement II is not the correct reason for statement I.
(c) Only statement I is correct.
(d) Only statement II is correct.

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,

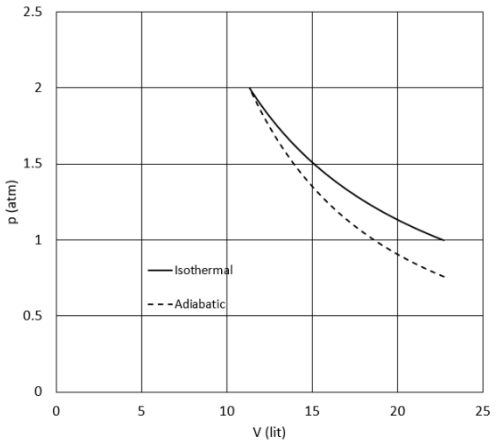
(a) 20 rad/mV (b) 2.0 rad/mV (c) 0.20 rad/mV (d) 0.020 rad/mV

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?

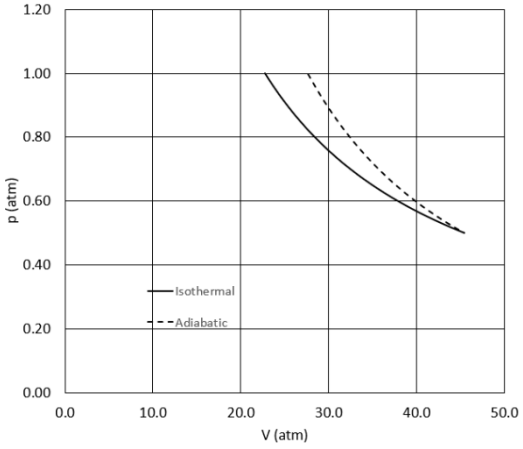
(a)



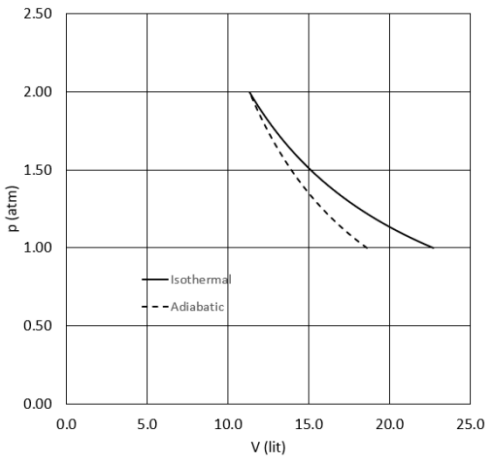
(b)



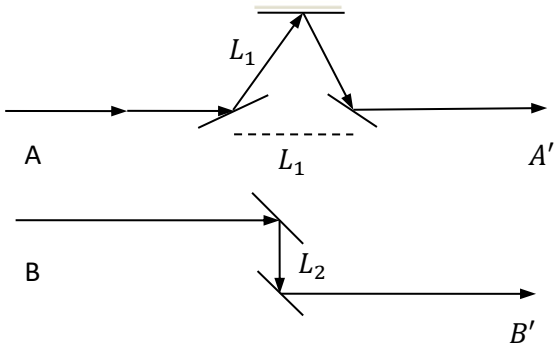
(c)



(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



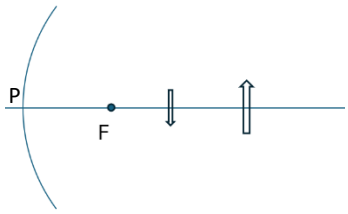
(a) $\frac{3\lambda}{4}$ (b) $\frac{3\lambda}{5}$ (c) $\frac{3\lambda}{10}$ (d) $\frac{3\lambda}{15}$

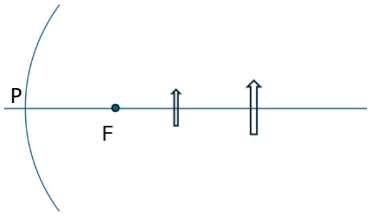
25. When a person of average height stands on a smooth surface with clear horizons, the approximate distance to the horizon from the person is
(a) 500 km (b) 50 km (c) 15 km (d) 5 km

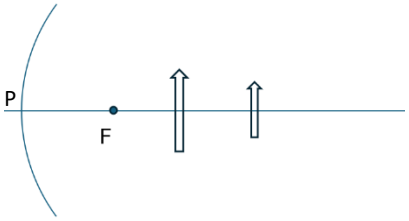
26. Imagine a new scale for measuring sound energy is designed. In this scale, 1 μJ energy incident per unit second per square meter, is denoted as 0 sonus. Every increase of 4 sonus increases the sound energy by 100 times. Two identical sound sources of rating 3.2 sonus are played simultaneously. It 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

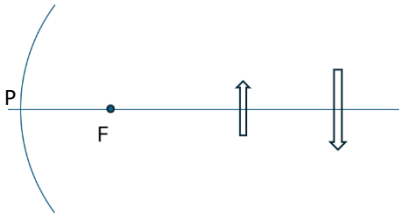
27. A radioactive sample of Na-24 used for irradiation of a patient is prepared exactly 6.0 hrs before it is to be used for a patient. It has half-life of 14.96 hrs. If it is expected to have activity of 40 kBq at the start of the treatment, what should be its mass when it is prepared?
(a) 5.90×10^{-4} μg (b) 2.46×10^{-5} μg (c) 3.94×10^{-6} μg (d) 1.64×10^{-7} μg

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.

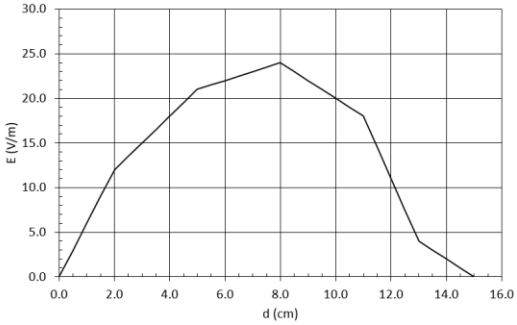
(a)


(b)


(c)


(d)


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

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

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

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

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

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

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) $\frac{1}{2(n+1)}$

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

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

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

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

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

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) $\frac{5}{2}$

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

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

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

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 $[0, 2\pi]$.

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) $\frac{17}{28}$

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

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) $a_{3000} < 30$

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) $f(0) = 1$

A – 2
ANY NUMBER OF OPTIONS (4, 3, 2 or 1) MAY BE CORRECT
MARKS WILL BE AWARDED ONLY IF ALL THE CORRECT OPTIONS ARE BUBBLED AND NO INCORRECT.

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.

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.

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.

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.

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) $a_6 = 322$

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 $(a - b)$

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

$$\vec{p} = \frac{\vec{b} \times \vec{c}}{[\vec{a}\ \vec{b}\ \vec{c}]}, \quad \vec{q} = \frac{\vec{c} \times \vec{a}}{[\vec{a}\ \vec{b}\ \vec{c}]} \quad \text{and} \quad \vec{r} = \frac{\vec{a} \times \vec{b}}{[\vec{a}\ \vec{b}\ \vec{c}]}.$$

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) $[\vec{p}\ \vec{q}\ \vec{r}] = \frac{1}{[\vec{a}\ \vec{b}\ \vec{c}]}$
(d) $\vec{p}$, $\vec{q}$, $\vec{r}$ are coplanar

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 $x = \pm 2$.

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.

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.

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.

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.

Rough Work