

INDIAN ASSOCIATION OF PHYSICS TEACHERS

NATIONAL STANDARD EXAMINATION IN ASTRONOMY 2019 - 20 (NSEA 2019 - 20)

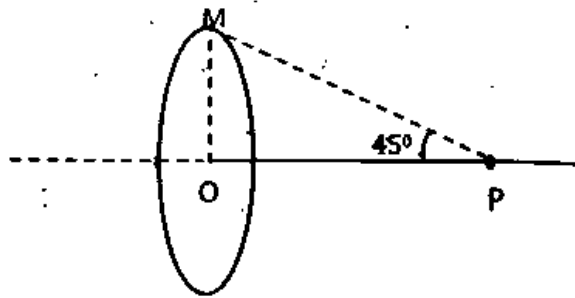
Date of Examination : November 24, 2019

Q. Paper Code: 41

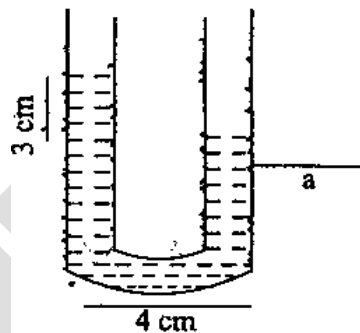
Total Time: 120 minutes

1. If a and b are the roots of $x^2 - 3x + p = 0$ while c and d are the roots of $x^2 - 12x + q = 0$.
Also if a, b, c, d are in GP then the value of $\frac{(q+p)}{(q-p)}$ is
- (a) $\frac{17}{15}$ (b) $\frac{19}{16}$
(c) $\frac{35}{32}$ (d) $\frac{9}{8}$
2. The date of which the Earth is at a minimum distance from the Sun is around
(a) 3 January (b) 4 July
(c) 22 June (d) 21 September
3. The plane of the circular coil is held in the east – west direction. A steady current passed through the coil produces a magnetic field (B) equal to $\sqrt{2}$ time the horizontal component of the earth's magnetic field (B_H) at the place. Now the plane of the coil is rotated carefully through an angle 45° about the vertical axis through its diameter. What is the deflection of the needle placed at the centre of the coil respect to B_H ?
- (a) $\tan^{-1} \frac{1}{2}$ (b) $\tan^{-1} \frac{1}{3}$
(c) $\tan^{-1} 2$ (d) $\tan^{-1} 3$
4. If the ratio of the sum of first n terms of two different AP series is $(7n + 1) : (4n + 27)$, the ratio of their 10^{th} term is
- (a) $\frac{135}{120}$ (b) $\frac{134}{103}$
(c) $\frac{78}{69}$ (d) $\frac{103}{89}$
5. The solution to the set of simultaneous equations with three variable x, y, z
 $x + y + z = 5$; $x^2 + y^2 + z^2 = 5$ and $xy + yz + zx = 10$ are
(a) all real (b) one real, other two complex
(c) two real, one complex (d) all complex
6. An asteroids closed approach to the Sun (perihelion) is 2 AU, and farthest distance from the Sun (aphelion) is 4 AU. The period of revolution of the asteroid and the eccentricity of the orbit are respectively
(a) 4.2 year, 0.40 (b) 4.8 year, 0.50
(c) 5.2 year, 0.33 (d) 6.0 year, 0.20

7. A circular coil carrying a definite current 'i' produces a magnetic field $B_0 = 2.83 \text{ T}$ at the centre 'O' of the coil. The magnetic field produced by the same current at a point 'P' on the axis of the coil, where an angle OPM as shown in the figure is 45° is

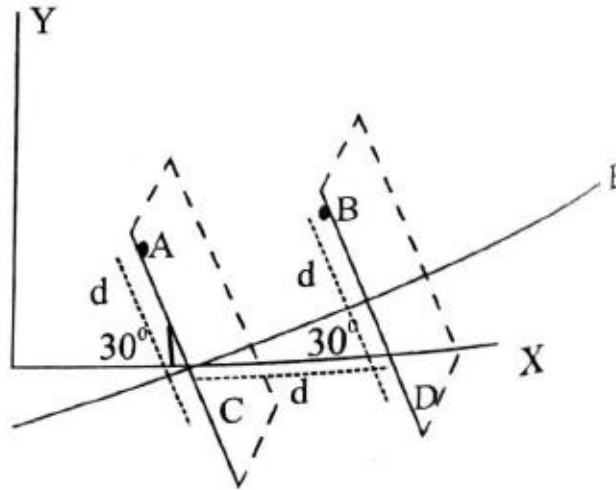


- (a) 1.23 T (b) 1.00 T
(c) 1.78 T (d) 2.83 T
8. A narrow U – tube of uniform cross – section, having a liquid of density ' ρ ', is made to move with an acceleration 'a' along the horizontal direction as shown in the figure. What should be the value of 'a' so that the difference in the level in the two arms of the tube is 3 cm ($g = 10 \text{ ms}^{-2}$)?



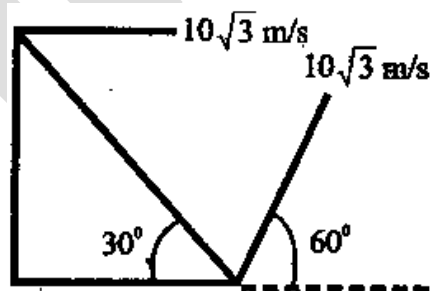
- (a) 6.5 ms^{-2} (b) 5.5 ms^{-2}
(c) 13.3 ms^{-2} (d) 7.5 ms^{-2}
9. The value of $4 \sin 50^\circ - \sqrt{3} \tan 50^\circ$ is
(a) -2 (b) -1
(c) 1 (d) $\sqrt{3}$
10. The value of $Z = \cos 10^\circ \cos 30^\circ \cos 50^\circ \cos 70^\circ$ is
(a) $3/8$ (b) $5/16$
(c) $5/8$ (d) $3/16$
11. The number of times a 5th magnitude star is brighter than an 8th magnitude star is
(a) 15.85 (b) 3
(c) 20 (d) 6.4

12. A uniform gravitational field (E) exists in a certain region of space. Consider two parallel planes perpendicular to the field E as shown in the figure. Three statements are given below
- Work done by the force in moving a particle of mass m from point A to B is $\frac{1}{2} mEd$
 - Work done in moving a particle from point B to D is zero
 - Work done in moving a particle from A to D is $\frac{\sqrt{3}}{2} mEd$



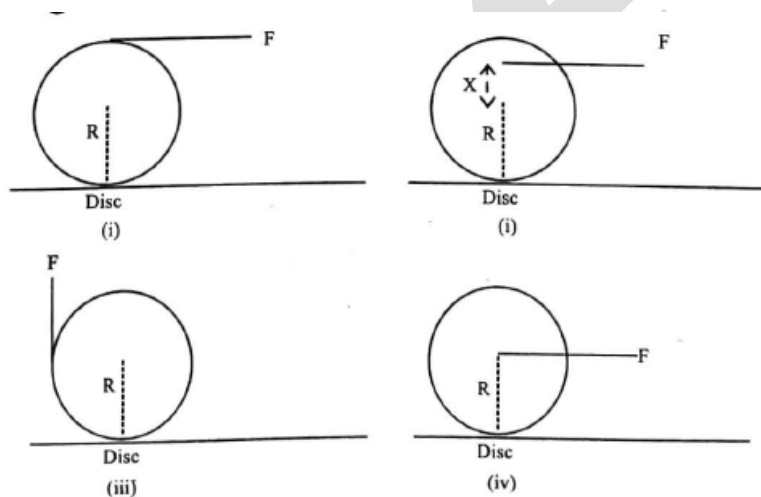
Choose the correct statement(s)

- i, ii and iii
 - i and ii only
 - i only
 - ii and iii only
13. A ball is projected with a speed of $10\sqrt{3} \text{ ms}^{-1}$ at angle of 60° from the foot of a wedge as shown in the figure. The wedge also starts moving horizontally with a speed of $10\sqrt{3} \text{ ms}^{-1}$. The time after which the ball hits the inclined surface of the wedge is



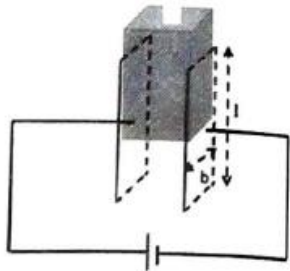
- $\sqrt{2} \text{ s}$
 - 2 s
 - $\sqrt{3} \text{ s}$
 - 3 s
14. In the previous question (number 13), what should be the velocity of the wedge so that the ball hits the incline perpendicular to it
- $8\sqrt{3} \text{ ms}^{-1}$ in the same direction
 - $5\sqrt{3} \text{ ms}^{-1}$ in the opposite direction
 - $16\sqrt{3} \text{ ms}^{-1}$ in the same direction
 - $15\sqrt{3} \text{ ms}^{-1}$ in the opposite direction

15. If 'p' is the perpendicular distance from the origin to the straight line $x \cos \theta - y \sin \theta = k \cos 2\theta$ and 'q' is the corresponding distance to the straight line $x \sec \theta - y \operatorname{cosec} \theta = k$, then the value of $p^2 + 4q^2$ is
- (a) $2k^2$ (b) k^2
(c) $4k^2$ (d) $3k^2$
16. If \bar{a} and \bar{b} are unit vectors and θ is the angle between \bar{a} and \bar{b} then $\sin \frac{\theta}{2}$ is equal to
- (a) 1 (b) $\frac{1}{2}|\bar{a} - \bar{b}|$
(c) 0 (d) $\frac{1}{2}|\bar{a} + \bar{b}|$
17. Which of the following statement is true for Saturn and Jupiter?
- (a) both rotate faster than the Earth
(b) both rotate slower than the Earth
(c) Only one rotates rapidly while the other rotates very slowly compared to Earth
(d) their periods of rotation are linked to their period of revolution
18. In which of the following cases friction cannot be zero for the disc having pure rolling?



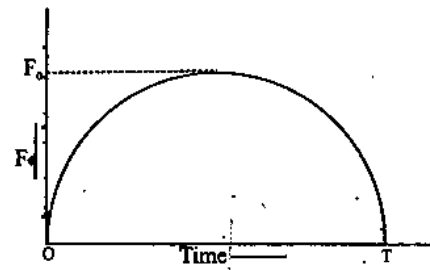
- (a) i, iii and iv (b) i and ii only
(c) i, ii, iii and iv (d) i, ii and iii
19. A and B are two locations 120m apart with a 40 m tall wall midway between them. The minimum velocity and the corresponding angle at which a ball be projected from A so as just to clear the wall and strike at B are
- (a) 28.63 ms^{-1} and 53° (b) 28.63 ms^{-1} and 37°
(c) 35.06 ms^{-1} and 53° (d) 28.28 ms^{-1} and 37°
20. The argument $[\arg(z)]$ of the complex number $z = \left(-\frac{1}{2} + i\frac{\sqrt{3}}{2}\right)$ is
- (a) $\frac{\pi}{6}$ (b) $\frac{\pi}{3}$
(c) $\frac{2\pi}{3}$ (d) $\frac{4\pi}{3}$

21. The eccentricity of the ellipse represented by $4x^2 + 9y^2 - 16x = 20$ is
- (a) $\frac{3}{5}$ (b) $\frac{\sqrt{5}}{3}$
(c) $\frac{\sqrt{3}}{5}$ (d) $\frac{1}{2}$
22. Which of the following is TRUE for Retrograde motion (apparent motion of planets in a direction opposite to the normal)?
- (a) caused by epicycles
(b) undergone only by superior planets
(c) undergone only by inferior planets
(d) an effect due to the projection of planet's orbit onto the sky
23. A proton and a deuteron are projected into a uniform magnetic field with velocity $50 \times 10^6 \text{ ms}^{-1}$ and $43.3 \times 10^6 \text{ ms}^{-1}$ at angles 30° and 60° respectively with respect to the direction of the magnetic field. Compare the respective pitch of their helical paths.
- (a) 1:2 (b) 2:1
(c) 1:1 (d) 4:1
24. In a time of 4.606 days a radioactive sample loses $\left(\frac{4}{5}\right)$ th of the amount present initially. The mean life of the sample is
- (a) 2.2 day (b) 2.86 day
(c) 2.46 day (d) 2.95 day
25. Assuming radius of the earth to be 6400 km, the distance to the horizon visible from a 180 m tall building is close to
- (a) 56 km (b) 48 km
(c) 90 km (d) 64 km
26. Since none of the six trigonometric functions are one-to-one, they are restricted in order to have their unambiguous inverse functions. This range of the inverse trigonometric functions is called the range of the principal values. Range of principal value of $\cot^{-1}(x)$ is
- (a) $-\frac{\pi}{2}$ to $+\frac{\pi}{2}$ (b) $-\pi$ to $+\pi$
(c) 0 to π (D) $-\frac{\pi}{2}$ to 0 or 0 to $\frac{\pi}{2}$
27. On which of the following planets would the Sun rise in the west?
- (a) Saturn (b) Mercury
(c) Venus (D) Jupiter
28. A prism of refracting angle 60° is made of material of refractive index 1.732. the angle of minimum deviation produced by this prism is close to
- (a) 30° (b) 38°
(c) 60° (d) 45°
29. Two particles undergo simple harmonic motion given by $y_1 = a \sin 50 \pi t$ and $y_2 = a \sin 40 \pi t$ respectively. Initially the particles are in phase. After what minimum time will the particles be in phase again?
- (a) 0.1 s (b) 0.2 s
(c) 0.25 s (d) 0.15 s

30. Bisectors of vertex angles A, B and C of triangle ABC intersect its circum-circle at the points D, E and F respectively. The angle EDF is equal to
 (a) $90^\circ - A/2$ (b) $45^\circ + A/2$
 (c) $90^\circ - B/2$ (d) A
31. ΔABC is right angled at B. A square is constructed on the side AC opposite to that of angle B. P is the centre of this square. The angle PBC is equal to
 (a) 30° (b) 45°
 (c) 60° (d) None of the above
32. A line through the three stars in Orion's belt appears to point towards which one of the following star?
 (a) Vega (b) Polaris
 (c) Rigel (d) Sirius
33. In an experiment on photoelectric effect, the maximum speed of photoelectron (v_{\max}) is measured for different frequencies (f) of incident radiation. On a graph of v_{\max} versus f , the slope of the curve at any points gives
 (a) Planck's constant (h)
 (b) Planck's constant divided by electron charge (h/e)
 (c) de-Broglie wavelength of the photoelectron
 (d) Wavelength of incident radiation
34. A dielectric slab of constant $\epsilon_r = 2$ is inserted into a parallel plate capacitor as shown in the figure. The spring attached to the slab can set the slab into oscillation of frequency ω . At equilibrium, end of the slab is at the middle of the plates. If the slab is pulled till the entire slab is inside the capacitor and allowed to oscillate, the current flowing through the circuit is
 (a) $-\frac{b\epsilon_0 V\omega\ell}{2d} \sin(\omega t)$ (b) $+\frac{b\epsilon_0 V\omega\ell}{2d} \cos(\omega t)$
 (c) $-\frac{b\epsilon_0 V\omega\ell}{2d} \sin^2(\omega t)$ (d) $-\frac{b\epsilon_0 V\omega\ell}{2d} \cos^2(\omega t)$
- 
35. If a, b, c are in G.P. and $\log_c a$, $\log_b c$ and $\log_a b$ are in A.P. the common difference of the A.P. is
 (a) $\frac{1}{2}$ (b) $\frac{2}{3}$
 (c) 1 (d) $\frac{3}{2}$
36. ABCD is a line segment trisected by the points B and C while P is any point on the circle whose diameter is BC. If angles APB and CPD are α and β respectively, the value of $\tan \alpha + \tan \beta$ is
 (a) $\frac{1}{2}$ (b) $\frac{1}{4}$
 (c) $\frac{3}{8}$ (d) $\frac{3}{2}$
37. A particle is projected with a velocity 20 ms^{-1} , at angle of 60° to the horizontal. The radius of curvature of its trajectory at a point where its velocity makes an angle of 37° with the horizontal is close to ($g = 10 \text{ ms}^{-2}$)
 (a) 16 m (b) 19.53 m
 (c) 15.52 m (d) 25 m

38. A body is thrown up in lift with a velocity u relative to moving lift and its time of flight is t . The acceleration with which the lift is moving will be
- (a) $\frac{u^2}{t} - g$ (b) $\frac{2u}{t} - g$
 (c) $\frac{2u}{t}$ (d) none of these

39. A particle of mass m , initially at rest, is acted upon by a variable force F for a brief interval of time T . It begins to move with a velocity u just after the force stops acting. F , as a function of time, is



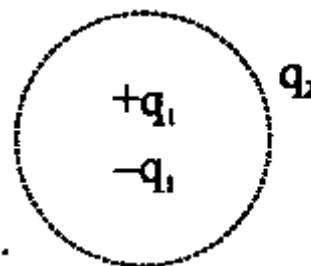
- (a) $u = \frac{\pi F_0^2}{2m}$ (b) $u = \frac{\pi T^2}{8m}$
 (c) $u = \frac{\pi F_0 T}{4m}$ (d) $u = \frac{F_0 T}{2m}$

40. If the product of two roots of the equation $x^4 - 11x^3 + kx^2 + 269x - 2001 = 0$ is -69 , the value of k is
- (a) 10 (b) 1
 (c) -5 (d) -10

41. By a chord of the curve $y = x^3$ we mean any line joining two points on it. The number of chords which have slope -1 is
- (a) Infinite (b) 0
 (c) 1 (d) 2

42. The universe is estimated to be between ten and twenty billion year old. This estimate is based on the value of the constant(s)
- (a) Speed of light (b) Fine structure constant
 (c) Planck constant (d) Hubble constant

43. Consider the charge configuration and a spherical Gaussian surface as shown in the figure. While calculating the flux of the electric field over any part of the spherical surface the electric field will be due to

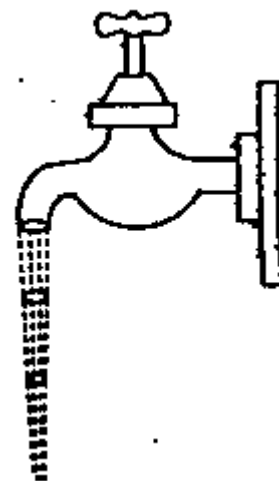


- (a) q_2
 (b) Only the positive charges
 (c) All the charges
 (d) $+q_1$ and $-q_1$

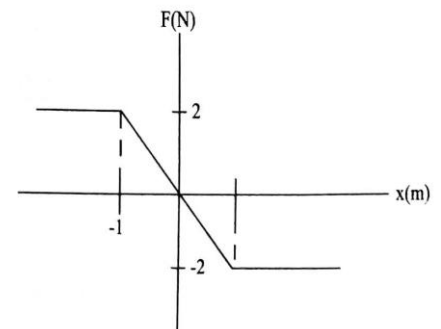
44. The expression for electric potential at any point due to an electric dipole (\vec{p}) is (with usual notation)

- (a) $k \frac{\vec{p} \times \vec{r}}{r^2}$ (b) $k \frac{\vec{p} \cdot \vec{r}}{r^2}$
 (c) $k \frac{\vec{p} \cdot \vec{r}}{r^2}$ (d) $k \frac{\vec{p} \cdot \vec{r}}{r^3}$

45. A function $f(n)$ is defined by $f(n) = \frac{4^n - 4^{-n}}{4^n + 4^{-n}}$ for every integer n . If p and q are integers such that $p > q$, the sign of $f(p) - f(q)$ is
- (a) Positive (b) Negative
(c) Indeterminate (d) zero
46. The first term of a descending A.P. series of 4 distinct positive integers with greatest possible last term and sum 2004 is
- (a) 552 (b) 536
(c) 512 (d) 504
47. If the Earth is made to rotate in the opposite sense (clockwise rather than counterclockwise), the length of a solar day will be
- (a) 53 hr 56 min (b) 24 hr
(c) 23 hr 52 min (d) 24 hr 4 min
48. In the case of a diatomic gas, the ratio of the heat used in doing work for expansion of the gas to the total heat given to it at constant pressure is
- (a) $\frac{2}{5}$ (b) $\frac{3}{7}$
(c) $\frac{2}{7}$ (d) $\frac{5}{7}$
49. Water coming out of the mouth of a tap and falling vertically in streamline flow forms a tapering column, i.e., the area of cross-section of the liquid column goes on decreasing as it moves down, the most accurate explanation for this is
- (a) As the water moves down, its speed increases and hence its pressure decreases. It is then compressed by the atmosphere
(b) Falling water tries to reach a terminal velocity and hence reduces the area of cross-section to balance upward and downward forces
(c) The mass of water flowing past any cross-section must remain constant. Also, water is almost incompressible. Hence, the rate of volume flow must remain constant.
(d) The surface tension causes the exposed surface area of the liquid to decrease continuously
50. If x, y, z are positive integers with $x + y + z = 10$, the maximum value of $xy + yz + zx + xyz$ is
- (a) 69 (b) 59
(c) 64 (d) 61
51. If a and b are positive real numbers and AB is a line segment in a plane. The possible number of distinct points C in the plane for which the triangle ABC will have the lengths of medians and altitudes through C as a and b respectively is
- (a) 1 (b) 2
(c) 4 (d) Infinitely many
52. The pair of planets, that is never visible at midnight is
- (a) Mars and Neptune (b) Venus and Neptune
(c) Neptune and Mercury (d) Mercury and Venus

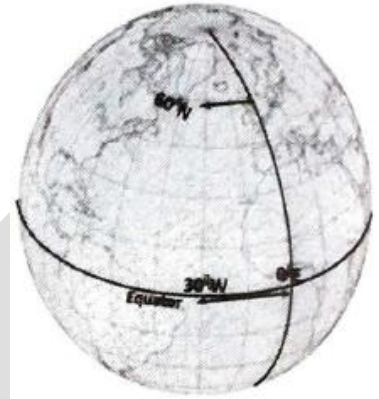


53. A drop of water is broken into two droplets of equal size. For this process, the correct statement is
- The sum of temperature of the two droplets together is equal to the original temperature of the drop.
 - The sum of masses of the two droplets is equal to the original mass of the drop
 - The sum of the radii of two droplets is equal to the radius of the original drop
 - The sum of the surface areas of the two droplets is equal to the surface area of the original drop
54. A bullet of mass m moving horizontally with velocity v strikes a wooden block of mass M suspended with a string of length l . The bullet gets embedded into the block as a result the block rises up to a height h . The initial speed of wooden block and the embedded bullet system is
- $\sqrt{2gh}$
 - $\frac{M+m}{m}\sqrt{2gh}$
 - $\frac{m}{M+m}2gh$
 - $\frac{M+m}{M}\sqrt{2gh}$
55. The number of diagonals in a regular polygon of 100 sides is
- 4950
 - 4850
 - 4750
 - 4650
56. Let a, b, c and p, q, r be all positive real numbers such that a, b, c are in G.P. and $a^p = b^q = c^r$. Then
- p, q, r are in G.P.
 - p, q, r are A.P.
 - p, q, r are in H.P.
 - p^2, q^2, r^2 are in G.P.
57. If you look overhead at 6 p.m. (standard sunset time) and notice that the moon is directly overhead, what phase is it in?
- Last quarter
 - First quarter
 - Full moon
 - 12th day from new moon
58. The potential energy of a particle in a certain field has the form $U = \frac{a}{r^2} - \frac{b}{r}$, where a and b are positive constants and r is the distance from the centre of the field. Find the value of r_0 corresponding to the equilibrium position of the particle. Is the equilibrium a stable or unstable
- $\frac{2a}{b}$ stable equilibrium
 - $\frac{a}{b}$ stable equilibrium
 - $\frac{2a}{b}$ unstable equilibrium
 - $\frac{a}{b}$ unstable equilibrium
59. The force acting on a particle is shown as a function of the position in a one dimensional system. The incorrect statement is
- If total energy of the system is 1 J, motion is SHM
 - If total energy of the system is 2J motion is periodic
 - Work done on the particle as it moves from $x = 3\text{m}$ to 2 m is 2J
 - Work done on the particle as it moves from $x = 3\text{m}$ to 2 m is -2J



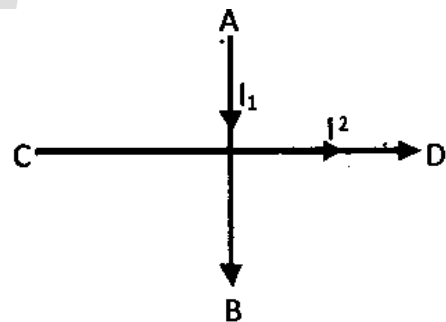
60. Let S_k be the sum of an infinite G.P. whose first term is k and common ratio is $\frac{k}{k+1}$ ($k > 0$). Then the value of $\sum_{k=1}^{\infty} \frac{(-1)^k}{S^k}$ is equal to
- (a) $\log_e 4$ (b) $\log_e 2 - 1$
(c) $1 - \log_e 2$ (d) $1 - \log_e 4$

61. Which of the following is the closest to the distance in kilometers of 30° extend to longitude on the surface of the earth along the equator? How much is the corresponding distance along a small circle (parallel to the equator) at $60^\circ N$ latitude?
- (a) 3500 Km, 3000 Km
(b) 3000 Km, 2000 Km
(c) 2500 Km, 1750 Km
(d) 3300 Km, 1650 Km

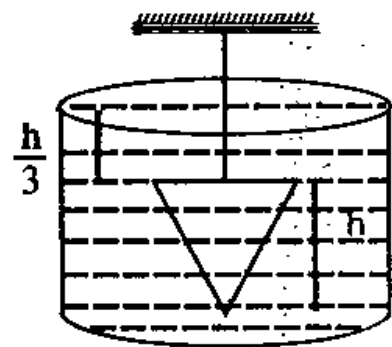


62. Any location on the surface of Earth, as a sphere, is determined by two coordinates – Latitude and Longitude. L
- (a) 0 degree (b) 90 degree
(c) 180 degree (d) None of these/indeterminate

63. Two long wires AB and CD carrying currents I_1 and I_2 are perpendicular to each other as shown in the figure (wires are insulated from each other)
- (a) Force on wire AB is towards left
(b) Force on wire AB is towards right
(c) Torque on wire AB is clockwise
(d) Torque on wire AB is anticlockwise



64. A right circular cone of the height h and radius r is suspended in liquid of density (ρ) . The density of cone is 2ρ and its circular face is at a depth $\frac{h}{3}$. The force exerted by liquid on the curved surface of cone is
- (a) zero
(b) $\frac{\pi r^2 h \rho g}{3}$
(c) $\pi r^2 h \rho g$
(d) $\frac{2\pi r^2 h \rho g}{3}$



65. A straight line through the point of intersection of the line $x + 2y = 4$ and $2x + y = 4$ meets the coordinate axes at A and B. The locus of the midpoint of AB is

- (a) $3(x + y) = 2xy$ (b) $2(x + y) = 3xy$
 (c) $2(x + y) = xy$ (d) $(x + y) = 3xy$
66. Let y be the solution of the differential equation $x \frac{dy}{dx} = \frac{y^2}{1 - y \log x}$ satisfying $y(1) = 1$. Then y satisfies
 (a) $y = x^{y-1}$ (b) $y = x^y$
 (c) $y = x^{y+1}$ (d) $y = x^{y+2}$
67. The circle on the celestial sphere along which declination of a star is measured is called
 (a) Diurnal circle (b) Great circle
 (c) Hour circle (d) Meridian
68. A circular wire frame of radius R is dipped in a soap solution of surface tension S . When it is taken out, a thin, soap film is formed inside the frame. If cross sectional area of wire is A , then the stress developed in the wire due to surface tension is
 (a) $\frac{\pi SR}{A}$ (b) $\frac{SR}{A}$
 (c) $\frac{2SR}{A}$ (d) $\frac{SR}{2A}$
69. If two waves represented by $y_1 = 4 \sin \omega t$ and $y_2 = 3 \sin \left(\omega t + \frac{\pi}{3} \right)$ interfere at a point, the amplitude of the resulting wave will be about
 (a) 7 (b) 6
 (c) 5 (d) 3.5
70. The value of $\lim_{n \rightarrow \infty} \frac{(n!)^{\frac{1}{n}}}{n}$ is
 (a) 1 (b) $\frac{1}{e^2}$
 (c) $\frac{1}{2e}$ (d) $\frac{1}{e}$
71. The value of the integral $\int_1^5 [|x - 3| + |1 - x|] dx$ is equal to
 (a) 4 (b) 8
 (c) 12 (d) 16
72. The definition of a nautical mile is
 (a) one arc minute of latitude along any line of longitude
 (b) one arc minute of latitude along any line of latitude
 (c) one arc second of latitude along any line of longitude
 (d) one arc second of longitude along any line of latitude
73. If the earth were to become a black hole, the minimum radius to which it should be compressed is about (mass remains constant, radius of earth = 6400 km)
 (a) 1.8 m (b) 9.0 mm
 (c) 3.6 cm (d) 1.8 km
74. The in centre of an equilateral triangle is $(1, 1)$ and the equation of one of the sides is $3x + 4y + 3 = 0$. Then the equation of the circum-circle of the triangle is

