INDIAN ASSOCIATION OF PHYSICS TEACHERS

NATIONAL STANDARD EXAMINATION IN ASTRONOMY - 2022

Date of Examination: November 26, 2022
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, and ipad during examination is STRICTLY PROHIBITED.
2. In addition to this question paper, you are given OMR Answer Sheet along with Candidate's copy.
3. On the OMR 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 **Ten-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 NSEA - 2022.
6. Question paper has two parts. In part A1 (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. 12 (a) (●) (c) (d)

   In part A2 (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. 52 (a) (●) (c) (●)
7. For **Part A1**, each correct answer carries 3 marks whereas 1 mark will be deducted for each wrong answer. In **Part A2**, 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 11 printed pages in this 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 OMR sheet for your reference.

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

OMR answer sheets are evaluated using machine, hence CHANGE OF ENTRY IS NOT ALLOWED. Scratching or overwriting may result in a wrong score.

DO NOT WRITE ON THE BACK SIDE OF THE OMR 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 3, 2022**

13. The answers/solutions to this question paper will be available on the website:
www.iapt.org.in **by December 2, 2022.**

14. CERTIFICATES and AWARDS:

Following certificates shall be awarded by IAPT to the students, successful in the NATIONAL STANDARD EXAMINATION IN ASTRONOMY – 2022

(i) CENTRE TOP 10 % To be downloaded from iapt.org.in after 15.01.23

(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 – 2023 at HBCSE Mumbai

Certificate for centre toppers shall be uploaded on iapt.org.in

15. List of students (with centre number and roll number only) having score above MAS will be displayed on the website: www.iapt.org.in by **December 25, 2022. See the Minimum Admissible Score clause** on the Student's brochure on the web.

16. List of students eligible to appear for Indian National Astronomy Olympiad (INAO – 2023) shall be displayed on www.iapt.org.in by December 30, 2022.

Constants you may need….

Magnitude of charge on electron $e = 1.60 \times 10^{-19}$ C	Avogadro's constant $A = 6.023 \times 10^{23}$ mol^{-1}
Mass of electron $m_e = 9.10 \times 10^{-31}$kg	Speed of light in free space $c = 3 \times 10^8$ m/s
Mass of proton $m_p = 1.67 \times 10^{-27}$ kg	Permittivity of free space $\varepsilon_0 = 8.85 \times 10^{-12}$ C^2 / N. m^2
Acceleration due to gravity $g = 9.81$ m. s^{-2}	Permeability of free space $\mu_0 = 4\pi \times 10^{-7}$ H / m
Universal constant of gravitation $G = 6.67 \times 10^{-11}$ Nm^2 / kg^2	Planck's constant $h = 6.63 \times 10^{-34}$ J.s
Universal gas constant R = 8.31 J / mol. K	Faraday constant = 96500 C / mol
Boltzmann constant $k = 1.38 \times 10^{-23}$ J/K	Rydberg constant $R = 1.097 \times 10^7$ m^{-1}
Stefan's constant $\sigma = 5.67 \times 10^{-8}$ W / m^2 K^4	Solar mass $= 1.99 \times 10^{30}$ kg
Wien's constant $b = 2.90 \times 10^{-3}$ m K	Average Earth - Sun distance (=1 AU) $= 1.5 \times 10^{11}$ m

INDIAN ASSOCIATION OF PHYSICS TEACHERS
NATIONAL STANDARD EXAMINATION IN ASTRONOMY
(NSEA - 2022)

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

Attempt All Sixty Questions

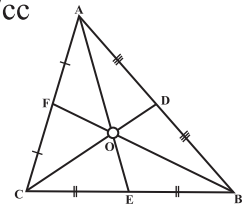
A - 1

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

1. If the perigee and the apogee of the Moon's orbit are 362600 km and 405400 km respectively, then the largest diameter of the moon apparent from the earth is larger than the apparent smallest diameter by
(a) 25% (b) 12% (c) 5% (d) None of these

2. A cylindrical bar magnet (of 6.0 cm length and 1.0 cm diameter) has magnetic moment 2.3×10^{-2} A. m^2. When suspended in a uniform, horizontal magnetic field of strength $B = 12 \times 10^{-4}$ T, with the axis of the bar magnet parallel to the direction of the field and set into small oscillations in the horizontal plane, the magnet oscillates with a period of 3.2 s. The density of the material of the magnet is
(a) 8.9 g/cc (b) 7.8 g/cc (c) 5.1 g/cc (d) 2.7 g/cc

3. AE, BF, CD are medians of the triangle ABC. If the area of the triangle is 36 (in some arbitrary units) then the area of the quadrilateral AFOD is …
(a) 12 (b) 6 (c) 18 (d) 36



4. If the moon takes 29.53 days to go from one New Moon to the next (i.e. go round in the sky once relative to the Sun), then it will go round once relative to the Vernal Equinox and the stars in a time
(a) less than 29.53 days (b) 29.53 days
(c) more than 29.53 days by about 1 day (d) more than 29.53 days by about 2 days

5. Define $f(x)$ for real values of x as $\frac{|x|}{1+|x|}$. The correct statement regarding f is
(a) $f(x)$ is an injective function on the real line.
(b) $f(x)$ is an unbounded function on the real line.
(c) $f(x)$ is a monotonically increasing function for real $x > 0$.
(d) $f(x)$ is differentiable every where on the real line.

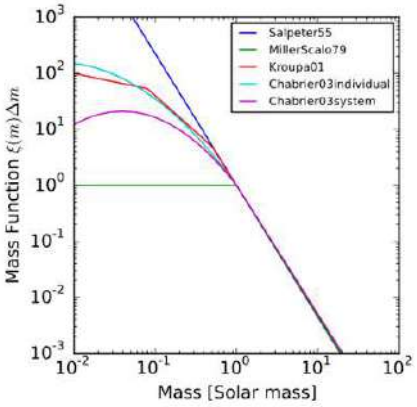
6. Consider a rocky planet with atmospheric pressure 5.0 MPa at the surface, radius 5000 km and surface gravity 7.5 m/s^2. The carbon dioxide content (by mass) of the atmosphere is 97% and the rest is mostly nitrogen. An estimate for the total mass of carbon dioxide in the planet's atmosphere is
(a) 2.0×10^{20} kg (b) 6.8×10^{13} kg (c) 2.0×10^{10} kg (d) 4.7×10^{8} kg

7. Pluto is not considered as a planet of our solar system because
(a) It does not orbit the Sun
(b) It has not 'cleared' the neighborhood around its orbit
(c) It does not have sufficient mass to achieve hydrostatic equilibrium under its own gravity
(d) Its orbital plane makes an angle of 17^o with the Earth's orbital plane

8. The Gomateshwara statue (18 m tall) is focused on a screen using a 50 mm focal length convex lens from a distance $u = 50$ m. To shrink the image to $1/5^{th}$ size when image is taken from the same distance by another lens, the focal length of the second lens should be
(a) 10 mm (b) 22 mm (c) 112 mm (d) 250 mm

9. Figure shows various approximations to what is called the Initial Mass Function (IMF) of stars which gives the number of stars in various mass ranges as a function of the logarithm of the mass log m = x as say y = f (x). One of the shapes is approximately an inverted parabola continuing as a straight line. Let the parabola portion be fitted by $y = y_0 + A (x - x_0)^2$ and the straight line portion be fitted by $y = -2.35 x + C$. If the parabolic and linear portions join smoothly at the point (x_1, y_1) the unknown parameters A and C are given by

Picture credit: Johannes Buchner CC, BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=44779435



(a) $\frac{2.35}{2 (x_1 - x_0)}, y_0 + \frac{2.35 (x_1 + x_0)}{2}$ (b) $\frac{-2.35}{2 (x_1 - x_0)}, y_0 + \frac{2.35 (x_1 + x_0)}{2}$

(c) $\frac{-2.35}{2 (x_1 - x_0)}, y_0 + \frac{-2.35 (x_1 + x_0)}{2}$ (d) $\frac{2.35}{2 (x_1 - x_0)}, y_0 + \frac{-2.35 (x_1 + x_0)}{2}$

10. Astronomers discover an exoplanet (a planet orbiting a star other than the Sun), that has an orbital period of 4.50 Earth years in a circular orbit around its star. The star has a measured mass of 3.70×10^{30} kg. The radius r of the exoplanet's orbit is approximately.
(a) 2.7×10^{11} m (b) 2.7×10^{12} m (c) 5.0×10^{13} m (d) 5.0×10^{11} m

11. The complex matrix $U = \begin{pmatrix} a + ib & c + id \\ e + if & g + ih \end{pmatrix}$ is unitary (*i.e.* its complex conjugate transpose is its inverse and $|\det U| = 1$). Which of the following holds regarding a, b, c, d, e, f, g, h
(a) only three of them are independent (b) only four of them are independent
(c) only five of them are independent (d) none of them are independent

12. A monoatomic ideal gas is at temperature T. Let v_x, v_y, v_z denote the components of velocity of the molecules. The mean value of $(v_x + v_y)^2$ is

(a) $\frac{kT}{m}$ (b) $\frac{8kT}{m}$ (c) $\frac{kT}{2m}$ (d) $\frac{2kT}{m}$

13. The orbit of Halley's comet about the Sun is such that it arrives at perihelion every 75.3 years. If the perihelion distance is 0.586 AU, the aphelion distance is approximately
(a) 70 AU (b) 80 AU (c) 35 AU (d) 40 AU

14. Earth has about 100 V/m potential gradient in clear weather. Potential increases in upward direction. If the conductivity of air is 2.0×10^{-14} SI unit. The total current given out by Earth (assuming clear weather everywhere) is
(a) 1.6×10^{-4} A (b) 1.0×10^{-3} A (c) 1.0×10^{3} A (d) 2.2×10^{9} A

15. Solve the given equation for x: $\log_6(4x+8) = 2$
(a) 7 (b) 6 (c) 3 (d) None of these

16. If gcd $(a, b) = 1$ where a and b are integers, then gcd $(a + b, a - b)$ can be
(a) 2 or 3 (b) 1 or 2 (c) 1 or 3 (d) 2 or 4

17. The probability that a student will pass in both English and Mathematics is 0.5. The probability for passing in English is 0.75 and the probability for failing in both English and Mathematics is 0.1. What is the probability for passing in Mathematics?
(a) 0.35 (b) 0.65 (c) 0.6 (d) 0.4

18. A wire mesh in a paraboloid shape can be used as collector of radio waves for a radio telescope. Such radio dishes are used to detect radio signals from distant galaxies. What will be the angular radius of the image of a point source emitting 21cm radio radiation, due to diffraction effects, if the dish is 250 m in diameter?
(a) 0.0010 arc minute (b) 0.058 arc minute (c) 3.5 arc minute (d) 211 arc minute

19. Which one of the following equations has no integer solutions?
(a) $2x^2 + 4y^3 = 23$ (b) $5x^3 - 2y^2 = 8$ (c) $15x^2 - 7y^2 = 107$ (d) $3x - 2y = 5$

20. LIGO gravitational wave observatory detected the merger of two black holes of masses 30 and 35 solar masses to form a single black hole of mass 62 solar masses. The total energy radiated away in the form of gravitational waves in the merger is
(a) 2.3×10^{44} joule (b) 4.0×10^{26} watt (c) 3.6×10^{49} watt (d) 5.4×10^{47} joule

21. Let $x^3 + y^3 = xy + 1$ be a function implicitly defined for y. Find y' (1) at the point (1,1).
(a) 1 (b) 2 (c) – 1 (d) 4

22. Two stars A and B, have masses M_A and M_B and radii R_A and R_B respectively. It is given that $R_A = R_B = R$, but $M_A \neq M_B$. Star A has a constant density ρ_0, and the density profile of star B is $\rho = \rho_0 \left(1 - \frac{r}{R}\right)$. In the region $0 < r < R$, the gravitational accelerations g_A and g_B of these two stars are related as

(a) $g_B = g_A\left(1 - \frac{3r}{4R}\right)$ (b) $g_B = g_A\left(1 - \frac{r}{12R}\right)$

(c) $g_B = g_A\left(1 - \frac{3r}{R}\right)$ (d) $g_B = g_A\left(1 - \frac{12r}{R}\right)$

23. If $\alpha = \sin^{-1}\frac{\sqrt{12}}{4}$ then the value of $\cot\alpha$ is
(a) $\frac{1}{\sqrt{3}}$ (b) $\frac{2}{\sqrt{3}}$ (c) $\frac{\sqrt{12}}{4}$ (d) $\frac{4}{\sqrt{12}}$

24. Imagine a large asteroid of circular disc shape with diameter $D = 50$ km and thickness 2 km. The magnitude of gravitational acceleration at distances $h = 100$ m and $h = 200$ m above the surface can be approximated to have the same value (neglecting corrections of the order of h/D)
(a) anywhere above the disc. (b) anywhere above the disc but not near the edges.
(c) only along the axis. (d) nowhere above the disc.

25. A cylindrical vessel of height h and radius r, filled with water, is falling down freely. All along the downward fall the vessel remains vertical. If ρ is the density of water and g the acceleration due to gravity, then the pressure of water at the bottom of the cylindrical vessel is
(a) ρgh (b) $2\rho gh$ (c) $\rho gh/2$ (d) None of these

26. A neutron, a proton and an alpha particle are projected together simultaneously along a uniform magnetic field, with equal energy. The separation between them will go on increasing as: (magnetic moments of both the particles may be neglected)
(a) $\propto t^{1/2}$ (b) $\propto t$ (c) $\propto t^{3/2}$ (d) $\propto t^2$

27. Which of the following is a convergent series?
(a) $\Sigma_2^\infty \frac{1}{n^2 \log n}$ (b) $\Sigma_2^\infty \frac{1}{n \log n}$ (c) $\Sigma_2^\infty \frac{1}{\log n}$ (d) None of these.

28. If the surface temperature of a star is 6000K, in which colour would it appear in a colour photograph?
(a) Red (b) Violet (c) Yellow (d) Blue

29. The value of the constant c such that the curve $y = x^2 + c$ is tangent to the line $y = 2x$ is
(a) $c = -1$ (b) $c = 1$ (c) $c = 2$ (d) $c = 3$

30. A circular disc of radius 'a' is placed at a distance 'a' in front of a spherical convex mirror of focal length '$4a$', with its axis along the principal axis of the mirror. Determine the solid angle (in steradians) subtended by the image at the centre of the disc.
(a) 1.58 (b) 0.83 (c) 0.54 (d) 0.44

31. The average flux of solar radiation on Earth is $F = 1.36 \times 10^3$ W m^{-2} and the average Earth-Sun distance is 1.5×10^{11} m. The power radiated by the Sun is
(a) 3.8×10^{26} W (b) 3.8×10^{33} W (c) 4.0×10^{28} W (d) None of these

32. Twelve identical resistors each of resistance R, are connected in the configuration of a regular octahedron (a solid made of eight equilateral triangles four of which meet at each vertex). Find the equivalent resistor between any two opposite vertices.

(a) $\frac{R}{6}$ (b) $\frac{R}{2}$ (c) $\frac{2R}{3}$ (d) $\frac{6R}{5}$

33. Find all values of positive even numbers n so that n. 2^n - 1 is divisible by 3
(a) $6k+2,\ k \in \mathbb{N}$ (b) $6k+4,\ k \in \mathbb{N}$ (c) $6k+6,\ k \in \mathbb{N}$ (d) $6k+8,\ k \in \mathbb{N}$

34. The photospheric radius of the Sun is 0.696 million km. Rotation period of the Sun at the solar equator is approximately 24 days. The end regions of the solar equator on the solar disc, are simultaneously and separately observed using an H alpha filter with mid wavelength 6563 Angstroms. The difference in measured wavelength between the observations at the two edges is
(a) 0.0459 Angstrom (b) 0.0229 Angstrom
(c) 0.1836 Angstrom (d) 0.0918 Angstrom

35. The radii of the circumcircle and the in-circle of a triangle are 2.5 cm and 1.0 cm respectively. If the perimeter of the triangle is 12 cm, then the area of the triangle is
(a) 15 cm^2 (b) 12 cm^2 (c) 9 cm^2 (d) 6 cm^2

36. The electron, muon and the tauon are particles of the lepton family. All have charge – e and spin $\frac{\hbar}{2}$. The mass of the muon is approximately 207 times the mass of the electron. The mass of a tauon is 3478 times the mass of an electron and 1.894 times the mass of a proton. The mass of a proton is 1836 times that of the electron. Consider a 'heavy' atom with a tauon and a proton in orbit around each other. Assuming the Bohr model of the atom to be applicable, estimate the ground state energy of this atom. (The ground state energy of the hydrogen atom is – 13.6 eV).
(a) – 8.9 eV (b) – 16.34 keV (c) – 13.6 eV (d) – 25.7 keV

37. A planet of mass m is in a circular orbit of radius r around a star of mass M and radius R (radius of the star). By some physical process the star instantaneously shrinks to a black hole of the same mass M. The final orbit of the planet will be
(a) circular with radius $2r$.
(b) a spiral going in towards the black hole.
(c) circular with radius r.
(d) a hyperbola as the planet escapes with speed greater than the escape speed.

38. Consider the two statements:
Statement A: Objects are closer than they appear when seen in a convex mirror.
Statement B: The image distance is always greater than the object distance for convex mirrors.
(a) Both statements are correct and statement B is the correct explanation of statement A.
(b) Both statements are correct but statement B is not the correct explanation of statement A.
(c) Statement A is correct but statement B is not correct.
(d) Statement B is correct but statement A is not correct.

39. Three sisters inherit n gold pieces, each weighing $1, 2, 3 \ldots . n$ (arbitry unit). For what n can the gold pieces be split into three heaps of equal weight?
(a) n is divisible by 5
(b) n is divisible by 3
(c) $n + 1$ is divisible by 5
(d) None of these

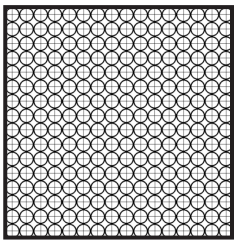
40. According to Wien's displacement law the wavelength of peak emission from a body is inversely proportional to the temperature of the body in kelvin. Two stars A and B with surface temperatures 3000 kelvin and 6000 kelvin respectively, are at the same distance from the Earth. They are of equal radius. The correct statement about the radiations emitted by the two stars is
(a) Both A and B will look equally bright in visible.
(b) A will look brighter than B in infrared.
(c) B will look brighter than A in infrared.
(d) A will emit more in the visible range than in the infrared.

41. Given the radius of the Earth as R and the height of the mast of a ship above sea level as h, when observed from a beach, the minimum distance along the sea surface d of the ship when the ship's mast goes below the horizon is (ignore the density variation of the atmosphere with height)

(a) $R\ \mathrm{Cos}^{-1}\left(\frac{R}{R+h}\right)$
(b) $R\ \mathrm{Tan}^{-1}\left(\frac{h}{R}\right)$
(c) $R\ \mathrm{Sin}^{-1}\left(\frac{h}{R}\right)$
(d) $\frac{Rh}{R+h}$

42. The sum ${}^{3}C_{3} + {}^{4}C_{3} + \ldots\ldots\ldots\ldots + {}^{n}C_{3}$ is equal to
(a) n!
(b) ${}^{n}C_{4}$
(c) ${}^{n+1}C_{4}$
(d) ${}^{n}C_{3}$

43. A cubical box is filled with a million identical spherical glass marbles all of radius 1.00 cm (the diagram shows representation of the positions of the marbles and not their actual number or size). The layers are placed exactly one above the other. If another set of smaller identical spherical marbles is introduced so that they just fit in the gaps between the first kind of marbles, then how much volume of water can fill the box fully?

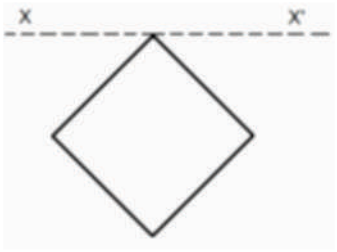


(a) $1.11\ \mathrm{m}^3$
(b) $2.08\ \mathrm{m}^3$
(c) $2.22\ \mathrm{m}^3$
(d) $2.56\ \mathrm{m}^3$

44. A rubber band is being stretched slowly and uniformly. Hooke's law holds good. Observed from any given point on the rubber band every other point
(a) will move away with a constant speed
(b) will move with speed inversely proportional to the distance to the point
(c) will appear stationary
(d) will move with a speed proportional to the distance to the point

45. A projectile is launched horizontally with speed $v_0 << v_{escape}$ from a height h above Earth's surface. Considering the Earth's curvature and non-uniformity of its gravity, viewed from space, the approximate shape of the trajectory of the projectile would be the arc of
(a) a parabola (b) a hyperbola (c) an ellipse (d) a circle

46. A thin wire of uniform cross section is bent to form a square. Mass of the square is M and length of one side is L. The moment of inertia of the loop about the axis XX' is



(a) $\frac{2}{3}ML^2$ (b) $\frac{4}{3}ML^2$

(c) $\frac{13}{6}ML^2$ (d) $\frac{16}{3}ML^2$

47. Let $F(x) = \begin{vmatrix} x & x^2 & x^3 \\ 1 & 1 & 1 \\ 2 & 4 & 8 \end{vmatrix}$

Then find $c \in (1, 2)$ such that $F'(c) = 0$

(a) $1 + \frac{1}{\sqrt{3}}$ (b) $\sqrt{3}$ (c) $\frac{1}{\sqrt{3}}$ (d) $1 - \sqrt{3}$

48. The distance to a latitude circle from the pole (= R θ where θ is the colatitude and R is the radius of the Earth assumed spherical) is equal in all directions along the surface of the sphere. For latitude circles, the ratio of circumference to the diameter along the surface of the sphere is

(a) $\pi \frac{\text{Cos } \theta}{\theta}$ (b) $\pi \frac{\text{Sin } \theta}{\theta}$ (c) $\pi \frac{\theta}{\text{Sin } \theta}$ (d) $\pi \frac{\theta}{\text{Cos } \theta}$

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.

49. In a two body system, Lagrange points are
    (a) total six in number
    (b) total five in number
    (c) locations where net force (gravitational + centrifugal)) is zero.
    (d) locations where the effective potential (gravitational + centrifugal) is zero

50. Which of the following problems are same as that of the problem of selecting r objects with repetition from n different objects?
    (a) The problem of distributing r identical objects with repetition into n different boxes.
    (b) The number of non-negative integer solutions to the equation: $x_1 + x_2 + ... + x_n = r$.
    (c) Permutations of r objects taken n at a time.
    (d) Combinations of r objects taken n at a time

51. A and B are two van-der-Waals gases. Critical temperature of gas B is double that of gas A. Which of the following statement/s is/are valid?
    (a) If the volume of molecules of B is same as that of the molecules of A, then the critical pressure of gas B is double that of gas A.
    (b) If the critical pressure of gas B is four times that of gas A, then the critical volume of gas B is double that of gas A.
    (c) If the critical volume of gas B is four times that of gas A, then the critical pressure of gas B must be double that of gas A.
    (d) If the critical volume of gas B is double that of gas A, then their critical pressures must be equal.

52. The tidal force (due to Sun/Moon) at the surface of the Earth
    (a) by Moon's gravity is stronger than that due to Sun's gravity
    (b) by Sun's gravity is stronger than that due to Moon's gravity
    (c) is proportional to $1/R^2$, if R is the distance between the centres of mass
    (d) is proportional to $1/R^3$, if R is the distance between the centres of mass

53. Which of the following statements is correct about the electrostatic field?
    (a) Field inside a uniform positively charged circular ring in the plane of the ring would be zero if the electrostatic force were proportional to 1/r.
    (b) Field inside a uniform positively charged spherical shell would be directed towards the centre if the electrostatic force were proportional to $1/r^3$.
    (c) Field in the plane of a uniform positively charged disc would be proportional to the distance from the centre if the force were proportional to 1/r.
    (d) Field above/below a uniform positively charged large plane would be inversely proportional to the distance from the plane if the force were proportional to $1/r^3$.

54. Identify the correct identities.
(a) ${}^nC_0 + {}^nC_2 + {}^nC_4 + ... = 2^{n-1}$
(b) ${}^nC_0 + {}^nC_1 + {}^nC_2 + ... + {}^nC_n = 2^n$
(c) $1{}^nC_1 + 2{}^nC_2 + 3{}^nC_3 + ... + n{}^nC_n = n2^{n-1}$
(d) ${}^nC_1 + {}^nC_3 + {}^nC_5 + ... = 2^{n-1}$

55. A geosychronous orbit is one
(a) which is synchronized with the rotation of the Earth
(b) which is synchronized with half the rotation period of the Earth
(c) which can have any inclination
(d) which can only be above the equator

56. Identify the correct statements about vectors A, B and C.
(a) $(A \times B) \times C$ has a nonzero component along the vector A
(b) $(A \times B) \times C$ is orthogonal to C
(c) $(A \times B) \times C$ has zero component along B.
(d) $(A \times B) \times C$ is orthogonal to A.

57. Ohm's law can be written as $I = \frac{V}{R}$. Resistance of any electronic component is defined as $R = \frac{V}{I}$
Which of the following statements are valid:
(a) Diode does not obey Ohm's law, hence its resistance cannot be found out.
(b) Ohm's law is equivalent to definition of resistance of electronic component.
(c) Ohm's law is valid only for naturally occurring materials and not for artificially created electronic materials.
(d) If resistance of a component varies with current then it does not obey Ohm's law.

58. Retrograde motion of planets
(a) is due to epicyclic motion
(b) arises from the projection of the planet's motion on the sky plane
(c) is exhibited only by the inner planets
(d) shows that the planets are not all moving with the same angular speed

59. Which of the following elements present in hemoglobin molecules were produced by stars
(a) Oxygen (b) Nitrogen (c) Hydrogen (d) Iron

60. Let $S = \{A, B, C ..\}$ denote either the set of real numbers or the set of $N \times N$ real square matrices and let $\circ$ denote either of the two operations addition or multiplication. Then which of the following statements hold/s always.
(a) There exists $E \in S$ such that $A \circ E = E \circ A = A$ for all $A \in S$
(b) $A \circ B = C$
(c) For every A there exists a B such that $A \circ B = E$
(d) $A \circ (B \circ C) = (A \circ B) \circ C$

Rough Work