UPSEE - 2004

Physics

1. Four smooth steel balls of equal mass at rest are free to move along a straight line without friction. The first ball is given a velocity of 0.4 m/s. It collides head on with the second elastically, the second one similarly with the third and so on. The velocity of the last ball is :
   (a) 0.4 m/s
   (b) 0.2 m/s
   (c) 0.1 m/s
   (d) 0.05 m/s

2. Let V and H be the vertical and horizontal components of earth's magnetic field at any point on earth. Near the north pole :
   (a) $V \gg H$
   (b) $V \ll H$
   (c) $V = H$
   (d) $V = H = 0$

3. A body is rolling down an inclined plane. Its translational and rotational kinetic energies are equal. The body is a :
   (a) solid sphere
   (b) hollow sphere
   (c) solid cylinder
   (d) hollow cylinder

4. A light beam is being reflected by using two mirrors, as in a periscope used in submarines. If one of the mirrors rotates by an angle θ, the reflected light will deviate from its original path by the angle :
   (a) 2θ
   (b) $0°$
   (c) θ
   (d) 4θ

5. If the density of a small planet is the same as that of earth, while the radius of the planet is 0.2 times that of the earth, the gravitational acceleration of the surface of that planet is :
   (a) 0.2 g
   (b) 0.4 g
   (c) 2 g
   (d) 4 g

6. A combination of two thin convex lenses of focal length 0.3m and 0.1m will have minimum spherical and chromatic aberrations if the distance between them is :
   (a) 0.1 m
   (b) 0.2 m
   (c) 0.3 m
   (d) 0.4 m

7. A satellite moves round the earth in a circular orbit of radius R making 1 rev/day. A second satellite moving in a circular orbit, moves round the earth once in 8 days. The radius of the orbit of the second satellite is :
   (a) $8R$
   (b) $4R$
   (c) $2R$
   (d) R

8. When $_{92}U^{235}$ is bombarded with one neutron, fission occurs and the products are three neutrons, $_{36}Kr^{94}$, and :
   (a) $_{56}Ba^{141}$
   (b) $_{54}Xe^{139}$
   (c) $_{56}Ba^{139}$
   (d) $_{58}I^{142}$

9. A wire of length L and cross-sectional area A is made of a material of Young's modulus Y. If the wire is stretched by an amount x, the work done is :
   (a) $\dfrac{YA}{L}x$
   (b) $\dfrac{YA}{L}x^2$
   (c) $\dfrac{YA}{2L}x$
   (d) $\dfrac{YA}{2L}x^2$

10. In Bohr's model of hydrogen atom, which of the following pairs of quantities are quantized ?
    (a) Energy and linear momentum
    (b) Linear and angular momentum
    (c) Energy and angular momentum
    (d) None of the above

11. The total energy radiated from a black body source is collected for 1 min and is used to heat a quantity of water. The temperature of water is found to increase from 20°C to 20.5°C. If the absolute temperature of the black body is doubled and the experiment is repeated with the same quantity of water at 20°C, the temperature of water will be :
   (a) 21°C
    (b) 22°C
    (c) 24°C
    (d) 28°C

...output of a NAND gate is 0 :

(a) if both inputs are 0

(b) if one input is 0 and the other input is 1

(c) if both inputs are 1

(d) either if both inputs are 1 or if one of the inputs is 1 and the other 0

13. Two equally charged, identical metal spheres A and B repel each other with a force F. The spheres are kept fixed with a distance r between them. A third identical, but uncharged sphere C is brought in contact with A and then placed at the mid-point of the line joining A and B. The magnitude of the net electric force on C is :

(a) F

(b) $3F/4$

(c) $F/2$

(d) $F/4$

14. In circuit shown below, the resistances are given in ohms and the battery is assumed ideal with emf equal to 3 V. The voltage across the resistance R_4 is :
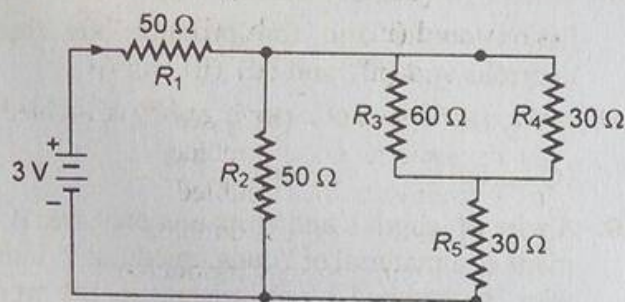
(a) 0.4 V

(b) 0.6 V

(c) 1.2 V

(d) 1.5 V

15. An electron, a proton, a deuteron and an alpha particle, each having the same speed are in a region of constant magnetic field perpendicular to the direction of the velocities of the particles. The radius of the circular orbits of these particles are respectively R_e, R_p, R_d and R_α. It follows that :

(a) $R_e = R_p$

(b) $R_p = R_d$

(c) $R_d = R_\alpha$

(d) $R_p = R_\alpha$

16. A current of $i = 2 \sin(\pi t/3)$ A is flowing in an inductor of 2 H. The amount of work done in increasing the current from 1.0 A to 2.0 A is :

(a) 1 J

(b) 2 J

(c) 3 J

(d) 4 J

17. Which of the following groups of forces could be in equilibrium ?

(a) 3 N, 4 N, 5 N

(b) 4 N, 5 N, 10 N

(c) 30 N, 40 N, 80 N

(d) 1 N, 3 N, 5 N

18. A bi-convex lens made of glass (refractive index 1.5) is put in a liquid of refractive index 1.7. Its focal length will :

(a) decrease and change sign

(b) increase and change sign

(c) decrease and remain of the same sign

(d) increase and remain of the same sign

19. Two rods each of mass m and length l are joined at the centre to form a cross. The moment of inertia of this cross about an axis passing through the common centre of the rods and perpendicular to the plane formed by them, is :

(a) $ml^2/12$

(b) $ml^2/6$

(c) $ml^2/3$

(d) $ml^2/2$

20. Spherical aberration in a lens :

(a) is minimum when most of the deviation is at the first surface

(b) is minimum when most of the deviation is at the second surface

(c) is minimum when the total deviation is equally distributed over the two surfaces

(d) does not depend on the above considerations

21. The displacement x (in metre) of a particle in, simple harmonic motion is related to time t (in seconds) as

$$x = 0.01 \cos\left(\pi t + \frac{\pi}{4}\right)$$

The frequency of the motion will be :

(a) 0.5 Hz

(b) 1.0 Hz

(c) $\frac{\pi}{2}$ Hz

(d) π Hz

22. A gate in which all inputs must be low to get a high output is called :

(a) a NAND gate

(b) an inverter

(c) a NOR gate

(d) an AND gate

23. Kepler's second law (law of areas) is nothing but a statement of :

(a) work energy theorem

(b) conservation of linear momentum

(c) conservation of angular momentum

(d) conservation of energy

24. If the energy of the photon is increased by a factor of 4, then its momentum :

(a) does not change

(b) decreases by a factor of 4

(c) increases by a factor of 4

(d) decreases by a factor of 2

25. The equation of a travelling wave is given by
$$y = 0.5 \sin (20x - 400t)$$
where x and y are in metre and t is in second. The velocity of the wave is :
(a) 10 m/s
(b) 20 m/s
(c) 200 m/s
(d) 400 m/s

26. A piece of copper and another of germanium are cooled from room temperature to 80 K. The resistance of :
(a) each of them increases
(b) each of them decreases
(c) copper increases and that of germanium decreases
(d) copper decreases and that of germanium increases

27. The radiation energy density per unit wavelength at a temperature T has a maximum at a wavelength λ_0. At temperature $2T$, it will have a maximum at a wavelength :
(a) $4\lambda_0$
(b) $2\lambda_0$
(c) $\lambda_0/2$
(d) $\lambda_0/4$

28. A $4\mu F$ condenser is charged to 400 V and then its plates are joined through a resistance. The heat produced in the resistance is :
(a) 0.16 J
(b) 0.32 J
(c) 0.64 J
(d) 1.28 J

29. A wire of diameter 0.02 m contains 10^{28} free electrons per cubic metre. For an electrical current of 100 A, the drift velocity of the free electrons in the wire is nearly :
(a) 1×10^{-19} m/s
(b) 5×10^{-10} m/s
(c) 2×10^{-4} m/s
(d) 8×10^{3} m/s

30. A short bar magnet, placed with its axis at 30° with an external magnetic field of 0.16 T, experiences a torque of magnitude 0.032 J. The magnetic moment of the bar magnet is : (in units of J/T)
(a) 4
(b) 0.2
(c) 0.5
(d) 0.4

31. If F is the force required to keep a train moving at a constant speed v, the power required is :
(a) $\frac{1}{2}Fv^2$
(b) Fv^2
(c) $\frac{1}{2}Fv$
(d) Fv

32. A circular metal plate of radius R is rotating with a uniform angular velocity ω with its plane perpendicular to a uniform magnetic field B. Then the emf developed between the centre and the rim of the plate is :
(a) $\pi\omega BR^2$
(b) ωBR^2
(c) $\pi\omega BR^2/2$
(d) $\omega BR^2/2$

33. In an elliptical orbit under gravitational force, in general :
(a) tangential velocity is constant
(b) angular velocity is constant
(c) radial velocity is constant
(d) areal velocity is constant

34. Material A has critical angle i_A, and material B has critical angle i_B ($i_B > i_A$). Then which of the following is true ?
(i) Light can be totally internally reflected when it passes from B to A
(ii) Light can be totally internally reflected when it passes from A to B
(iii) Critical angle for total internal reflection is $i_B - i_A$
(iv) Critical angle between A and B is $\sin^{-1}\left(\dfrac{\sin i_A}{\sin i_B}\right)$
(a) (i) and (iii)
(b) (i) and (iv)
(c) (ii) and (iii)
(d) (ii) and (iv)

35. When the speed of a moving body is doubled :
(a) its acceleration is doubled
(b) its momentum is doubled
(c) its kinetic energy is doubled
(d) its potential energy is doubled

36. If we observe the single slit Fraunhofer diffraction with wavelength λ and slit width e, the width of the central maxima is 2θ. On decreasing the slit width for the same λ :
(a) θ increases
(b) θ remains unchanged
(c) θ decreases
(d) θ increases or decreases depending on the intensity of light

37. A water tank, open to the atmosphere, has a leak in it in the form of a circular hole, located at a height h below the open surface of water. The velocity of the water coming out of the hole is :
(a) $\sqrt{gh/2}$
(b) $\sqrt{gh}$
(c) $\sqrt{2gh}$
(d) $2\sqrt{gh}$

38. An electron beam in an X-ray tube is accelerated through a potential of 40×10^3 V. These are then made to fall on a tungsten target. The shortest wavelength of X-rays emitted by the tube is :

(a) 0.31 A
(b) 3.1 Å
(c) 0.31 cm
(d) 3.1 cm

39. A wave is represented by the equation $y = a \cos(kx - \omega t)$ is superposed with another wave to form a stationary wave such that the point $x = 0$ is a node. The equation of the other wave is :

(a) $a \sin(kx + \omega t)$ (b) $-a \sin(kx - \omega t)$
(c) $-a \cos(kx + \omega t)$ (d) $a \cos(kx + \omega t)$

40. In the spectrum of hydrogen atom, the ratio of the longest wavelength in Lyman series to the longest wavelength in the Balmer series is :

(a) 5/27
(b) 1/93
(c) 4/9
(d) 3/2

41. In Young's double slit experiment, the separation between the slits is halved and the distance between the slits and screen is doubled. The fringe-width will :

(a) be halved
(b) be doubled
(c) be quadrupled
(d) remain unchanged

42. In order to prepare a *p*-type semiconductor, pure silicon can be doped with :

(a) phosphorus
(b) aluminium
(c) antimony
(d) germanium

43. A square of side a has charge Q at its centre and charge q at one of the corners. The work required to be done in moving the charge q from the corner to the diagonally opposite corner is :

(a) zero
(b) $\dfrac{Qq}{4\pi \varepsilon_0 a}$

(c) $\dfrac{Qq\sqrt{2}}{4\pi \varepsilon_0 a}$
(d) $\dfrac{Qq}{2\pi \varepsilon_0 a}$

44. A voltmeter essentially consists of :

(a) a high resistance, in series with a galvanometer
(b) a low resistance, in series with a galvanometer
(c) a high resistance in parallel with a galvanometer
(d) a low resistance in parallel with a galvanometer

45. The dimensions of $e^2/4\pi\varepsilon_0 hc$, where e, ε_0, h and c are electronic charge, electric permittivity, Planck's constant and velocity of light in vacuum respectively, is :

(a) $[M^0 L^0 T^0]$
(b) $[M^1 L^0 T^0]$
(c) $[M^0 L^1 T^0]$
(d) $[M^0 L^0 T^1]$

46. The magnetic susceptibility of any paramagnetic material changes with absolute temperature T as :

(a) directly proportional to T
(b) remains constant
(c) inversely proportional to T
(d) exponentially decaying with T

47. Find the magnitude and direction of an electric field that will balance an alpha particle. The mass and charge of a proton are 1.67×10^{-27} kg and 1.6×10^{-19} C. (Take $g = 9.8$ ms^{-2}) :

(a) 2×10^{-7} N/C, vertically downwards
(b) 2×10^{-7} N/S, vertically upwards
(c) 6×10^{-4} N/C, vertically downwards
(d) 6×10^{-4} N/c, vertically upwards

48. An electric dipole of moment $\vec{p}$ placed in a uniform electric field $\vec{E}$ has minimum potential energy when the angle between $\vec{p}$ and $\vec{E}$ is :

(a) zero
(b) $\dfrac{\pi}{2}$

(c) π
(d) $\dfrac{3\pi}{2}$

49. A 5 kg stationary bomb is exploded in three parts having mass 1 : 1 : 3 respectively. Parts having same mass move in perpendicular directions with velocity 39 m/s, then the velocity of the bigger part will be :

(a) $10\sqrt{2}$ m/s
(b) $\dfrac{10}{\sqrt{2}}$ m/s

(c) $13\sqrt{2}$ m/s
(d) $\dfrac{15}{\sqrt{2}}$ m/s

50. The ratio of fundamental frequency of an organ pipe opened at both ends to that of the organ pipe closed at one end is :

(a) 1 : 1
(b) 1.5 : 1
(c) 2 : 1
(d) 3 : 1

51. If a long spring is stretched by 0.02 m, its potential energy is U. If the spring is stretched by 1 m, then its potential energy will be :

(a) $\dfrac{U}{5}$
(b) U

(c) $5U$
(d) $25U$

52. X-rays are produced by accelerating electrons by voltage V and let they strike a metal of atomic number Z. The highest frequency of X-rays produced is proportional to :

(c) $(Z-1)$ (b) Z

(d) $(Z-1)^2$

53. If the radius of the earth were to shrink by 1%, with its mass remaining the same, the acceleration due to gravity on the earth's surface would :

(a) decrease by 1%   (b) decrease by 2%

(c) increase by 1%   (d) increase by 2%

54. A neon sign does not produce :

(a) a line spectrum

(b) an emission spectrum

(c) an absorption spectrum

(d) photons

55. A police car horn emits a sound at a frequency 240 Hz when the car is at rest. If the speed of sound is 330 m/s, the frequency heard by an observer who is approaching the car at a speed of 11 m/s, is :

(a) 248 Hz   (b) 244 Hz

(c) 240 Hz   (d) 230 Hz

56. The nucleus $_{92}U^{234}$ splits exactly in half in a fission reaction in which two neutrons are released. The resultant nuclei are :

(a) $_{46}Pd^{116}$ (b) $_{45}Rh^{117}$

(c) $_{45}Rh^{116}$ (d) $_{46}Pd^{117}$

57. 70 cal of heat is required to raise the temperature of 2 moles of an ideal gas from 30°C to 35°C while the pressure of the gas is kept constant. The amount of the heat required to raise the temperature of the same gas through the same temperature range at constant volume is : (gas constant $R=2$ cal/mol-K)

(a) 70 cal   (b) 60 cal

(c) 50 cal   (d) 30 cal

58. A silicon diode has a threshold voltage of 7 V. If an input voltage given by $2\sin(\pi t)$ is supplied to a half-wave rectifier circuit using this diode, the rectified output has a peak value of :

(a) 2 V   (b) 1.4 V

(c) 1.3 V   (d) 0.7 V

59. A charge Q is placed at the centre of a cube of side a. The flux through any one of the sides is :

(a) Q/ε_0 (b) $Q/6\varepsilon_0$

(c) $Q/4\varepsilon_0$ (d) $Q/24\varepsilon_0$

60. An electron moving with a unifrom velocity along the positive x-direction enters a magnetic field directed along the positive y-directed along. The force on the electron is directed along :

(a) positive y-direction

(b) negative y-direction

(c) positive z-direction

(d) negative z-direction

61. A body is thrown vertically upwards with velocity u. The distance travelled by it in the fifth and the sixth seconds are equal. The velocity u is given by ($g = 9.8$ m/s^2)

(a) 24.5 m/s   (b) 49.0 m/s

(c) 73.5 m/s   (d) 98.0 m/s

62. When a piece of a ferromagnetic substance is put in a uniform magnetic field, the flux density inside it is four times the flux density away from the piece. The magnetic permeability of the material (in N/A^2) is :

(a) 1   (b) 2

(c) 3   (d) 4

63. Consider elastic collision of a particle of mass m moving with a velocity u with another particle of the same mass at rest. After the collision the projectile and the struck particle move in directions making angles θ_1 and θ_2 respectively with the initial direction of motion. The sum of the angles $\theta_1 + \theta_2$ is :

(a) 45°   (b) 90°

(c) 135°   (d) 180°

64. A coil of $N=100$ turns carries a current $I=5A$ and creates a magnetic flux $\phi = 10^{-5}$ Tm^2 per turn. The value of its inductance L will be :

(a) 0.05 mH   (b) 0.10 mH

(c) 0.15 mH   (d) 0.20 mH

65. A person sitting in a chair in a satellite feels weightless because :

(a) the earth does not attract the objects in a satellite

(b) the normal force by the chair on the person balances the earth's attraction

(c) the normal force is zero

(d) the person in satellite is not accelerated

66. When a light beam passes from a medium of one refractive index to another, its :

(a) frequency changes

(b) frequency and wavelength change

(c) wavelength and velocity change

(d) velocity and frequency change

... is zero, what will be the value of angular momentum ?

(a) Constant in magnitude but changing in direction

(b) Changing in magnitude but constant in direction

(c) Constant in both magnitude and direction

(d) Zero

68. The energy of the highest energy photon of Balmer series of hydrogen spectrum is close to :

(a) 13.6 eV
(b) 3.4 eV
(c) 1.5 eV
(d) 0.85 eV

69. An ideal spring of force constant k is broken into two identical pieces. The force constant of each of the smaller springs is :

(a) $k/2$
(b) k
(c) $2k$
(d) $4k$

70. The kinetic energy of an electron with de-Broglie wavelength of 3 nm is :

(a) 0.168 eV
(b) 16.6 eV
(c) 1.68 eV
(d) 2.5 eV

71. A horizontal pipe of cross-sectional diameter 5 cm carries water at a velocity of 4 m/s. The pipe is connected to a smaller pipe with a cross-sectional diameter 4 cm. The velocity of water through the smaller pipe is :

(a) 6.25 m/s
(b) 5.0 m/s
(c) 3.2 m/s
(d) 2.56 m/s

72. The approximate nuclear radius is proportional to (A is the mass number and Z the atomic number) :

(a) $\sqrt{A}$
(b) $A^{1/3}$
(c) $\sqrt{Z}$
(d) $Z^{1/3}$

73. A Carnot engine absorbs an amount Q of heat from a reservoir at an absolute temperature T and rejects heat to a sink at a temperature of $T/3$. The amount of heat rejected is :

(a) $Q/4$
(b) $Q/3$
(c) $Q/2$
(d) $2Q/3$

74. A molecule with a dipole moment p is placed in an electric field of strength E. Initially the dipole is aligned parallel to the field. If the dipole is to be rotated to be anti-parallel to the field the work required to be done by an external agency is :

(a) $-2pE$
(b) $-pE$
(c) pE
(d) $2pE$

75. The following four wires are made of the same material and are at the same temperature. Which one of them has highest electrical resistance ?

(a) Length = 50 cm, diameter = 0.5 mm
(b) Length = 100 cm, diameter = 1 mm
(c) Length = 200 cm, diameter = 2 mm
(d) Length = 300 cm, diameter = 3 mm

Chemistry

1. Which of the following has highest knocking ?

(a) Olefins
(b) Branched chain olefins
(c) Straight chain olefins
(d) Aromatic hydrocarbons

2. Which is most basic in character ?

(a) CsOH
(b) KOH
(c) NaOH
(d) LiOH

3. The mass of $BaCO_3$ produced when excess CO_2 is bubbled through a solution of 0.205 mole $Ba(OH)_2$ is :

(a) 81 g
(b) 40.5 g
(c) 20.25 g
(d) 162 g

4. Would gaseous HCl be considered as an Arrhenius acid ?

(a) Yes
(b) No
(c) Not known
(d) Gaseous HCl does not exist

5. The degree of hydrolysis in hydrolytic equilibrium

$$A^- + H_2O \rightleftharpoons HA + OH^-$$

at salt concentration of 0.001 M is : ($K_a = 1 \times 10^{-5}$)

(a) 1×10^{-3}
(b) 1×10^{-4}
(c) 5×10^{-4}
(d) 1×10^{-6}

6. The formula of potash alum is :

(a) $K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 24H_2O$
(b) $K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 18H_2O$
(c) $K_2SO_4 \cdot (NH_4)_2SO_4 \cdot 18H_2O$
(d) $Na_2SO_4 \cdot Al_2(SO_4)_3 \cdot 24H_2O$

7. Which of the following has the lowest freezing point ?

(a) 0.1 m sucrose
(b) 0.1 m urea
(c) 0.1 m ethanol
(d) 0.1 m glucose

8. No two electron can have the same values of .... quantum numbers.
   (a) one
   (b) two
   (c) three
   (d) four

9. A litre of solution is saturated with AgCl. To this solution if 1.0×10^{-4} mole of solid NaCl is added, what will be the $[Ag^+]$, assuming no volume change ?
   (a) More
   (b) Less
   (c) Equal
   (d) Zero

10. The formula of mineral borax is :
    (a) $Na_2B_4O_7$
    (b) $Na_2B_4O_7 \cdot 4H_2O$
    (c) $Na_2B_4O_7 \cdot 5H_2O$
    (d) $Na_2B_4O_7 \cdot 10H_2O$

11. An aerosol is a :
    (a) dispersion of a solid or liquid in a gas
    (b) dispersion of a solid in a liquid
    (c) dispersion of a liquid in a liquid
    (d) solid solution

12. A compound contains 54.55% carbon, 9.09% hydrogen, 36.36% oxygen. The empirical formula of this compound is :
    (a) C_3H_5O
    (b) $C_4H_8O_2$
    (c) $C_2H_4O_2$
    (d) C_2H_4O

13. Which of the following is most likely to show optical isomerism ?
    (a) HC $\equiv$ C $-$ C $-$ C $\equiv$ CH (with H above and Cl below)
    (b) HC $\equiv$ C $-$ C $-$ CH$_3$ (with H above and Cl below)
    (c) HC $\equiv$ C $-$ C $-$ H (with H above and Cl below)
    (d) HC $\equiv$ C $-$ C $=$ CH$_2$ (with Cl below)
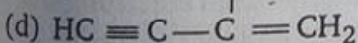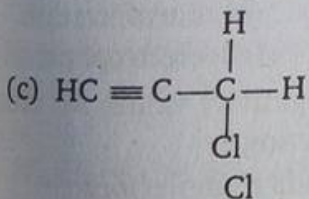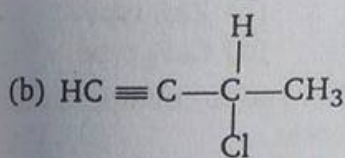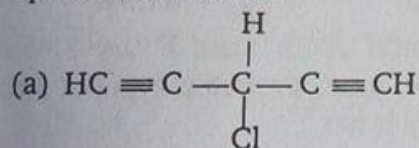
14. The correct order of ionization energy for comparing carbon, nitrogen and oxygen atoms is :
    (a) $C > N > O$
    (b) $C > N < O$
    (c) $C < N > O$
    (d) $C < N < O$

15. Which of the following functional groups, cannot be reduced to alcohol using NaBH$_4$ in ethanolic solution ?
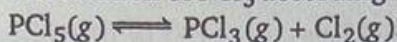
(a) $R-O-R$
(b) $RCOCl$
(c) $R-COOH$
(d) $R-CHO$

16. Which one of the following is expected to have largest size ?
    (a) F^-
    (b) O^{2-}
    (c) Al^{3+}
    (d) N^{3-}

17. Acetylene reacts with HCN in the presence of $Ba(CN)_2$ to yield :
    (a) 1, 1-dicyanoethane
    (b) 1, 2-dicyanoethane
    (c) vinyl cyanide
    (d) none of the above

18. An aqueous solution of potash alum gives :
    (a) two types of ions
    (b) only one type of ion
    (c) four types of ions
    (d) three types of ions

19. pH of 1 M NH$_3$ aqueous solution is : $(K_b = 1.8 \times 10^{-5})$
    (a) 11.13
    (b) 12.5
    (c) 13.42
    (d) 11.55

20. Equivalent weight of an acid :
    (a) depends on the reaction involved
    (b) depends upon the number of oxygen atoms present
    (c) is always constant
    (d) none of the above

21. The formation of SO$_3$ takes place according to the following reaction :
    $2SO_2 + O_2 \rightleftharpoons 2SO_3; \Delta H = -45.2\,kcal$
    The formation of SO$_3$ is favoured by :
    (a) increase in temperature
    (b) removal of oxygen
    (c) increase of volume
    (d) increase of pressure

22. The compound in which cation is isoelectronic with anion is :
    (a) NaCl
    (b) CsF
    (c) NaI
    (d) K_2S

23. Which of the following equations correctly represents the standard heat of formation (ΔH_f°) of methane ?
    (a) C (diamond) + 4H(g) $\longrightarrow$ CH$_4$(g)
    (b) C (diamond) + 2H$_2$(g) $\longrightarrow$ CH$_4$(g)
    (c) C (graphite) + 2H$_2$(g) $\longrightarrow$ CH$_4$(g)
    (d) C (graphite) + 4H(g) $\longrightarrow$ CH$_4$(g)

24. The paramagnetic molecule at ground state among the following is :
    (a) H_2
    (b) O_2
    (c) N_2
    (d) CO

25. What is the effect of increasing pressure on the dissociation of PCl_5 according to the equation ?
    $$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$$
    (a) Dissociation decreases
    (b) Dissociation increases
    (c) Dissociation does not change
    (d) None of the above

26. The ground state term symbol for an electronic state is governed by :
    (a) Heisenberg's principle
    (b) Hund's rule
    (c) Aufbau principle
    (d) Pauli exclusion principle

27. Reaction of alkyl halides with aromatic compounds in presence of anhydrous $AlCl_3$ is known as :
    (a) Friedel-Craft's reaction
    (b) Hofmann degradation
    (c) Kolbe's synthesis
    (d) Beckmann rearrangement

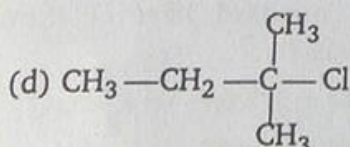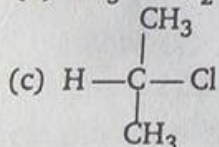28. The following compound will undergo electrophilic substitution more readily than benzene :
    (a) nitrobenzene
    (b) benzoic acid
    (c) benzaldehyde
    (d) phenol

29. The following salt shows maximum covalent character :
    (a) $AlCl_3$
    (b) $MgCl_2$
    (c) CsCl
    (d) $LaCl_3$

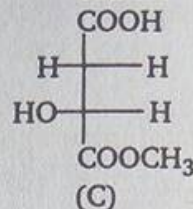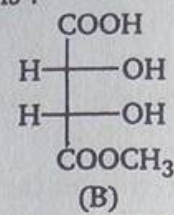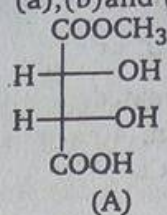30. Which chlorine atom is more electronegative in the following ?
    (a) $CH_3 - Cl$
    (b) $CH_3 - CH_2 - Cl$
    (c) $H - \underset{CH_3}{\overset{CH_3}{C}} - Cl$
    (d) $CH_3 - CH_2 - \underset{CH_3}{\overset{CH_3}{C}} - Cl$

31. Which of the following is paramagnetic ?
    (a) B_2
    (b) C_2
    (c) N_2
    (d) F_2

32. The correct statement about the compounds (a), (b) and (c) is :

    COOCH₃   COOH
    H—OH   H—OH
    H—OH   H—OH
    COOH   COOCH₃
    (A)   (B)

    COOH
    H—H
    HO—H
    COOCH₃
    (C)

    (a) (A) and (B) are identical
    (b) (A) and (B) are diastereomers
    (c) (A) and (C) are enantiomers
    (d) (A) and (B) are enantiomers

33. What is the ratio of mass of an electron to the mass of a proton ?
    (a) $1:2$
    (b) $1:1$
    (c) $1:1837$
    (d) $1:3$

34. The heat of combustion of carbon to CO_2 is -393.5 kJ/mol. The heat released upon formation of 35.2 g of CO_2 from carbon and oxygen gas is :
    (a) $+315$ kJ
    (b) -31.5 kJ
    (c) -315 kJ
    (d) $+31.5$ kJ

35. The ionic radii of Rb^+ and I^- are 1.46 Å and 2.16 Å. The most probable type of structure exhibited by it is :
    (a) CsCl type
    (b) ZnS type
    (c) NaCl type
    (d) CaF_2 type

36. A precipitate is changed to colloidal solution by the following process :
    (a) dialysis
    (b) ultrafiltration
    (c) peptization
    (d) electrophoresis

37. Pauling's electronegativity values for elements are useful in predicting :
    (a) polarity of bonds in molecules
    (b) position of elements in electromotive series
    (c) co-ordination number
    (d) dipole moment of various molecules

38. The movement of colloidal particles towards their respective electrodes in the presence of an electric field is known as :
    (a) electrolysis
    (b) Brownian movement
    (c) dialysis
    (d) electrophoresis

39. The trigonal bipyramidal geometry results from the hybridisation :
   (a) dsp^3 or sp^3d
   (b) dsp^2 or sp^2d
   (c) d^2sp^3 or sp^3d^2
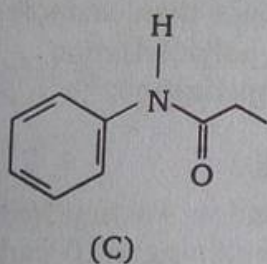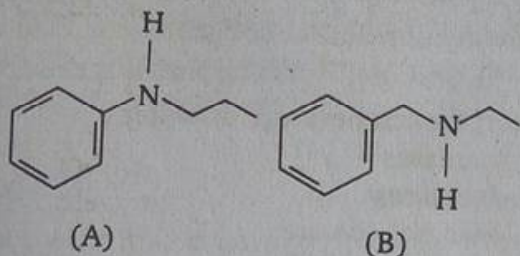   (d) d^3p^2 or d^2p^3

40. Two moles of PCl_5 were heated in a closed vessel of 2 L. At equilibrium, 40% of PCl_5 is dissociated into PCl_3 and Cl_2. The value of equilibrium constant is :
   (a) 0.53
   (b) 0.267
   (c) 2.63
   (d) 5.3

41. $[EDTA]^{4-}$ is a :
   (a) monodentate ligand
   (b) bidentate ligand
   (c) quadridentate ligand
   (d) hexadentate ligand

42. Which one of the following compound is most basic ?

(A)   (B)

(C)

   (a) (A)
   (b) (B)
   (c) (C)
   (d) All are equally basic

43. The number of secondary hydrogens in 2, 2-dimethyl butane is :
   (a) 8
   (b) 6
   (c) 4
   (d) 2

44. Which of the following will not give iodoform test ?
   (a) Isopropyl alcohol
   (b) Ethanol
   (c) Ethanal
   (d) Benzyl alcohol

45. The molecule having smallest bond angle is :
   (a) H_2O
   (b) H_2S
   (c) NH_3
   (d) H_2Te

46. The most appropriate reagent to distinguish between acetaldehyde and formaldehyde is :
   (a) Fehling's solution
   (b) Tollen's reagent
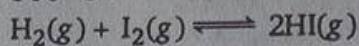   (c) Schiff's reagent
   (d) iodine in presence of base

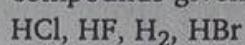47. Which of the following substances acts as an oxidising as well as a reducing agent ?
   (a) Na_2O
   (b) $SnCl_2$
   (c) Na_2O_2
   (d) $NaNO_2$

48. What is the effect of having the pressure by doubling the volume on the following system at 500°C ?
   $$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$$
   (a) Shift to reactant side
   (b) Shift to product formation
   (c) Liquefaction of HI
   (d) No effect

49. Identify the non-polar molecule in the set of compounds given :
   HCl, HF, H_2, HBr
   (a) H_2
   (b) HCl
   (c) HF, HBr
   (d) HBr

50. Which of the following acts as protective colloid ?
   (a) Silica gel
   (b) Gelatin
   (c) Sodium acetate
   (d) None of these

51. Which of the following molecules has three-fold axis of symmetry ?
   (a) NH_3
   (b) C_2H_4
   (c) CO_2
   (d) SO_2

52. The number of coulombs required to reduce 12.3 g of nitrobenzene to aniline is :
   (a) 115800 C
   (b) 5790 C
   (c) 28950 C
   (d) 57900 C

53. A solid is made of two elements X and Z. The atoms Z are in CCP arrangement while the atom X occupy all the tetrahedral sites. What is the formula of the compound ?
   (a) XZ
   (b) XZ_2
   (c) X_2Z
   (d) X_2Z_3

54. The solubility product of Barium sulphate is 1.5×10^{-9} at 18°C. Its solubility in water at 18°C is :
   (a) 1.5×10^{-9}
   (b) 1.5×10^{-5}
   (c) 3.9×10^{-9}
   (d) 3.9×10^{-5}

55. Doping of Silicon (Si) with boron(B) leads to :
   (a) n-type semiconductor
   (b) p-type semiconductor
   (c) metal
   (d) insulator

56. pH scale was introduced by :
    (a) Arrhenius   (b) Sorensen
    (c) Lewis   (d) Lowery

57. Chlorination of benzene is not possible in the following reaction :
    (a) $C_6H_6 + Cl_2 \xrightarrow{FeCl_3}$

    (b) $C_6H_6 + HOCl \xrightarrow{H^+}$

    (c) $C_6H_6 + I-Cl \xrightarrow{ZnCl_2}$

    (d) $C_6H_6 + Cl_2 \xrightarrow{AlCl_3}$

58. Which of the following orders regarding relative stability of free radicals is correct ?
    (a) $3° < 2° < 1°$ (b) $3° > 2° > 1°$
    (c) $1° < 2° > 3°$ (d) $3° > 2° < 1°$

59. Which of the following pairs involves isoelectronic ions ?
    (a) Mn^{3+} and Fe^{2+} (b) Mn^{2+} and Fe^{3+}
    (c) Cr^{3+} and Mn^{2+} (d) Fe^{2+} and Co^{2+}

60. A polymer containing nitrogen is :
    (a) bakelite   (b) dacron
    (c) rubber   (d) nylon-66

61. Which one of the following has the highest electronegativity ?
    (a) Br   (b) Cl
    (c) P   (d) Si

62. The conversion of acetophenone to acetanilide is best accomplished by using :
    (a) Beckmann rearrangement
    (b) Curtius rearrangement
    (c) Lossen rearrangement
    (d) Hofmann rearrangement

63. Which one of the following is called amphoteric solvent ?
    (a) Ammonium hydroxide
    (b) Chloroform
    (c) Benzene
    (d) Water

64. 100 mL of 0.04 N HCl aqueous solution is mixed with 100 mL of 0.02 N NaOH solution. The pH of the resulting solution is :
    (a) 1.0   (b) 1.7
    (c) 2.0   (d) 2.3

65. The strength in volumes of a solution containing 30.36 g/L of H_2O_2 is :
    (a) 10 volume   (b) 20 volume
    (c) 5 volume   (d) none of these

66. The number of orbitals present in the shell with $n = 4$ is :
    (a) 16   (b) 8
    (c) 18   (d) 32

67. Which of the following is the best protective colloid ?
    (a) Gelatin (Gold No. = 0.005)
    (b) Gum arabic (Gold No. = 0.15)
    (c) Egg albumin (Gold No. = 0.08)
    (d) None of the above

68. If a system is at equilibrium, the rate of forward to the reverse reaction is :
    (a) less   (b) equal
    (c) high   (d) at equilibrium

69. Producer gas is a mixture of :
    (a) CO and N_2 (b) CO_2 and H_2
    (c) N_2 and O_2 (d) CH_4 and N_2

70. Enthalpy of solution of NaOH (solid) in water is -41.6 kJ mol^{-1}. When NaOH is dissolved in water, the temperature of water :
    (a) increases
    (b) decreases
    (c) does not change
    (d) fluctuates indefinitely

71. Formation of terylene is an example of :
    (a) condensation polymerisation
    (b) addition polymerisation
    (c) esterification
    (d) saponification

72. A petroleum fraction having boiling range 70-200°C and containing 6-10 carbon atoms per molecule is called :
    (a) natural gas   (b) gas oil
    (c) gasoline   (d) kerosene

73. Electrons in a paramagnetic compound are :
    (a) shared   (b) unpaired
    (c) donated   (d) paired

74. The dehydration of 2-methyl butanol with conc. H_2SO_4 gives :
    (a) 2-methyl butene as major product
    (b) pentene
    (c) 2-methyl but-2-ene as major product
    (d) 2-methyl pent-2-ene

75. The final products formed on the addition of KI to copper sulphate solution are :
    (a) $K_2SO_4 \cdot CuI_2$ and I_2
    (b) $K_2SO_4 \cdot Cu_2I_2$ and I_2
    (c) K_2SO_4 and Cu_2O

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    (b) $K_2SO_4 \cdot Cu_2I_2$ and I_2
    (c) K_2SO_4 and Cu_2O
    (d) $K_2SO_4 \cdot CuO$ and I_2

Mathematics

1. The coefficient of x^{100} in the expansion of $\sum_{j=0}^{200} (1 + x)^j$ is:

   (a) $\binom{200}{100}$

   (b) $\binom{201}{102}$

   (c) $\binom{200}{101}$

   (d) $\binom{201}{100}$

2. The circles $x^2 + y^2 - 10x + 16 = 0$ and $x^2 + y^2 = r^2$ intersect each other at two distinct points, if :

   (a) $r < 2$

   (b) $r > 8$

   (c) $2 < r < 8$

   (d) $2 \le r \le 8$

3. Three numbers are in AP such that their sum is 18 and sum of their squares is 158. The greatest number among them is :

   (a) 10

   (b) 11

   (c) 12

   (d) none of these

4. Let $\vec{a}$, $\vec{b}$ and $\vec{c}$ be three vectors. Then, scalar triple product $[\vec{a}\ \vec{b}\ \vec{c}]$ is equal to :

   (a) $[\vec{b}\ \vec{a}\ \vec{c}]$

   (b) $[\vec{a}\ \vec{c}\ \vec{b}]$

   (c) $[\vec{c}\ \vec{b}\ \vec{a}]$

   (d) $[\vec{b}\ \vec{c}\ \vec{a}]$

5. The roots of the equation $x^4 - 2x^3 + x = 380$ are :

   (a) $5, -4, \dfrac{1 \pm 5\sqrt{-3}}{2}$

   (b) $-5, 4, -\dfrac{1 \pm 5\sqrt{-3}}{2}$

   (c) $5, 4, \dfrac{-1 \pm 5\sqrt{-3}}{2}$

   (d) $-5, -4, \dfrac{1 \pm 5\sqrt{-3}}{2}$

6. Let $y = x^{x^{x^{\cdots}}}$, then $\dfrac{dy}{dx}$ is equal to :

   (a) yx^{y-1}

   (b) $\dfrac{y^2}{x(1 - y \log x)}$

   (c) $\dfrac{y}{x(1 + y \log x)}$

   (d) none of these

7. $\int \dfrac{(\tan^{-1} x)^3}{(1 + x^2)}\, dx$ is equal to :

   (a) $3(\tan^{-1} x)^2 + c$

   (b) $\dfrac{(\tan^{-1} x)^4}{4} + c$

   (c) $(\tan^{-1} x)^4 + c$

   (d) none of these

8. 'X' speaks truth in 60% and 'Y' in 50% of the cases. The probability that they contradict each other narrating the same incident is :

   (a) $\dfrac{1}{4}$

   (b) $\dfrac{1}{3}$

   (c) $\dfrac{1}{2}$

   (d) $\dfrac{2}{3}$

9. A set contains $2n + 1$ elements. The number of subsets of this set containing more than n elements is equal to :

   (a) 2^{n-1}

   (b) 2^n

   (c) 2^{n+1}

   (d) 2^{2n}

10. The area between the parabola $y = x^2$ and the line $y = x$ is :

    (a) $\dfrac{1}{6}$ sq unit

    (b) $\dfrac{1}{3}$ sq unit

    (c) $\dfrac{1}{2}$ sq unit

    (d) none of these

11. The eccentricity of the hyperbola $5x^2 - 4y^2 + 20x + 8y = 4$ is :

    (a) $\sqrt{2}$

    (b) $\dfrac{3}{2}$

    (c) 2

    (d) 3

12. $\lim\limits_{x \to 0} \left[\dfrac{e^x - e^{\sin x}}{x - \sin x} \right]$ is equal to :

    (a) -1

    (b) 0

    (c) 1

    (d) none of these

13. $\int_0^\pi \dfrac{x\, dx}{1 + \sin x}$ is equal to :

    (a) $-\pi$

    (b) $\dfrac{\pi}{2}$

    (c) π

    (d) none of these

14. A man of mass 80 kg is travelling in a lift. The reaction between the floor of the lift and the man when the lift is accelerating upwards at $4\ m/s^2$ and the acceleration due to gravity $g = 9.81\ m/s^2$, is equal to :

    (a) 884.8 N

    (b) 784.8 N

    (c) 464 N

    (d) 1104.8 N

15. The argument of $(1 - i\sqrt{3})/(1 + i\sqrt{3})$ is :

    (a) $60°$

    (b) $120°$

    (c) $210°$

    (d) $240°$

16. The points z_1, z_2, z_3, z_4 in a complex plane are vertices of a parallelogram taken in order, then:

(a) $z_1 + z_4 = z_2 + z_3$ (b) $z_1 + z_3 = z_2 + z_4$

(c) $z_1 + z_2 = z_3 + z_4$ (d) none of these

17. The harmonic mean between two numbers is $14\frac{2}{5}$ and the geometric mean is 24. The greater number between them is :

(a) 72 (b) 54

(c) 36 (d) none of these

18. The angle between two forces each equal to P when their resultant is also equal to P is :

(a) $\frac{2\pi}{3}$ (b) $\frac{\pi}{3}$

(c) π (d) $\frac{\pi}{2}$

19. The solution of the differential equation $\sec^2 x \tan y\, dx + \sec^2 y \tan x\, dy = 0$ is :

(a) $\tan y \tan x = c$ (b) $\frac{\tan y}{\tan x} = c$

(c) $\frac{\tan^2 x}{\tan y} = c$ (d) none of these

20. The real roots of the equation $x^{2/3} + x^{1/3} - 2 = 0$ are :

(a) 1, 8 (b) $-1, -8$

(c) $-1, 8$ (d) $1, -8$

21. Let $f(x) = \begin{cases} \sin x, & \text{for } x \geq 0 \\ 1 - \cos x, & \text{for } x \leq 0 \end{cases}$ and $g(x) = e^x$.

Then, $(gof)'(0)$ is :

(a) 1 (b) -1

(c) 0 (d) none of these

22. Cosine of the angle between two diagonals of a cube is equal to :

(a) $\frac{2}{\sqrt{6}}$ (b) $\frac{1}{3}$

(c) $\frac{1}{2}$ (d) none of these

23. In a certain population 10% of the people are rich, 5% are famous and 3% are rich and famous. The probability that a person picked at random from the population is either famous or rich but not both, is equal to :

(a) 0.07 (b) 0.08

(c) 0.09 (d) 0.12

24. Three numbers are in GP such that their sum is 38 and their product is 1728. The greatest number among them is :

(a) 18 (b) 16

(c) 14 (d) none of these

25. The equation of the circle touching $x = 0$, $y = 0$ and $x = 4$ is :

(a) $x^2 + y^2 - 4x - 4y + 16 = 0$

(b) $x^2 + y^2 - 8x - 8y + 16 = 0$

(c) $x^2 + y^2 + 4x + 4y - 4 = 0$

(d) $x^2 + y^2 - 4x - 4y + 4 = 0$

26. Let $f(x) = \begin{cases} 1, & \text{when } x \text{ is rational} \\ 0, & \text{when } x \text{ is irrational} \end{cases}$ then $\lim_{x \to 0} f(x)$ is :

(a) 0 (b) 1

(c) $\frac{1}{2}$ (d) none of these

27. $\vec{a}$, $\vec{b}$ and $\vec{c}$ are three vectors with magnitude $|\vec{a}| = 4, |\vec{b}| = 4, |\vec{c}| = 2$ and such that $\vec{a}$ is perpendicular to $(\vec{b} + \vec{c})$, $\vec{b}$ is perpendicular to $(\vec{c} + \vec{a})$ and $\vec{c}$ is perpendicular to $(\vec{a} + \vec{b})$. It follows that $|\vec{a} + \vec{b} + \vec{c}|$ is equal to :

(a) 9 (b) 6

(c) 5 (d) 4

28. Let z_1 and z_2 be complex numbers, then $|z_1 + z_2|^2 + |z_1 - z_2|^2$ is equal to :

(a) $|z_1|^2 + |z_2|^2$ (b) $2(|z_1|^2 + |z_2|^2)$

(c) $2(z_1^2 + z_2^2)$ (d) $4z_1 z_2$

29. If $\tan \theta + \tan\left(\theta + \frac{\pi}{3}\right) + \tan\left(\theta + \frac{2\pi}{3}\right) = 3$, then :

(a) $\tan 2\theta = 1$

(b) $\tan 3\theta = 1$

(c) $\tan^2 \theta = 1$

(d) $\tan^3 \theta = 1$

30. Let $y = t^{10} + 1$ and $x = t^8 + 1$, then $\frac{d^2 y}{dx^2}$ is equal to :

(a) $\frac{5}{2} t$ (b) $20 t^8$

(c) $\frac{5}{16 t^6}$ (d) none of these

31. The vectors $\vec{AB} = 3\hat{i} + 5\hat{j} + 4\hat{k}$ and $\vec{AC} = 5\hat{i} - 5\hat{j} + 2\hat{k}$ are the sides of a triangle ABC. The length of the median through A is :

(a) $\sqrt{13}$ unit (b) $2\sqrt{5}$ unit

(c) 5 unit (d) 10 unit

32. If **a**, **b**, **c** are three non-coplanar vectors, then $(\vec{a} + \vec{b} + \vec{c}) \cdot [(\vec{a} + \vec{b}) \times (\vec{a} + \vec{c})]$ is :

(a) 0

(b) $2[\vec{a} \; \vec{b} \; \vec{c}]$

(c) $-[\vec{a} \; \vec{b} \; \vec{c}]$

(d) $[\vec{a} \; \vec{b} \; \vec{c}]$

33. $\int \dfrac{dx}{x(x^5 + 1)}$ is equal to :

(a) $\dfrac{1}{5} \log x^5 (x^5 + 1) + c$

(b) $\dfrac{1}{5} \log \left(\dfrac{x^5 + 1}{x^5} \right) + c$

(c) $\dfrac{1}{5} \log \left(\dfrac{x^5}{x^5 + 1} \right) + c$

(d) none of the above

34. A function f on R into itself is continuous at a point a in R, iff for each $\epsilon > 0$, there exists, $\delta > 0$ such that :

(a) $|f(x) - f(a)| < \epsilon \Rightarrow |x - a| < \delta$

(b) $|f(x) - f(a)| > \epsilon \Rightarrow |x - a| > \delta$

(c) $|x - a| > \delta \Rightarrow |f(x) - f(a)| > \epsilon$

(d) $|x - a| < \delta \Rightarrow |f(x) - f(a)| < \epsilon$

35. $\int \dfrac{x + \sin x}{1 + \cos x} dx$ is equal to :

(a) $x \tan \dfrac{x}{2} + c$

(b) $x \sec^2 \dfrac{x}{2} + c$

(c) $\log \cos \dfrac{x}{2}$

(d) none of these

36. A straight line through the point (1, 1) meets the x-axis at 'A' and the y-axis at 'B'. The locus of the mid point of AB is :

(a) $2xy + x + y = 0$

(b) $x + y - 2xy = 0$

(c) $x + y + 2 = 0$

(d) $x + y - 2 = 0$

37. If $A = \begin{bmatrix} 2 & 4 & 5 \\ 4 & 8 & 10 \\ -6 & -12 & -15 \end{bmatrix}$, then rank of A is equal to :

(a) 0

(b) 1

(c) 2

(d) 3

38. A bag contains 8 red and 7 black balls. Two balls are drawn at random. The probability that both the balls are of the same colour, is :

(a) $\dfrac{14}{15}$

(b) $\dfrac{11}{15}$

(c) $\dfrac{7}{15}$

(d) $\dfrac{4}{15}$

39. If $\sin^2 \theta = \dfrac{x^2 + y^2 + 1}{2x}$, then x must be :

(a) -3

(b) -2

(c) 1

(d) none of these

40. The solution of equation $\cos^2 \theta + \sin \theta + 1 = 0$ lies in the interval :

(a) $\left(-\dfrac{\pi}{4}, \dfrac{\pi}{4} \right)$

(b) $\left(\dfrac{\pi}{4}, \dfrac{3\pi}{4} \right)$

(c) $\left(\dfrac{3\pi}{4}, \dfrac{5\pi}{4} \right)$

(d) $\left(\dfrac{5\pi}{4}, \dfrac{7\pi}{4} \right)$

41. Coefficient of x^{19} in the polynomial $(x - 1)(x - 2) \ldots (x - 20)$ is equal to :

(a) 210

(b) -210

(c) 20!

(d) none of these

42. Two pillars of equal height stand on either side of a road way which is 60 m wide. At a point in the road way between the pillars, the elevation of the top of pillars are 60° and 30°. The height of the pillars is :

(a) $15\sqrt{3}$ m

(b) $\dfrac{15}{\sqrt{3}}$ m

(c) 15 m

(d) 20 m

43. A light string passing over a light smooth pulley carries masses of 3 kg and 5 kg at its ends. If the string is allowed to move from the rest, the acceleration of the motion is equal to :

(a) $(g/2)$ m/s²

(b) $(g/4)$ m/s²

(c) $2g$ m/s²

(d) $4g$ m/s²

44. The equation of the directrix of the parabola $x^2 + 8y - 2x = 7$ is :

(a) $y = 3$

(b) $y = -3$

(c) $y = 2$

(d) $y = 0$

45. If $iz^4 + 1 = 0$, then z can take the value :

(a) $\dfrac{1 + i}{\sqrt{2}}$

(b) $\cos \dfrac{\pi}{8} + i \sin \dfrac{\pi}{8}$

(c) $\dfrac{1}{4i}$

(d) i

46. If $\vec{a} = \hat{i} + \hat{j} - \hat{k}$, $\vec{b} = 2\hat{i} + 3\hat{j} + \hat{k}$, and $\vec{c} = \hat{i} + \alpha \hat{j}$ are coplanar vectors, the value of α is :

(a) $-\dfrac{4}{3}$

(b) $\dfrac{3}{4}$

(c) $\dfrac{4}{3}$

(d) 2

47. The equation of the tangent parallel to $y - x + 5 = 0$ drawn to $\dfrac{x^2}{3} - \dfrac{y^2}{2} = 1$ is :

(a) $x - y - 1 = 0$

(b) $x - y + 2 = 0$

(c) $x + y - 1 = 0$

(d) $x + y + 2 = 0$

48. The equation $y^2 - x^2 + 2x - 1 = 0$ represents :
    (a) a hyperbola
    (b) an ellipse
    (c) a pair of straight lines
    (d) a rectangular hyperbola

49. The minimum value of $3 \sin \theta + 4 \cos \theta$ is :
    (a) 5
    (b) 1
    (c) 3
    (d) -5

50. A man in swimming with the uniform velocity of 6 km/h straight across a river which is flowing at the rate of 2 km/h. If the breadth of the river is 300 m, the distance between the point and the man is initially directed to and the point it will reach on the opposite bank of the river is equal to :
    (a) 100 m
    (b) 200 m
    (c) 300 m
    (d) 400 m

51. A ball is thrown vertically upwards from the ground with velocity 15 m/s and rebounds from the ground with one-third of its striking velocity. The ratio of its greatest heights before and after striking the ground is equal to :
    (a) 4 : 1
    (b) 9 : 1
    (c) 5 : 1
    (d) 3 : 1

52. If the position vectors of the vertices A, B, C of a triangle ABC are $7\hat{j} + 10\hat{k}, -\hat{i} + 6\hat{j} + 6\hat{k}$ and $-4\hat{i} + 9\hat{j} + 6\hat{k}$ respectively, the triangle is :
    (a) equilateral
    (b) isosceles
    (c) scalene
    (d) right angled and isosceles also

53. The number of solutions of the equation $2 \cos (e^x) = 5^x + 5^{-x}$, are :
    (a) no solution
    (b) one solution
    (c) two solutions
    (d) infinitely many solutions

54. Probability of throwing 16 in one throw with three dice is :
    (a) $\dfrac{1}{36}$
    (b) $\dfrac{1}{18}$
    (c) $\dfrac{1}{72}$
    (d) $\dfrac{1}{9}$

55. The differential equation of all straight lines passing through origin is :
    (a) $y = \sqrt{x}\,\dfrac{dy}{dx}$
    (b) $\dfrac{dy}{dx} = y + x$
    (c) $\dfrac{dy}{dx} = y - x$
    (d) none of these

56. If $\vec{a}, \vec{b}, \vec{c}$ are three unit vectors such that $\vec{a} + \vec{b} + \vec{c} = \vec{0}$, where $\vec{0}$ is null vector, then $\vec{a} \cdot \vec{b} + \vec{b} \cdot \vec{c} + \vec{c} \cdot \vec{a}$ is :
    (a) -3
    (b) -2
    (c) $-\dfrac{3}{2}$
    (d) 0

57. The expression $2 \cos \dfrac{\pi}{13} + \cos \dfrac{9\pi}{13} + \cos \dfrac{3\pi}{13} + \cos \dfrac{5\pi}{13}$ is equal to :
    (a) -1
    (b) 0
    (c) 1
    (d) none of these

58. $\cos^{-1} \dfrac{1}{2} + 2 \sin^{-1} \dfrac{1}{2}$ is equal to :
    (a) $\dfrac{\pi}{4}$
    (b) $\dfrac{\pi}{6}$
    (c) $\dfrac{\pi}{3}$
    (d) $\dfrac{2\pi}{3}$

59. If $f(x) = (a - x^n)^{1/n}$, where $a > 0$ and $n \in N$, then $fof(x)$ is equal to :
    (a) a
    (b) x
    (c) x^n
    (d) a^n

60. The number of reflexive relations of a set with four elements is equal to :
    (a) 2^{16}
    (b) 2^{12}
    (c) 2^8
    (d) 2^4

61. The maximum horizontal range of a ball projected with a velocity of 39.2 m/s is (take $g = 9.8 \text{ m/s}^2$) :
    (a) 100 m
    (b) 127 m
    (c) 157 m
    (d) 177 m

62. Maximum value of $\sin x - \cos x$ is equal to :
    (a) $\sqrt{2}$
    (b) 1
    (c) 0
    (d) none of these

63. The equation of the bisector of the acute angles between the lines $3x - 4y + 7 = 0$ and $12x + 5y - 2 = 0$ is :
    (a) $99x - 27y - 81 = 0$
    (b) $11x - 3y + 9 = 0$
    (c) $21x + 77y - 101 = 0$
    (d) $21x + 77y + 101 = 0$

64. To reduce the differential equation $\dfrac{dy}{dx} + P(x)y = Q(x) \cdot y^n$ to the linear form, the substitution is :
    (a) $v = \dfrac{1}{y^n}$
    (b) $v = \dfrac{1}{y^{n-1}}$
    (c) $v = y^n$
    (d) $v = y^{n-1}$

65. A particle possess two velocities simultaneously at an angle of $\tan^{-1}\frac{12}{5}$ to each other. Their resultant is 15 m/s. If one velocity is 13 m/s, then the other will be :
    (a) 5 m/s   (b) 4 m/s
    (c) 12 m/s   (d) 13 m/s

66. If in the expansion of $(1 + x)^{21}$, the coefficients of x^r and x^{r+1} be equal, then r is equal to :
    (a) 9   (b) 10
    (c) 11   (d) 12

67. A train is running at 5 m/s and a man jumps out of it with a velocity 10 m/s in a direction making an angle of 60° with the direction of the train. The velocity of the man relative to the ground is equal to :
    (a) 12.24 m/s   (b) 11.25 m/s
    (c) 14.23 m/s   (d) 13.23 m/s

68. A ball is projected vertically upward with a velocity 112 m/s. The time taken by it to return to the point of projection is ($g = 10$ m/s²) :
    (a) 11 s   (b) 33 s
    (c) 5.5 s   (d) 22 s

69. If the sides of a triangle are 4, 5 and 6 cm, then area of the triangle is equal to :
    (a) $\frac{15}{4}$ cm²   (b) $\frac{15}{4}\sqrt{7}$ cm²
    (c) $\frac{4}{15}\sqrt{7}$ cm²   (d) none of these

70. The volume of a spherical cap of height h cut off from a sphere of radius a is equal to :
    (a) $\frac{\pi}{3}h^2(3a - h)$
    (b) $\pi(a - h)(2a^2 - h^2 - ah)$
    (c) $\frac{4\pi}{3}h^3$
    (d) none of the above

71. The eccentricity of the hyperbola conjugate to $x^2 - 3y^2 = 2x + 8$ is :
    (a) $\frac{2}{\sqrt{3}}$ (b) $\sqrt{3}$
    (c) 2   (d) none of these

72. The area of the parallelogram whose adjacent sides are $\hat{i} - \hat{k}$ and $2\hat{j} + 3\hat{k}$ is :
    (a) 2   (b) 4
    (c) $\sqrt{17}$ (d) $2\sqrt{13}$

73. Integrating factor of the differential equation $\frac{dy}{dx} + P(x)y = Q(x)$ is :
    (a) $\int P\,dx$ (b) $\int Q\,dx$
    (c) $e^{\int P\,dx}$ (d) $e^{\int Q\,dx}$

74. Angle of intersection of the curves $r = \sin\theta + \cos\theta$ and $r = 2\sin\theta$ is equal to :
    (a) $\frac{\pi}{2}$ (b) $\frac{\pi}{3}$
    (c) $\frac{\pi}{4}$ (d) none of these

75. Define f on R into itself by
    $$f(x) = \begin{cases} x\sin\frac{1}{x}, & \text{when } x \neq 0 \\ 0, & \text{when } x = 0 \end{cases}, \text{ then :}$$
    (a) f is continuous at 0 but not differentiable at 0
    (b) f is both continuous and differentiable at 0
    (c) f is differentiable but not continuous at 0
    (d) none of the above

ANSWERS

PHYSICS

1. (a)	2. (a)	3. (d)	4. (a)	5. (a)	6. (b)	7. (b)	8. (c)	9. (d)	10. (c)
11. (d)	12. (c)	13. (a)	14. (a)	15. (c)	16. (c)	17. (a)	18. (b)	19. (b)	20. (c)
21. (a)	22. (b)	23. (c)	24. (c)	25. (b)	26. (d)	27. (c)	28. (b)	29. (c)	30. (d)
31. (d)	32. (d)	33. (d)	34. (d)	35. (b)	36. (a)	37. (c)	38. (a)	39. (c)	40. (a)
41. (c)	42. (b)	43. (a)	44. (a)	45. (a)	46. (c)	47. (b)	48. (a)	49. (c)	50. (c)
51. (d)	52. (d)	53. (d)	54. (c)	55. (a)	56. (a)	57. (c)	58. (c)	59. (b)	60. (d)
61. (b)	62. (d)	63. (b)	64. (d)	65. (c)	66. (c)	67. (c)	68. (b)	69. (c)	70. (b)
71. (a)	72. (b)	73. (b)	74. (d)	75. (a)					

CHEMISTRY

1. (c)	2. (a)	3. (b)	4. (b)	5. (a)	6. (a)	7. (c)	8. (d)	9. (b)	10. (d)
11. (a)	12. (d)	13. (b)	14. (c)	15. (a)	16. (d)	17. (c)	18. (d)	19. (a)	20. (a)
21. (d)	22. (d)	23. (c)	24. (b)	25. (a)	26. (d)	27. (a)	28. (d)	29. (a)	30. (d)
31. (a)	32. (d)	33. (c)	34. (c)	35. (c)	36. (c)	37. (a)	38. (d)	39. (a)	40. (b)
41. (d)	42. (b)	43. (d)	44. (d)	45. (d)	46. (d)	47. (d)	48. (d)	49. (a)	50. (b)
51. (a)	52. (d)	53. (c)	54. (d)	55. (d)	56. (b)	57. (b)	58. (b)	59. (b)	60. (d)
61. (b)	62. (a)	63. (d)	64. (c)	65. (a)	66. (a)	67. (a)	68. (b)	69. (a)	70. (a)
71. (a)	72. (c)	73. (b)	74. (a)	75. (b)					

MATHEMATICS

1. (a)	2. (c)	3. (b)	4. (d)	5. (a)	6. (b)	7. (b)	8. (c)	9. (d)	10. (a)
11. (b)	12. (c)	13. (c)	14. (d)	15. (a)	16. (b)	17. (a)	18. (a)	19. (a)	20. (d)
21. (c)	22. (b)	23. (c)	24. (a)	25. (d)	26. (b)	27. (b)	28. (b)	29. (b)	30. (c)
31. (c)	32. (c)	33. (c)	34. (a)	35. (a)	36. (b)	37. (b)	38. (c)	39. (d)	40. (d)
41. (b)	42. (a)	43. (b)	44. (a)	45. (b)	46. (c)	47. (a)	48. (c)	49. (d)	50. (a)
51. (b)	52. (d)	53. (a)	54. (a)	55. (d)	56. (c)	57. (b)	58. (d)	59. (b)	60. (d)
61. (c)	62. (a)	63. (c)	64. (b)	65. (b)	66. (b)	67. (d)	68. (d)	69. (b)	70. (a)
71. (c)	72. (c)	73. (c)	74. (c)	75. (a)					