Physics

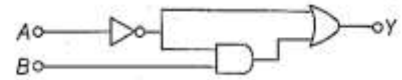
1. Consider three vectors $A = \hat{\imath} + \hat{\jmath} - 2\hat{k}$, $B = \hat{\imath} - \hat{\jmath} + \hat{k}$ and $C = 2\hat{\imath} - 3\hat{\jmath} + 4\hat{k}$. A vector X of the form $\alpha A + \beta B$ (α and β are numbers) is perpendicular to C. The ratio of α and β is.
(a) $1:1$ (c) $-1:1$
(b) $2:1$ (d) $3:1$

2. Three capacitors 3μ F, 6μ F and 6μ F are connected in series to a source of 120 V . The potential difference, in volt, across the 3μ F capacitor will be.
(a) 24 (b) 30
(c) 40 (d) 60

3. A galvanometer having internal resistance 10Ω requires 0.01 A for a full scale deflection. To convert this galvanometer to a voltmeter of full-scale deflection at 120 V , we need to connect a resistance of
(a) 11990Ω in series
(b) 11990Ω in parallel
(c) 12010Ω in series
(d) 12010Ω in parallel

4. A whistle whose air column is open at both ends has a fundamental frequency of 5100 Hz . If the speed of sound in air is $340\ \mathrm{ms}^{-1}$, the length of the whistle, in cm, is.
(a) $5/3$ (b) $10/3$
(c) 5 (d) $20/3$

5. The output Y of the logic circuit given below is.



(a) $\bar{A} + B$ (b) $\bar{A}$
(c) $(\bar{A} + B) \cdot \bar{A}$ (d) $\overline{(\bar{A} + B)} \cdot A$

6. One mole of an ideal monoatomic gas is heated at a constant pressure from 0°C to 100°C. Then the change in the internal energy of the gas is (Given, $R = 8.32\ \mathrm{J\ mol^{-1}\ K^{-1}}$).
(a) 0.83×10^3 J
(b) 4.6×10^3 J
(c) 2.08×10^3 J
(d) 1.25×10^3 J

7. The ionization energy of hydrogen is 13.6 eV . The energy of the photon released when an electron jumps from the first excited state ($n = 2$) to the ground state of a hydrogen atom is.
(a) 3.4 eV (b) 4.53 eV
(c) 10.2 eV (d) 13.6 eV

8. A parallel plate capacitor is charged and then disconnected from the charging battery. If the plates are now moved farther apart by pulling at them by means of insulating handles, then.
(a) the energy stored in the capacitor decreases
(b) the capacitance of the capacitor increases
(c) the charge on the capacitor decreases
(d) the voltage across the capacitor increases

9. When a particle executing SHM oscillates with a frequency v, then the kinetic energy of the Particle.
(a) changes periodically with a frequency of v
(b) changes periodically with a frequency of $2v$
(c) changes periodically with a frequency of $v/2$
(d) remains constant

10. In which of the following pairs, the two physical quantities have different dimensions?
(a) Planck's constant and angular momentum
(b) Impulse and linear momentum
(c) Moment of inertia and moment of a force
(d) Energy and torque

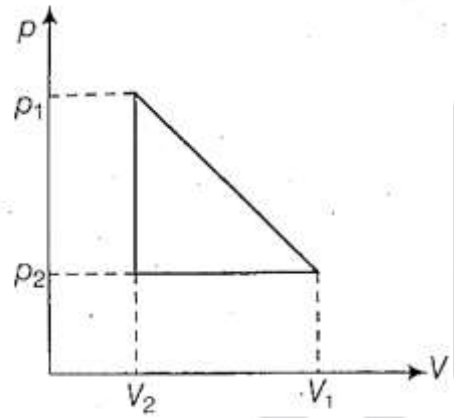
11. A cricket ball thrown across a field is at heights h_1 and h_2 from the point of projection at times t_1 and t_2 respectively after the throw. The ball is caught by a fielder at the same height as that of projection. The time of flight of the ball in this journey is.

(a) $\frac{h_1t_2^2-h_2t_1^2}{h_1t_2-h_2t_1}$ (b) $\frac{h_1t_1^2+h_2t_2^2}{h_2t_1+h_1t_2}$
(c) $\frac{h_1t_2^2+h_2t_1^2}{h_1t_2+h_2t_1}$ (d) $\frac{h_1t_1^2-h_2t_2^2}{h_1t_1-h_2t_2}$

12. A small metal sphere of radius a is falling with a velocity v through a vertical column of a viscous liquid. If the coefficient of viscosity of the liquid is η, then the sphere encounters an opposing force of.
(a) $6\pi\eta a^2 v$ (b) $\frac{6\eta v}{\pi a}$
(c) $6\pi\eta a v$ (d) $\frac{\pi\eta v}{6a^3}$

13. A scientist proposes a new temperature scale in which the ice point is 25 X (X is the new unit of temperature) and the steam point is 305 X . The specific heat capacity of water in this new scale is (in $\text{Jkg}^{-1}\text{X}^{-1}$).
(a) 4.2×10^3 (b) 3.0×10^3
(c) 1.2×10^3 (d) 1.5×10^3

14. One mole of a van der Waals' gas obeying the equation $\left(p+\frac{a}{V^2}\right)(V-b)=RT$ undergoes the quasi-static cyclic process which is shown in the $p-V$ diagram. The net heat absorbed by the gas in this process is.



(a) $\frac{1}{2}(p_1-p_2)(V_1-V_2)$
(b) $\frac{1}{2}(p_1+p_2)(V_1-V_2)$
(c) $\frac{1}{2}\left(p_1+\frac{a}{V_1^2}-p_2-\frac{a}{V_2^2}\right)(V_1-V_2)$
(d) $\frac{1}{2}\left(p_1+\frac{a}{V_1^2}+p_2+\frac{a}{V_2^2}\right)(V_1-V_2)$

15. A wooden block is floating on water kept in a beaker. 40% of the block is above the water surface. Now the beaker is kept inside a lift that starts going upward with acceleration equal to $g/2$. The block will then
(a) sink
(b) float with 10% above the water surface
(c) float with 40% above the water surface
(d) float with 70% above the water surface

16. A smooth massless string passes over a smooth fixed pulley. Two masses m_1 and $m_2, (m_1>m_2)$ are tied at the two ends of the string. The masses are allowed to move under gravity starting from rest. The total external force acting on the two masses is.
(a) $(m_1+m_2)g$ (b) $\frac{(m_1-m_2)^2}{m_1+m_2}g$
(c) $(m_1-m_2)g$ (d) $\frac{(m_1+m_2)^2}{m_1-m_2}g$

17. To determine the coefficient of friction between a rough surface and a block, the surface is kept inclined at 45° and the block is released from rest. The block takes a time t in moving a distance d. The rough surface is then replaced by a smooth surface and the same experiment is repeated. The block now takes a time $t/2$ in moving down the same distance d. The coefficient of friction is.
(a) ¾ (b) 5/4
(c) ½ (d) $1/\sqrt{2}$

18. A metal rod is fixed rigidly at two ends so as to prevent its thermal expansion. If L, α and Y respectively denote the length of the rod, coefficient of linear thermal expansion and Young's modulus of its material, then for an increase in temperature of the rod by ΔT, the longitudinal stress developed in the rod is.
(a) inversely proportional to α
(b) inversely proportional to Y
(c) directly proportional to $\Delta T/Y$
(d) independent of L

19. A particle is moving uniformly in a circular path of radius r. When it moves through an angular displacement θ, then the magnitude of the corresponding linear displacement will be.
(a) $2r\cos\left(\frac{\theta}{2}\right)$ (b) $2r\cot\left(\frac{\theta}{2}\right)$
(c) $2r\tan\left(\frac{\theta}{2}\right)$ (d) $2r\sin\left(\frac{\theta}{2}\right)$

20. A uniform rod is suspended horizontally from its mid-point. A piece of metal whose weight is w is suspended at a distance l from the mid-point. Another weight W_1 is suspended on the other side at a distance l_1 from the mid-point to bring the rod to a horizontal position. When w is completely immersed in water, w_1 needs to be kept at a distance l_2 from the mid-point to get the rod back into horizontal position. The specific gravity of the metal piece is.
(a) $\frac{w}{w_1}$ (b) $\frac{wl_1}{wl-w_1l_2}$
(c) $\frac{4}{4-l_2}$ (d) $\frac{l_1}{l_2}$.

21. A drop of some liquid of volume $0.04\ \text{cm}^3$ is placed on the surface of a glass slide. Then another glass slide is placed on it in such a way that the liquid forms a thin layer of area $20\ \text{cm}^2$ between the surfaces of the two slides. To separate the slides a force of 16×10^5 dyne has to be applied normal to the surfaces. The surface tension of the liquid is (in dyne $-\text{cm}^{-1}$).
(a) 60 (b) 70
(c) 80 (d) 90

22. An electron in a circular orbit of radius 0.05 nm performs 10^{16} revolutions per second. The magnetic moment due to this rotation of electron is (in Am ^{2})
(a) 2.16×10^{-23}
(b) 3.21×10^{-22}
(c) 3.21×10^{-24}
(d) 1.26×10^{-23}

23. A very small circular loop of radius a is initially (at $t = 0$) coplanar and concentric with a much larger fixed circular loop of radius b. A constant current I flows in the larger loop. The smaller loop is rotated with a constant angular speed ω about the common diameter. The emf induced in the smaller loop as a function of time t is.
(a) $\frac{\pi a^2\mu_0 l}{2b}\omega\cos(\omega t)$ (b) $\frac{\pi a^2\mu_0 l}{2b}\omega\sin(\omega^2 t^2)$
(c) $\frac{\pi a^2\mu_0 l}{2b}\omega\sin(\omega t)$ (d) $\frac{\pi a^2\mu_0 l}{2b}\omega\sin^2(\omega t)$

24. A luminous object is separated from a screen by distance d. A convex lens is placed between the object and the screen such that it forms a distinct image on the screen. The maximum possible focal length of this convex lens is.
(a) $4d$ (b) $2d$
(c) $\frac{d}{2}$ (d) $\frac{d}{4}$.

25. An infinite sheet carrying a uniform surface charge density σ lies on the xy-plane. The work done to carry a charge q from the point A $= a(\hat{\imath} + 2\hat{\jmath} + 3\hat{k})$ to the point B $= a(\hat{\imath} - 2\hat{\jmath} + 6\hat{k})$ (where a is a constant with the dimension of length and ε_0 is the permittivity of free space) is.
(a) $\frac{3\sigma aq}{2\varepsilon_0}$ (b) $\frac{2\sigma aq}{\varepsilon_0}$
(c) $\frac{5\sigma aq}{2\varepsilon_0}$ (d) $\frac{3\sigma aq}{\varepsilon_0}$

26. The intensity of magnetization of a bar magnet is $5.0 \times 10^4\text{Am}^{-1}$. The magnetic length and the area of cross-section of the magnet are 12 cm and $1\ \text{cm}^2$ respectively. The magnitude of magnetic moment of this bar magnet is (in SI unit).

(a) 0.6 (b) 1.3
(c) 1.24 (d) 2.4

27. A particle moves with constant acceleration along a straight line starting from rest. The percentage increase in its displacement during the 4 th second compared to that in the 3 rd second is.

(a) 33% (b) 40%
(c) 66% (d) 77%

28. A proton of mass m and charge q is moving in a plane with kinetic energy E. If there exists a uniform magnetic field B, perpendicular to the plane of the motion, the proton will move in a circular path of radius.

(a) $\frac{2Em}{qB}$ (b) $\frac{\sqrt{2Em}}{qB}$
(c) $\frac{\sqrt{Em}}{2qB}$ (d) $\sqrt{\frac{2Eq}{mB}}$

29. An artificial satellite moves in a circular orbit around the earth. Total energy of the satellite is given by E. The potential energy of the satellite is.

(a) $-2E$ (b) $2E$
(c) $\frac{2E}{3}$ (d) $-\frac{2E}{3}$

30. In which of the following phenomena, the heat waves travel along straight lines with the speed of light?

(a) Thermal conduction
(b) Forced convection
(c) Natural convection
(d) Thermal radiation

31. In the bandgap between valence band and conduction band in a material is 5.0 eV , then the material is.

(a) semiconductor
(b) good conductor
(c) superconductor
(d) insulator

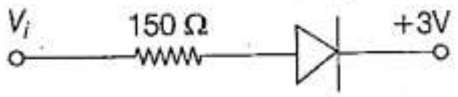
32. A uniform solid spherical ball is rolling down a smooth inclined plane from a height h. The velocity attained by the ball when it reaches the bottom of the inclined plane is v. If the ball is now thrown vertically upwards with the same velocity v, the maximum height to which the ball will rise is.

(a) $\frac{5h}{8}$ (b) $\frac{3h}{5}$
(c) $\frac{5h}{7}$ (d) $\frac{7h}{9}$

33. Two coherent monochromatic beams of intensities I and $4I$ respectively are superposed. The maximum and minimum intensities in the resulting pattern are.

(a) 5/ and 3/
(b) 9/ and 3/
(c) $4I$ and /
(d) 9/ and /

34. In the circuit shown assume the diode to be ideal. When V_i increases from 2 V to 6 V , the change in the current is (in mA).



(a) zero (b) 20
(c) 80/3 (d) 40

35. If n denotes a positive integer, h the Planck's constant, q the charge and B the magnetic field, then the quantity $\left[\frac{nh}{2\pi qB}\right]$ has the dimension of.

(a) area (b) length
(c) speed (d) acceleration

36. In a transistor output characteristics commonly used in common emitter configuration, the

base current I_B, the collector current I_C and the collector-emitter voltage V_{CE} have values of the following orders of magnitude in the active region.

(a) I_B and I_C both are in μA and V_{CE} in volt
(b) I_B is in μA and I_C is in mA and V_{CE} in volt
(c) I_B is in mA and I_C is in μA and V_{CE} in mV
(d) I_B is in mA and I_C is in mA and V_{CE} in mV

37. The displacement of a particle in a periodic motion is given by $y = 4\cos^2\left(\frac{t}{2}\right)\sin(1000t)$. This displacement may be considered as the result of superposition of n independent. harmonic oscillations. Here n is.

(a) 1 (b) 2
(c) 3 (d) 4

38. Consider a black body radiation in a cubical box at absolute temperature T. If the length of each side of the box is doubled and the temperature of the walls of the box and that of the radiation is halved, then the total energy.

(a) halves
(b) doubles
(c) quadruples
(d) remains the same

39. Consider two concentric spherical metal shells of radii r_1 and $r_2 (r_2 > r_1)$. If the outer shell has a charge q and the inner one is grounded, the charge on the inner shell is.

(a) $\frac{-r_2}{r_1} q$ (b) zero
(c) $\frac{-r_1}{r_2} q$ (d) $-q$

40. Four cells, each of emf E and internal resistance r, are connected in series across an external resistance R. By mistake one of the cells is connected in reverse. Then the current in the external circuit is.

(a) $\frac{2E}{4r+R}$ (b) $\frac{3E}{4r+R}$
(c) $\frac{3E}{3r+R}$ (d) $\frac{2E}{3r+R}$

41. Same quantity of ice is filled in each of the two metal containers P and Q having the same size, shape and wall thickness but made of different materials. The containers are kept in identical surroundings. The ice in P melts completely in time t_1 whereas in Q takes a time t_2. The ratio of thermal conductivities of the materials of P and Q is.

(a) $t_2 : t_1$ (b) $t_1 : t_2$
(c) $t_1^2 : t_2^2$ (d) $t_2^2 : t_1^2$

42. For the radioactive nuclei that undergo either α or β decay, which one of the following cannot occur?

(a) Isobar of original nucleus is produced
(b) Isotope of the original nucleus is produced
(c) Nuclei with higher atomic number than that of the original nucleus is produced
(d) Nuclei with lower atomic number than that of the original nucleus is produced

43. A car is moving with a speed of 72 $\text{km} - \text{h}^{-1}$ towards a roadside source that emits sound at a frequency of 850 Hz . The car driver listens to the sound while approaching the source and again while moving away from the source after crossing it. If the velocity of sound is 340 ms^{-1}, the difference of the two frequencies, the driver hears is.

(a) 50 Hz (b) 85 Hz
(c) 100 Hz (d) 150 Hz

44. The energy of gamma (γ) ray photon is E_γ and that of an X-ray photon is E_X. If the visible light photon has an energy of E_v, then we can say that.

(a) $E_X > E_\gamma > E_v$
(b) $E_\gamma > E_v > E_x$
(c) $E_\gamma > E_X > E_v$
(d) $E_X > E_V > E_\gamma$

45. The intermediate image formed by the objective of a compound microscope is.

(a) real, inverted and magnified
(b) real, erect and magnified
(c) virtual, erect and magnified
(d) virtual, inverted and magnified

46.A solid uniform sphere resting on a rough horizontal plane is given a horizontal impulse directed through its centre so that it starts sliding with an initial velocity v_0. When it finally starts rolling without slipping the speed of its centre is

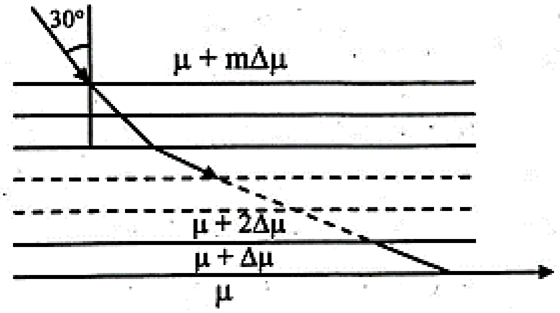
(a) $\frac{2}{7}v_0$ (b) $\frac{3}{7}v_0$
(c) $\frac{5}{7}v_0$ (d) $\frac{6}{7}v_0$

47. The de-Broglie wavelength of an electron is the same as that of a 50 keV X-ray photon. The ratio of the energy of the photon to the kinetic energy of the electron is (the energy equivalent of electron mass is 0.5 MeV).

(a) $1:50$ (b) $1:20$
(c) $20:1$ (d) $50:1$

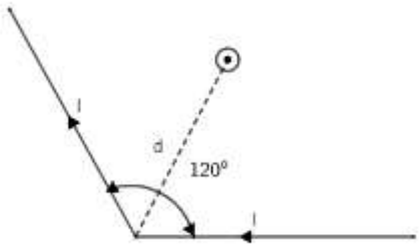
48. A glass slab consists of thin uniform layers of progressively decreasing refractive indices RI (see figure) such that the RI of any layer is $\mu - m\Delta\mu$. Here, μ and $\Delta\mu$ denote the RI of 0th layer and the difference in RI between any two consecutive layers, respectively. The integer $m = 0, 1, 2, 3, \ldots$ denotes the numbers of the successive layers.

A ray of light from the 0th layer enters the 1st layer at an angle of incidence of 30°. After undergoing the m th refraction, the ray emerges parallel to the interface. If $\mu = 1.5$ and $\Delta\mu = 0.015$, the value of m is



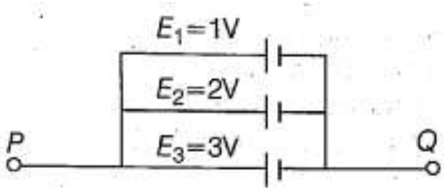
(a) 20 (b) 30
(c) 40 (d) 50

49. A long conducting wire carrying a current I is bent at 120° (see figure). The magnetic field B at a point P on the right bisector of bending angle at a distance d from the bend is (μ_0 is the permeability of free space).



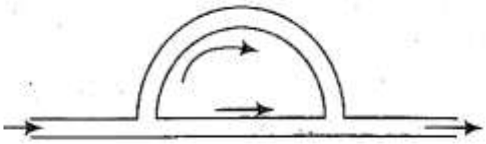
(a) $\frac{3\mu_0 I}{2\pi d}$ (b) $\frac{\mu_0 I}{2\pi d}$
(c) $\frac{\mu_0 I}{\sqrt{3}\pi d}$ (d) $\frac{\sqrt{3}\mu_0 I}{2\pi d}$

50. A circuit consists of three batteries of emf $E_1 = 1$ V, $E_2 = 2$ V and $E_3 = 3$ V and internal resistances 1Ω, 2Ω and 1Ω respectively which are connected in parallel as shown in the figure. The potential difference between points P and Q is.



(a) 1.0 V (b) 2.0 V
(c) 2.2 V (d) 3.0 V

51. Sound waves are passing through two routes-one in straight path and the other along a semicircular path of radius r and are again combined into one pipe and superposed as shown in the figure. If the velocity of sound waves in the pipe is v, then frequencies of resultant waves of maximum amplitude will be integral multiples of.



(a) $\frac{V}{r(\pi-2)}$ (b) $\frac{V}{r(\pi-1)}$
(c) $\frac{2v}{r(\pi-1)}$ (d) $\frac{V}{r(\pi+1)}$

52. To determine the composition of a bimetallic alloy, a sample is first weighed in air and then in water. These weights are found to be w_1 and w_2 respectively. If the densities of the two constituents metals are ρ_1 and ρ_2 respectively, then the weight of the first metal in the sample is (where ρ_w is the density of water).

(a) $\frac{\rho_1}{\rho_w(\rho_2-\rho_1)}[w_1(\rho_2-\rho_w)-w_2\rho_2]$
(b) $\frac{\rho_1}{\rho_w(\rho_2+\rho_1)}[w_1(\rho_2-\rho_w)+w_2\rho_2]$
(c) $\frac{\rho_1}{\rho_w(\rho_2-\rho_1)}[w_1(\rho_2+\rho_w)-w_2\rho_1]$
(d) $\frac{\rho_1}{\rho_w(\rho_2-\rho_1)}[w_1(\rho_1-\rho_w)-w_2\rho_1]$

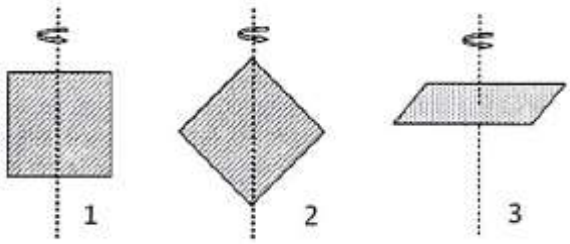
53. A 10 W electric heater is used to heat a container filled with 0.5 kg of water. It is found that the temperature of water and the container rises by 3°K in 15 min . The container is then emptied, dried and filled with 2 kg of oil. The same heater now raises the temperature of container-oil system by 2°K in 20 min . Assuming that there is no heat loss in the process and the specific heat of water is $4200 \text{ J kg}^{-1} \text{ K}^{-1}$, the specific heat of oil in the same unit is equal to

(a) 1.50×10^3 (b) 2.55×10^3
(c) 3.00×10^3 (d) 5.10×10^3

54. An object is placed 30 cm away from a convex lens of focal length 10 cm and a sharp image is formed on a screen. Now a concave lens is placed in contact with the convex lens. The screen now has to be moved by 45 cm to get a sharp image again. The magnitude of focal length of the concave lens is (in cm).

(a) 72 (b) 60
(c) 36 (d) 20

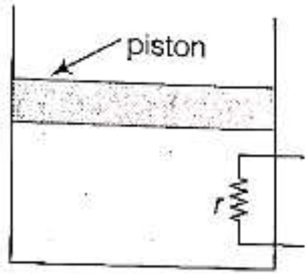
55. Three identical square plates rotate about the axes shown in the figure in such a way that their kinetic energies are equal. Each of the rotation axes passes through the centre of the square. Then the ratio of angular speeds $\omega_1 : \omega_2 : \omega_3$ is.'



(a) $1:1:1$ (b) $\sqrt{2}:\sqrt{2}:1$
(c) $1:\sqrt{2}:1$ (d) $1:2:\sqrt{2}$

56. A heating element of resistance r is fitted inside an adiabatic cylinder which carries a frictionless piston of mass m and cross-section A as shown in diagram. The cylinder contains one mole of an ideal diatomic gas. The current flows through the element such that the temperatures rises with

time t as $\Delta T = \alpha t + \frac{1}{2}\beta t^2$ (α and β are constants), while pressure remains constant. The atmospheric pressure above the piston is P_0. Then.



(a) the rate of increase in internal energy is $\frac{5}{2}R(\alpha + \beta t)$

(b) the current flowing in the element is $\sqrt{\frac{5}{2r}R(\alpha + \beta t)}$

(c) the piston moves upwards with constant acceleration

(d) the piston moves upwards with constant speed

57. A thin rod AB is held horizontally so that it can freely rotate in a vertical plane about the end A as shown in the figure. The potential energy of the rod when it hangs vertically is taken to be zero. The end B of the rod is released from rest from a horizontal position. At the instant the rod makes an angle θ with the horizontal.

(a) the speed of end B is proportional to $\sqrt{\sin\theta}$

(b) the potential energy is proportional to $(1 - \cos\theta)$

(c) the angular acceleration is proportional to $\cos\theta$

(d) the torque about A remains the same as its initial value

58. Find the correct statement(s) photoelectric effect.

(a) There is no significant time delay between the about absorption of a suitable radiation and the emission of electrons

(b) Einstein analysis gives a threshold frequency above which no electron can be emitted

(c) The maximum kinetic energy of the emitted photoelectrons is proportional to the frequency of incident radiation

(d) The maximum kinetic energy of electrons does not depend on the intensity of radiation

59. Half of the space between the plates of a parallel-plate capacitor is filled with a dielectric material of dielectric constant K. The remaining half contains air as shown in the figure. The capacitor is now given a charge Q. Then

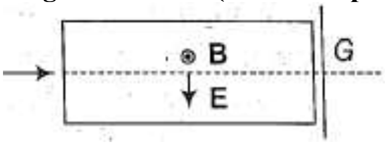
(a) electric field in the dielectric-filled region is higher than that in the air-filled region

(b) on the two halves of the bottom plate the charge densities are unequal

(c) charge on the half of the top plate above the air-filled part is $\frac{Q}{K+1}$

(d) capacitance of the capacitor shown above is $(1 + K)\frac{C_0}{2}$, where C_0 is the capacitance of the same capacitor with the dielectric removed.

60. A stream of electrons and protons are directed towards a narrow slit in a screen (see figure). The intervening region has a uniform electric field $\mathbf{E}$ (vertically downwards) and a uniform magnetic field $\mathbf{B}$ (out of the plane of the figure) as shown. Then.



(a) electrons and protons with speed $\frac{|E|}{|B|}$ will pass through the slit

(b) protons with speed $|E|/|B|$ will pass through the slit, electrons of the same speed will not

(c) neither electrons nor protons will go through the slit irrespective of their speed

(d) electrons will always be deflected upwards irrespective of their speed

CHEMISTRY

61. The emission spectrum of hydrogen discovered first and the region of the electromagnetic spectrum in which it belongs, respectively are.

(a) Lyman, ultraviolet

(b) Lyman, visible
(c) Balmer, ultraviolet
(d) Balmer, visible

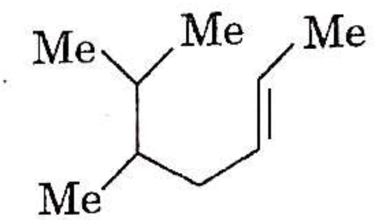
62. The electronic configuration of Cu is.
(a) $[\mathrm{Ne}] 3s^2, 3p^6, 3d^9, 4s^2$
(b) $[\mathrm{Ne}] 3s^2, 3p^6, 3d^{10}, 4s^1$
(c) $[\mathrm{Ne}] 3s^2, 3p^6, 3d^3, 4s^2, 4p^6$
(d) $[\mathrm{Ne}] 3s^2, 3p^6, 3d^5, 4s^2, 4p^4$

63. As per de-Broglie's formula a macroscopic particle of mass 100 g and moving at a velocity of 100 cm s^{-1} will have a wavelength of .
(a) 6.6×10^{-29} cm
(b) 6.6×10^{-30} cm
(c) 6.6×10^{-31} cm
(d) 6.6×10^{-32} cm

64. For one mole of an ideal gas, the slope of V vs. T curve at constant pressure of 2 atm is X L mol^{-1} K^{-1}. The value of the ideal universal gas constant ' R ' in terms of X is.
(a) X L atm mol^{-1} K^{-1}
(b) $\frac{X}{2}$ L atm mol^{-1} K^{-1}
(c) $2 \times$ Latmmol^{-1} K^{-1}
(d) $2 \times$ atmL^{-1} mol^{-1} K^{-1}

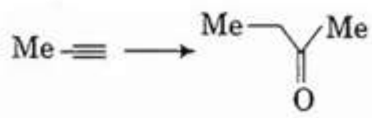
65. At a certain temperature the time required for the complete diffusion of 200 mL of H_2 gas is 30 min . The time required for the complete diffusion of 50 mL of O_2 gas at the same temperature will be.
(a) 60 min (b) 30 min
(c) 45 min (d) 15 min

66. The IUPAC name of the following molecule is



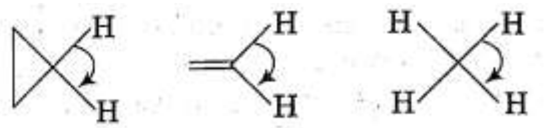
(a) 5,6-dimethylhept-2-ene
(b) 2,3-dimethylhept-5-ene
(c) 5,6-dimethylhept-3-ene
(d) 5-iso-propylhex-2-ene

67. The reagents to carry out the following conversion are



(a) $HgSO_4$/dil $\cdot$ H_2SO_4
(b) BH_3; H_2O_2/NaOH
(c) OsO_4; HIO_4
(d) $NaNH_2/CH_3$ l; $HgSO_4$/ dil $\cdot$ H_2SO_4

68. The correct order of decreasing H $-$ C $-$ H angle in the following molecule is.



I II III

(a) I > II > III (b) II > I > III
(c) III > II > I (d) I > III > II

69. During the emission of a positron from a nucleus, the mass number of the daughter element

remains the same but the atomic number.

(a) is decreased by 1 unit
(b) is decreased by 2 units
(c) is increased by 1 unit
(d) remains unchanged

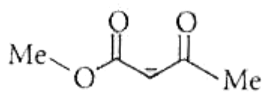
70. β-emission is always accompanied by

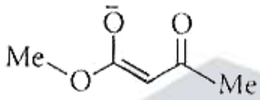
(a) formation of antineutrino and α-particle
(b) emission of α-particle and γ-ray
(c) formation of antineutrino and γ-ray
(d) formation of antineutrino and positron

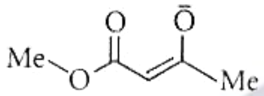
71. Four gases P, Q, R and S have almost same values of ' b ' but their ' a ' values (a, b are van der Waals' constants) are in the order $Q < R < S < P$. At a particular temperature, among the four gases, the most easily liquefiable one is.

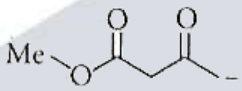
(a) P (b) Q
(c) R (d) S

72. Among the following structures the one which is not a resonating structure of others is.


I

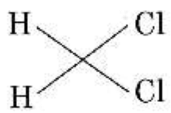

II

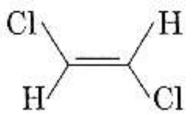

III

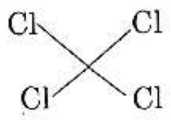

IV

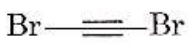
(a) I (b) II
(c) III (d) IV

73. The compound that will have a permanent dipole moment among the following is.


I

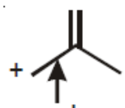

II

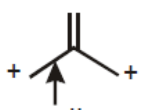

III

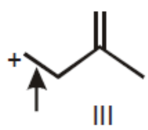

IV

(a) 1 (b) II
(c) III (d) IV

74. The correct order of decreasing length of the bond as indicated by the arrow in the following structures is.


I


II


III

(a) I > II > III
(b) II > I > III
(c) III > II > I
(d) I > III > II

75. An atomic nucleus having low n/p ratio tries to find stability by

(a) the emission of an α-particle
(b) the emission of a positron

(c) capturing an orbital electron (K-electron capture)
(d) emission of a β-particle

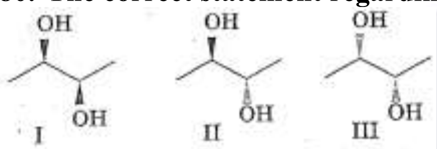
76. $\left({}_{32}Ge^{76}, {}_{34}Se^{76}\right)$ **and** $\left({}_{14}Si^{30}, {}_{16}S^{32}\right)$ **are examples of**
(a) isotopes and isobars
(b) isobars and isotones
(c) isotones and isotopes
(d) isobars and isotopes

77. ${}_{98}Cf^{246}$ **was formed along with a neutron when an unknown radioactive substance was bombarded with** ${}_{6}C^{12}$**. The unknown substance was.**
(a) ${}_{91}Pa^{234}$ (b) ${}_{90}Th^{234}$
(c) ${}_{92}U^{235}$ (d) ${}_{92}U^{238}$

78. The rate of a certain reaction is given by, rate $= k[H^+]^n$.
The rate increases 100 times when the pH changes from 3 to 1 . The order (n) of the reaction is.
(a) 2 (b) 0
(c) 1 (d) 1.5

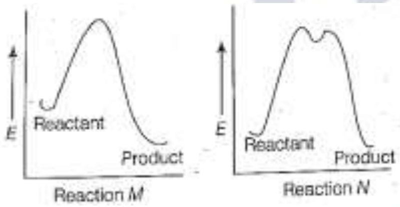
79. The values of ΔH and ΔS of a certain reaction are $-400\ kJ\ mol^{-1}$ and $-20\ kJ\ mol^{-1}\ K^{-1}$ respectively. The temperature below which the reaction is spontaneous, is.
(a) 100 K (b) 20°C
(c) 20 K (d) 120°C

80. The correct statement regarding the following compounds is.



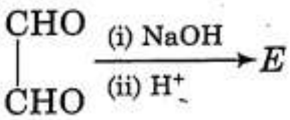
(a) all three compounds are chiral
(b) only I and II are chiral
(c) I and III are diastereomers
(d) only I and III are chiral

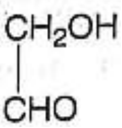
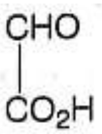
81. The correct statement regarding the following energy diagrams is.

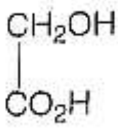
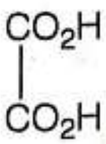


(a) Reaction M is faster and less exothermic than reaction N
(b) Reaction M is slower and less exothermic than reaction N
(c) Reaction M is faster and more exothermic than reaction N
(d) Reaction M is slower and more exothermic than reaction N

82. In the following reaction, the product E is.



(a)  (b) 

(c)  (d) 

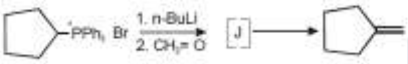
83. If Cl_2 is passed through hot aqueous NaOH , the products formed have Cl in different oxidation states. These are indicated as.
(a) -1 and +1

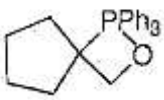
(b) -1 and +5
(c) +1 and +5
(d) -1 and +3

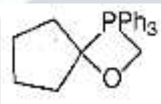
84. Commercial sample of H_2O_2 is labeled as 10 V . Its % strength is nearly.
(a) 3 (b) 6
(c) 9 (d) 12

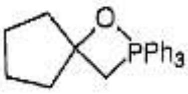
85. The enthalpy of vaporisation of a certain liquid at its boiling point of $35^\circ C$ is $24.64\ kJ\ mol^{-1}$. The value of change in entropy for the process is.
(a) $704 JK^{-1}\ mol^{-1}$
(b) $80 JK^{-1}\ mol^{-1}$
(c) $24.64 JK^{-1}\ mol^{-1}$
(d) $7.04 JK^{-1}\ mol^{-1}$

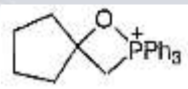
86. Given that
$C + O_2 \longrightarrow CO_2; \Delta H^\circ = -x$ kJ
$2CO + O_2 \longrightarrow 2CO_2; \Delta H^\circ = -y$ kJ
The heat of formation of carbon monoxide will be
(a) $\frac{y-2x}{2}$ (b) $y + 2x$
(c) $2x - y$ (d) $\frac{2x-y}{2}$

87. The intermediate J in the following Wittig reaction is.


(a) 

(b) 

(c) 

(d) 

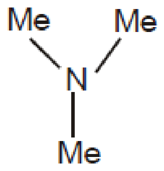
88. Among the following compounds, the one(s) that gives (give) effervescence with aqueous $NaHCO_3$ solution is (are)
$(CH_3CO)_2O$ CH_3COOH PhOH CH_3COCHO
I II III IV
(a) I and II
(b) I and III
(c) Only II
(d) I and IV

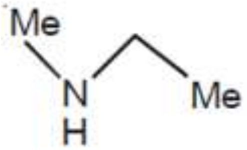
89. The 4th higher homologue of ethane is.
(a) butane (b) pentane
(c) hexane (d) heptane

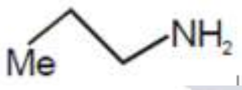
90. In case of heteronuclear diatomics of the type AB, where A is more electronegative than B, bonding molecular orbital resembles the character of A more than that of B. The statement
(a) is false
(b) is true
(c) cannot be evaluated since data is not sufficient.
(d) is true only for certain systems

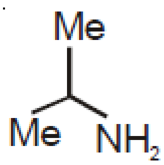
91. The hydrides of the first elements in groups 15-17, namely NH_3, H_2O and HF respectively show abnormally high values for melting and boiling points. This is due to.
(a) small size of N, O and F
(b) the ability to form extensive intermolecular H-bonding
(c) the ability to form extensive intramolecular H-bonding
(d) effective van der Waals' Interaction

92. The quantity of electricity needed to separately electrolyze 1 M solution of $ZnSO_n$, $AlCl_3$ and $AgNO_3$ completely is in the ratio of.
(a) 2: 3: 1 (b) 2: 1: 1
(c) 2: 1: 3 (d) 2: 2: 1

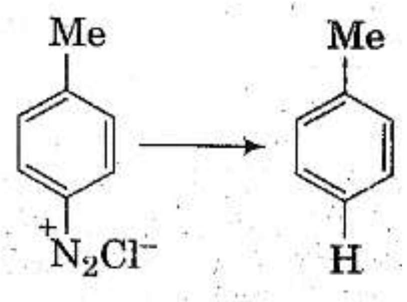
93. The amount of electrolytes required to coagulate a given amount of AgI colloidal solution (-ve charge) will be in the order.
(a) $NaNO_3 > Al_2(NO_3)_3 > Ba(NO_3)_2$
(b) $Al_2(NO_3)_3 > Ba(NO_3)_2 > NaNO_3$
(c) $Al_2(NO_3)_3 > NaNO_3 > Ba(NO_3)_2$
(d) $NaNO_3 > Ba(NO_3)_2 > Al_2(NO_3)_3$
94. The value of ΔH for cooling 2 mole of an ideal monoatomic gas from 225°C to 125°C at constant pressure will be [given $C_p = \frac{5}{2}R$].
(a) $250R$ (b) $-500R$
(c) $500R$ (d) $-250R$
95. An amine C_3H_9 N reacts with benzene sulphonyl chloride to form a white precipitate which is insoluble in aq. NaOH. The amine is.
(a) 

(b) 

(c) 

(b) 

96. The number of amino acids and number of peptide bonds in a linear tetrapeptide (made of different amino acids) are respectively.
(a) 4 and 4
(b) 5 and 5
(c) 5 and 4
(d) 4 and 3
97. Among the following, the one which is not a "green house gas", is
(a) N_2O (b) CO_2
(c) CH_4 (d) O_2
98. The pH of 10^{-4}MKOH solution will be.
(a) 4 (b) 11
(c) 10.5 (d) 10
99. The system that contains the maximum number of atoms is.
(a) 4.25 g of NH_3
(b) 8 g of O_2
(c) 2 g of H_2
(d) 4 g of He
100. Among the following observations, the correct one that differentiates between SO_3^{2-} and SO_4^{2-} is.
(a) both form precipitate with $BaCl_2, SO_3^{2-}$ dissolves in HCl but SO_4^{2-} does not
(b) SO_3^{2-} forms precipitate with $BaCl_2, SO_4^{2-}$ does not
(c) SO_4^{2-} forms precipitate with $BaCl_2, SO_3^{2-}$ does not
(d) both form precipitate with $BaCl_2, SO_4^{2-}$ dissolves in HCl but SO_3^{2-} does not
101. Metal ion responsible for the Minimata disease is.
(a) Co^{2+} (b) Hg^{2+}
(c) Cu^{2+} (d) Zn^{2+}
102. The reagent with which the following reaction is best accomplished is



(a) H_3PO_2 (b) H_3PO_3
(c) H_3PO_4 (d) $NaHSO_3$

103. In DNA, the consecutive deoxynucleotides are connected via.

(a) phosphodiester linkage
(b) phosphomonoester linkage
(c) phosphotriester linkage
(d) amide linkage

104. The reaction of aniline with chloroform under alkaline conditions leads to the formation of

(a) phenylcyanide
(b) phenylisonitrile
(c) phenylcyanate
(d) phenylisocyanate

105. The two half-cell reactions of an electrochemical cell is given as

$\mathbf{Ag^+ + e^- \longrightarrow Ag;\ E^\circ_{Ag^+/Ag} = -0.3995\ V}$

$\mathbf{Fe^{2+} \longrightarrow Fe^{3+} + e^-;\ E^\circ_{Fe^{3+}/Fe^{2+}} = -0.7120\ V}$

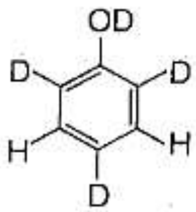
The value of cell EMF will be

(a) -0.3125 V
(b) 0.3125 V
(c) 1.114 V
(d) -1.114 V

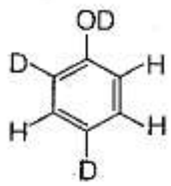
106. The compressibility factor (Z) of one mole of a van der Waals' gas of negligible ' a ' value is.

(a) 1 (b) $\frac{bp}{RT}$
(c) $1 + \frac{bp}{RT}$ (d) $1 - \frac{bp}{RT}$

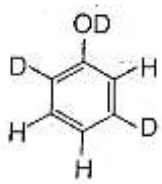
107. When phenol is treated with D_2SO_4/D_2O, some of the hydrogens get exchanged. The final product in this exchange reaction is.



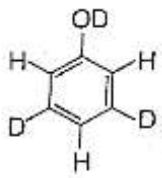
(a)



(b)

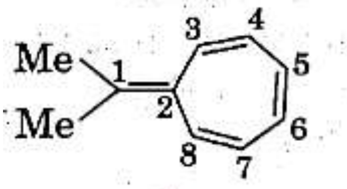


(c)



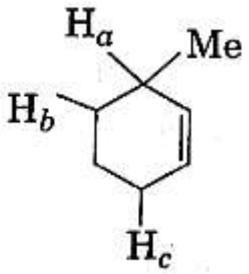
(d)

108. The most likely protonation site in the following molecule is.



(a) C-1 (b) C-2
(c) C – 3 (d) C-6

109. The order of decreasing ease of abstraction of hydrogen atoms in the following molecule.



(a) $H_a > H_b > H_c$
(b) $H_a > H_c > H_b$
(c) $H_b > H_a > H_c$
(d) $H_c > H_b > H_a$

110. At 25°C, the molar conductance of 0.007 M hydrofluoric acid is $150 \mathrm{mhocm}^2 \mathrm{~mol}^{-1}$ and its $\Lambda_m^{\circ} = 500 \mathrm{mhocm}^2 \mathrm{~mol}^{-1}$. The value of the dissociation constant of the acid at the given concentration at 25°C is
(a) 7×10^{-4}M
(b) 7×10^{-5}M
(c) 9×10^{-3}M
(d) 9×10^{-4}M

111. To observe an elevation of boiling point of 0.05°C, the amount of a solute (mol. wt. = 100) to be added to 100 g of water ($K_b = 0.5$) is.
(a) 2 g (b) 0.5 g
(c) 1 g (d) 0.75 g

112. The volume of ethyl alcohol (density 1.15 g/cc) that has to be added to prepare 100 cc of 0.5 M ethyl alcohol solution in water is.
(a) 1.15 cc (b) 2 cc
(c) 2.15 cc (d) 2.30 cc

113. The bond angle in NF_3(102.3°) is smaller than NH_3(107.2°). This is because of.
(a) large size of F compared to H
(b) large size of N compared to F
(c) opposite polarity of N in the two molecules
(d) small size of H compared to N

114. A piece of wood from an archaeological sample has 5.0 counts min^{-1} per gram of C-14, while a fresh sample of wood has a count of $15.0 \mathrm{~min}^{-1} \mathrm{~g}^{-1}$. If half-life of C-14 is 5770 yr , the age of the archaeological sample is
(a) 8,500yr (b) 9,200yr
(c) 10,000yr (d) 11,000yr

115. The structure of XeF_6 is experimentally determined to be distorted octahedron. Its structure according to VSEPR theory is.
(a) octahedron
(b) trigonal bipyramid
(c) pentagonal bipyramid
(d) tetragonal bipyramid

116. Two gases X (molecular weight M_X) and Y (molecular weight $M_Y ; M_Y > M_X$) are at the same temperature $T_{\text{in two different}}$ containers. Their root mean square velocities are C_X and C_Y respectively. If the average kinetic energies per molecule of two gases X and Y are E_X and E_Y respectively then

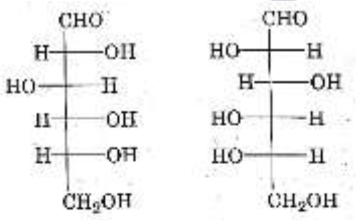
which of the following relation(s) is(are) true?
(a) $E_X > E_Y$
(b) $C_X > C_Y$
(c) $E_X = E_Y = (3/2)RT$
(d) $E_X = E_Y = (3/2)k_B T$

117. For a spontaneous process, the correct statement(s) is (are)
(a) $(\Delta G_{\text{system}})_{T,p} > 0$
(b) $(\Delta S_{\text{system}}) + (\Delta S_{\text{surroundings}}) > 0$
(c) $(\Delta G_{\text{system}})_{T,p} < 0$
(d) $(\Delta U_{\text{system}})_{T,V} > 0$

118. The formal potential of Fe^{3+}/Fe^{2+} in a sulphuric acid and phosphoric acid mixture ($E^\circ = +0.61$ V) is much lower than the standard potential ($E^\circ = +0.77$ V). This is due to.
(a) formation of the species $[FeHPO_4]^+$
(b) lowering of potential upon complexation
(c) formation of the species $[FeSO_4]^+$
(d) high acidity of the medium

119. Cupric compounds are more stable than their cuprous counterparts in solid state. This is Because.
(a) the endothermic character of the 2nd IP of Cu is not so high
(b) size of Cu^{2+} is less than Cu^+
(c) Cu^{2+} has stabler electronic configuration as compared to Cu^+
(d) the lattice energy released for cupric compounds is much higher than Cu^+

120. Among the following statements about the molecules X and Y, the one(s) which correct is(are)



(a) X and Y are diastereomers
(b) X and Y are enantiomers
(c) X and Y are both aldohexoses
(d) X is a D-sügar and Y is an L-sugar

Mathematics

121. The number of solution(s) of the equation $\sqrt{x+1} - \sqrt{x-1} = \sqrt{4x-1}$ is/are
(a) 2 (b) 0
(c) 3 (d) 1

122. The value of $|z|^2 + |z-3|^2 + |z-i|^2$ is minimum when z equals
(a) $2 - \frac{2}{3}i$ (b) $45 + 3i$
(c) $1 + \frac{i}{3}$ (d) $1 - \frac{i}{3}$

123. If $f(x) = \begin{cases} 2x^2+1, & x \le 1 \\ 4x^3-1, & x > 1 \end{cases}$, then $\int_0^2 f(x)dx$ is.
(a) 47/3 (b) 50/3
(c) 1/3 (d) 47/2

124. If $\lim\limits_{x\to 0} \frac{2a\sin x - \sin 2x}{\tan^3 x}$ exists and is equal to 1 , then the value of a is.
(a) 2 (b) 1
(c) 0 (d) -1

125. The solution of the equation

$\log_{101}\log_7(\sqrt{x+7}+\sqrt{x})=0$ **is .**
(a) 3 (b) 7
(c) 9 (d) 49

126. The integrating factor of the differential equation $(1+x^2)\frac{dy}{dx}+y=e^{\tan^{-1}x}$ is.
(a) $\tan^{-1}x$ (b) $1+x^2$
(c) $e^{\tan^{-1}x}$ (d) $\log_e(1+x^2)$

127. If $\sqrt{y}=\cos^{-1}x$, then it satisfies the differential equation $(1-x^2)\frac{d^2y}{dx^2}-x\frac{dy}{dx}=c$, where c is equal to.
(a) 0 (b) 3
(c) (d) 2

128. The number of digits in 20^{301} (given, $\log_{10}2=0.3010$) is.
(a) 602 (b) 301
(c) 392 (d) 391

129. The area of the region bounded by the curves $y=x^2$ and $x=y^2$ is.
(a) 1/3 (b) 1/2
(c) ¼ (d) 3

130. If R be the set of all real numbers and $f:R\to R$ is given by $f(x)=3x^2+1$. Then, the set $f^{-1}([1,6])$ is.
(a) $\left\{-\sqrt{\frac{5}{3}},0,\sqrt{\frac{5}{3}}\right\}$ (b) $\left[-\sqrt{\frac{5}{3}},\sqrt{\frac{5}{3}}\right]$
(c) $\left[-\sqrt{\frac{1}{3}},\sqrt{\frac{1}{3}}\right]$ (d) $\left(-\sqrt{\frac{5}{3}},\sqrt{\frac{5}{3}}\right)$

131. The value of $\tan\frac{\pi}{5}+2\tan\frac{2\pi}{5}+4\cot\frac{4\pi}{5}$ is.
(a) $\cot\frac{\pi}{5}$ (b) $\cot\frac{2\pi}{5}$
(c) $\cot\frac{4\pi}{5}$ (d) $\cot\frac{3\pi}{5}$

132. Let $f(x)$ be a differentiable function in $[2,7]$. If $f(2)=3$ and $f'(x)\le 5$ for all x in $(2,7)$, then the maximum possible value of $f(x)$ at $x=7$ is.
(a) 7 (b) 15
(c) 28 (d) 14

133. Let the number of elements of the sets A and B be p and q, respectively. Then, the number of relations from the set A to the set B is.
(a) 2^{p+q} (b) 2^{pq}
(c) $p+q$ (d) pq

134. In a $\triangle ABC$, $\tan A$ and $\tan B$ are the roots of $pq(x^2+1)=r^2x$. Then, $\triangle ABC$ is.
(a) a right angled triangle
(b) an acute angled triangle
(c) an obtuse angled triangle
(d) an equilateral triangle

135. If $y=4x+3$ is parallel to a tangent to the parabola $y^2=12x$, then its distance from the normal parallel to the given line is.
(a) $\frac{213}{\sqrt{17}}$ (b) $\frac{219}{\sqrt{17}}$
(c) $\frac{211}{\sqrt{17}}$ (d) $\frac{210}{\sqrt{17}}$

136. Let the equation of an ellipse be $\frac{x^2}{144}+\frac{y^2}{25}=1$. Then, the radius of the circle with centre $(0,\sqrt{2})$ and passing through the foci of the ellipse is.
(a) 9 (b) 7
(c) 11 (d) 5

137. The straight lines $x+y=0, 5x+y=4$ and $x+5y=4$ form.
(a) an isosceles triangle
(b) an equilateral triangle

(c) a scalene triangle
(d) a right angled triangle

138. If $\sin^{-1}\left(\frac{x}{13}\right) + \text{cosec}^{-1}\left(\frac{13}{12}\right) = \frac{\pi}{2}$, then the value of x is.
(a) 5 (b) 4
(c) 12 (d) 11

139. The value of λ for which the curve $(7x+5)^2 + (7y+3)^2 = \lambda^2(4x+3y-24)^2$ represents a parabola is.
(a) $\pm\frac{6}{5}$ (b) $\pm\frac{7}{5}$
(c) $\pm\frac{1}{5}$ (d) $\pm\frac{2}{5}$

140. Let $f(x) = x + 1/2$. Then, the number of real values of x for which the three unequal terms $f(x), f(2x), f(4x)$ are in HP is.
(a) 1 (b) 0
(c) 3 (d) 2

141. Let $f(x) = 2x^2 + 5x + 1$. If we write $f(x)$ as $f(x) = a(x+1)(x-2) + b(x-2)(x-1) + c(x-1)(x+1)$ for real numbers a, b, c, then
(a) there are infinite number of choices for a, b, c
(b) only one choice for a but infinite number of choices for b and c
(c) exactly one choice for each of a, b, c
(d) more than one but finite number of choices for a, b, c

142. If α, β are the roots of $ax^2 + bx + c = 0 (a \neq 0)$ and $\alpha + h; \beta + h$ are the roots of $px^2 + qx + r = 0$ $(p \neq 0)$, then the ratio of the squares of their discriminants is
(a) $a^2 : p^2$
(b) $a : p^2$
(c) $a^2 : p$
(d) $a : 2p$

143. Let p, q be real numbers. If α is the root of $x^2 + 3p^2x + 5q^2 = 0, \beta$ is a root of $x^2 + 9p^2x + 15q^2 = 0$ and $0 < \alpha < \beta$, then the equation $x^2 + 6p^2x + 10q^2 = 0$ has a root γ that always satisfies.
(a) $\gamma = \frac{\alpha}{4} + \beta$
(b) $\beta < \gamma$
(c) $\gamma = \frac{\alpha}{2} + \beta$
(d) $\alpha < \gamma < \beta$

144. The equation of the common tangent with positive slope to the parabola $y^2 = 8\sqrt{3}x$ and the hyperbola $4x^2 - y^2 = 4$ is.
(a) $y = \sqrt{6}x + \sqrt{2}$
(b) $y = \sqrt{6}x - \sqrt{2}$
(c) $y = \sqrt{3}x + \sqrt{2}$
(d) $y = \sqrt{3}x - \sqrt{2}$

145. The point on the parabola $y^2 = 64x$ which is nearest to the line $4x + 3y + 35 = 0$ has Coordinates.
(a) $(9, -24)$
(b) $(1, 81)$
(c) $(4, -16)$
(d) $(-9, -24)$

146. Let z_1, z_2 be two fixed complex numbers in the argand plane and z be an arbitrary point satisfying $|z - z_1| + |z - z_2| = 2|z_1 - z_2|$. Then, the locus of z will be.
(a) an ellipse
(b) a straight line joining z_1 and z_2
(c) a parabola
(d) a bisector of the line segment joining z_1 and z_2

147. The function $f(x) = \frac{\tan\left\{\pi\left[x - \frac{\pi}{2}\right]\right\}}{2 + [x]^2}$, where $[x]$ denotes the greatest integer $\leq x$, is.

(a) continuous for all values of x
(b) discontinuous at $x=\frac{\pi}{2}$
(c) not differentiable for some values of x
(d) discontinuous at $x=-2$

148. The function $f(x)=a\sin|x|+be^{|x|}$ is differentiable at $x=0$ when
(a) $3a+b=0$
(b) $3a-b=0$
(c) $a+b=0$
(d) $a-b=0$

149. If the coefficient of x^8 in $\left(ax^2+\frac{1}{bx}\right)^{13}$ is equal to the coefficient of x^{-8} in $\left(ax-\frac{1}{bx^2}\right)^{13}$, then a and b will satisfy the relation.
(a) $ab+1=0$
(b) $ab=1$
(c) $a=1-b$
(d) $a+b=-1$

150. If $I=\int_0^2 e^{x^4}(x-a)dx=0$, then α lies in the interval.
(a) $(0,2)$
(b) $(-1,0)$
(c) $(2,3)$
(d) $(-2,-1)$

151. The solution of the differential equation $y\frac{dy}{dx}=x\left[\frac{y^2}{x^2}+\frac{\phi\left(\frac{y^2}{x^2}\right)}{\phi'\left(\frac{y^2}{x^2}\right)}\right]$ is (where , c is a constant)

(a) $\phi\left(\frac{y^2}{x^2}\right)=cx$
(b) $x\phi\left(\frac{y^2}{x^2}\right)=c$
(c) $\phi\left(\frac{y^2}{x^2}\right)=cx^2$
(d) $x^2\phi\left(\frac{y^2}{x^2}\right)=c$

152. Suppose that the equation $f(x)=x^2+bx+c=0$ has two distinct real roots α and β. The angle between the tangent to the curve $y=f(x)$ at the point $\left(\frac{\alpha+\beta}{2},f\left(\frac{\alpha+\beta}{2}\right)\right)$ and the positive direction of the x-axis is.
(a) $0°$ (b) $30°$
(c) $60°$ (d) $90°$

153. The function $f(x)=x^2+bx+c$, where b and c real constants, describes
(a) one-to-one mapping
(b) onto mapping
(c) not one-to-one but onto mapping
(d) neither one-to-one nor onto mapping

154. Let $n\geq 2$ be an integer, $A=\begin{bmatrix}\cos(2\pi/n) & \sin(2\pi/n) & 0\\ -\sin(2\pi/n) & \cos(2\pi/n) & 0\\ 0 & 0 & 1\end{bmatrix}$ and I is the identity matrix of order 3. Then,
(a) $A^n=I$ and $A^{n-1}\neq I$
(b) $A^m\neq I$ for any positive integer m
(c) A is not invertible
(d) $A^m=O$ for a positive integer m

155. Ram is visiting a friend. Ram knows that his friend has 2 children and 1 of them is a boy. Assuming that a child is equally likely to be a boy or a girl, then the probability that the other child is a girl, is
(a) ½ (b) 1/3
(c) 2/3 (d) 7/10

156. The value of the sum

$({}^{n}C_1)^2+({}^{n}C_2)^2+({}^{n}C_3)^2+\cdots+({}^{n}C_n)^2$ is
(a) $({}^{2n}C_n)^2$
(b) ${}^{2n}C_n$
(c) ${}^{2n}C_n+1$
(d) ${}^{2n}C_n-1$

157. The remainder obtained when $1!+2!+3!+\cdots+11!$ is divided by 12 is
(a) 9 (b) 8
(c) 7 (d) 6

158. Out of 7 consonants and 4 vowels, the number of words (not necessarily meaningful) that] can be made, each consisting of 3 consonants and 2 vowels, is.
(a) 24800 (b) 25100
(c) 25200 (d) 25400

159. Let $S=\frac{2}{1}\,{}^{n}C_0+\frac{2^2}{2}\,{}^{n}C_1+\frac{2^3}{3}\,{}^{n}C_2+\cdots+\frac{2^{n+1}}{n+1}\,{}^{n}C_n$. Then, S equals
(a) $\frac{2^{n+1}-1}{n+1}$ (b) $\frac{3^{n+1}-1}{n+1}$
(c) $\frac{3^n-1}{n}$ (d) $\frac{2^n-1}{n}$

160. Let R be the set of all real numbers and $f:[-1,1]\to R$ be defined by $f(x)=\begin{cases}x\sin\frac{1}{x}, & x\neq 0\\ 0, & x=0\end{cases}$. Then,
(a) f satisfies the conditions of Rolle's theorem on $[-1,1]$
(b) f satisfies the conditions of Lagrange's mean value theorem on $[-1,1]$
(c) f satisfies the conditions of Rolle's theorem on $[0,1]$
(d) f satisfies the conditions of Lagrange's mean value theorem on $[0,1]$

161. If a, b and c are positive numbers in a GP, then the roots of the quadratic equation $(\log_e a)x^2-(2\log_e b)x+(\log_e c)=0$ are.
(a) -1 and $\frac{\log_e C}{\log_e a}$
(b) 1 and $-\frac{\log_e c}{\log_e a}$
(c) 1 and $\log_a c$
(d) -1 and $\log_c a$

162. There is a group of 265 persons who like either singing or dancing or painting. In this group 200 like singing, 110 like dancing and 55 like painting. If 60 persons like both singing and dancing, 30 like both singing and painting and 10 like all three activities, then the number of persons who like only dancing and painting is.
(a) 10 (b) 20
(c) 30 (d) 40

163. The range of the function $y=3\sin\left(\sqrt{\frac{\pi^2}{16}-x^2}\right)$ is.
(a) $[0,\sqrt{3/2}]$ (b) $[0,1]$.
(c) $[0,3/\sqrt{2}]$ (d) $[0,\infty)$.

164. The value of $\lim_{x\to 0}\frac{\int_0^{x^2}\cos(t^2)dt}{x\sin x}$ is
(a) 1 (b) -1
(c) 2 (d) $\log_e 2$

165. Let $f(x)$ be a differentiable function and $f'(4)=5$. Then, $\lim_{x\to 2}\frac{f(4)-f(x^2)}{x-2}$ equals .
(a) 0 (b) 5
(c) 20 (d) -20

166. The sum of the series $\sum_{n=1}^{\infty}\sin\left(\frac{n!\pi}{720}\right)$ is.

(a) $\sin\left(\frac{\pi}{180}\right)+\sin\left(\frac{\pi}{360}\right)+\sin\left(\frac{\pi}{540}\right)$
(b) $\sin\left(\frac{\pi}{6}\right)+\sin\left(\frac{\pi}{30}\right)+\sin\left(\frac{\pi}{120}\right)+\sin\left(\frac{\pi}{360}\right)$
(c) $\sin\left(\frac{\pi}{6}\right)+\sin\left(\frac{\pi}{30}\right)+\sin\left(\frac{\pi}{120}\right)$
$+\sin\left(\frac{\pi}{360}\right)+\sin\left(\frac{\pi}{720}\right)$
(d) $\sin\left(\frac{\pi}{180}\right)+\sin\left(\frac{\pi}{360}\right)$

167. Let I denote the 3×3 identity matrix and P be a matrix obtained by rearranging the columns of I. Then,
(a) there are six distinct choices for P and $\det(P)=1$
(b) there are six distinct choices for P and $\det(P)-\pm 1$
(c) there are more than one choices for P and some of them are not invertible
(d) there are more than one choices for P and $P^{-1}=I$ in each choice

168. The coefficient of x^3 in the infinite series expansion of $\frac{2}{(1-x)(2-x)}$, for $|x|<1$, is.
(a) $-\frac{1}{16}$ (b) $\frac{15}{8}$
(c) $-\frac{1}{8}$ (d) $\frac{15}{16}$

169. For every real number x, let $f(x)=\frac{x}{1!}+\frac{3}{2!}x^2+\frac{7}{3!}x^3+\frac{15}{4!}x^4+\cdots$. Then, the equation $f(x)=0$ has.
(a) no real solution
(b) exactly one real solution
(c) exactly two real solutions
(d) infinite number of real solutions

170. Let S denote the sum of the infinite series $1+\frac{8}{2!}+\frac{21}{3!}+\frac{40}{4!}+\frac{65}{5!}+\cdots$. Then,
(a) $S<8$
(b) $S>12$
(c) $8<S<12$
(d) $S=8$

171. Let $[x]$ denote the greatest integer less than or equal to x for any real number x. Then, $\lim_{n\to\infty}\frac{[n\sqrt{2}]}{n}$ is equal to.
(a) 0 (b) 2
(c) $\sqrt{2}$ (d) 1

172. Suppose that $f(x)$ is a differentiable function such that $f'(x)$ is continuous, $f'(0)=1$ and $f''(0)$ does not exist. Let $g(x)=xf'(x)$. Then,
(a) $g'(0)$ does not exist
(b) $g'(0)=0$
(c) $g'(0)=1$
(d) $g'(0)=2$

173. Let z_1 be a fixed point on the circle of radius 1 centred at the origin in the argand plane and $z_1\neq\pm1$. Consider an equilateral triangle inscribed in the circle with z_1,z_2,z_3 as the vertices taken in the counter clockwise direction. Then, $z_1z_2z_3$ is equal to.
(a) z_1^2 (b) z_1^3
(c) z_1^4 (d) z_1

174. Suppose that z_1,z_2,z_3 are three vertices of an equilateral triangle in the argand plane. Let $\alpha=\frac{1}{2}(\sqrt{3}+i)$ and β be a non-zero complex number. The points $\alpha z_1+\beta,\alpha z_2+\beta,\alpha z_3+\beta$ will be.
(a) the vertices of an equilateral triangle
(b) the vertices of an isosceles triangle
(c) collinear
(d) the vertices of a scalene triangle

175. The curve $y=(\cos x+y)^{1/2}$ satisfies the differential equation.

(a) $(2y-1)\frac{d^2y}{dx^2}+2\left(\frac{dy}{dx}\right)^2+\cos x=0$
(b) $\frac{d^2y}{dx^2}-2y\left(\frac{dy}{dx}\right)^2+\cos x=0$
(c) $(2y-1)\frac{d^2y}{dx^2}-2\left(\frac{dy}{dx}\right)^2+\cos x=0$
(d) $(2y-1)\frac{d^2y}{dx^2}-\left(\frac{dy}{dx}\right)^2+\cos x=0$

176. In the argand plane, the distinct roots of $1+z+z^3+z^4=0$ (z is a complex number) represent vertices of
(a) a square
(b) an equilateral triangle
(c) a rhombus
(d) a rectangle

177. In a $\triangle ABC, a, b, c$ are the sides of the triangle opposite to the angles A, B, C, respectively. Then, the value of $a^3\sin(B-C)+b^3\sin(C-A)+c^3\sin(A-B)$ is equal to.
(a) 0 (b) 1
(c) 3 (d) 2

178. Let α, β be the roots of $x^2-x-1=0$ and $S_n=\alpha^n+\beta^n$, for all integers $n\geq 1$. Then, for every integer $n\geq 2$.
(a) $S_n+S_{n-1}=S_{n+1}$
(b) $S_n-S_{n-1}=S_{n+1}$
(c) $S_{n-1}=S_{n+1}$
(d) $S_n+S_{n-1}=2S_{n+1}$

179. A fair six-faced die is rolled 12 times. The probability that each face turns up twice is equal to.
(a) $\frac{12!}{6!6!6^{12}}$ (b) $\frac{2^{12}}{2^6 6^{12}}$
(c) $\frac{12!}{2^6 6^{12}}$ (d) $\frac{12!}{6^2 6^{12}}$

180. If α, β are the roots of the quadratic equation $x^2+px+q=0$, then the values of $\alpha^3+\beta^3$ and $\alpha^4+\alpha^2\beta^2+\beta^4$ are respectively.
(a) $3pq-p^3$ and $p^4-3p^2q+3q^2$
(b) $-p(3q-p^2)$ and $(p^2-q)(p^2+3q)$
(c) $pq-4$ and p^4-q^4
(d) $3pq-p^3$ and $(p^2-q)(p^2-3q)$

181. The solution of the differential equation

$\frac{dy}{dx}+\frac{y}{x\log_e x}=\frac{1}{x}$ under the condition $y=1$ when $x=e$ is
(a) $2y=\log_e x+\frac{1}{\log_e x}$
(b) $y=\log_e x+\frac{2}{\log_e x}$
(c) $y\log_e x=\log_e x+1$
(d) $y=\log_e x+e$

182. Let $f(x)=\max\{x+|x|, x-[x]\}$, where $[x]$ denotes the greatest integer $\leq x$. Then, the value of $\int_{-3}^{3} f(x)dx$ is.
(a) 0 (b) 51/2
(c) 21/2 (d) 1

183. Let $X_n=\left\{z=x+iy: |z|^2\leq\frac{1}{n}\right\}$ for all integers $n\geq 1$. Then, $\cap_{n=1}^{\infty} X_n$ is.
(a) a singleton set
(b) not a finite set
(c) an empty set
(d) a finite set with more than one element

184. Applying Lagrange's Mean Value Theorem for a suitable function $f(x)$ in $[0, h]$, we

have $f(h) = f(0) + hf'(\theta h), 0 < \theta < 1$. Then, for $f(x) = \cos x$, the value of $\lim_{h\to 0^+} \theta$ is.
(a) 1 (b) 0
(c) ½ (d) 1/3

185. The equation of hyperbola whose coordinates of the foci are $(\pm 8, 0)$ and the length of latusrectum is 24 units, is.
(a) $3x^2 - y^2 = 48$
(b) $4x^2 - y^2 = 48$
(c) $x^2 - 3y^2 = 48$
(d) $x^2 - 4y^2 = 48$

186. A student answers a multiple choice question with 5 alternatives, of which exactly one is correct. The probability that he knows the correct answer is $p, 0 < p < 1$. If he does not know the correct answer, he randomly ticks one answer. Given that he has answered the question correctly, the probability that he did not tick the answer randomly, is.
(a) $\frac{3p}{4p+3}$ (b) $\frac{5p}{3p+2}$
(c) $\frac{5p}{4p+1}$ (d) $\frac{4p}{3p+1}$

187. $\cos\frac{2\pi}{7} + \cos\frac{4\pi}{7} + \cos\frac{6\pi}{7}$
(a) is equal to zero
(b) lies between 0 and 3
(c) is a negative number
(d) lies between 3 and 6

188. Suppose $M = \int_0^{\pi/2} \frac{\cos x}{x+2} dx$,

$N = \int_0^{\pi/4} \frac{\sin x\cos x}{(x+1)^2} dx$. Then, the value of $(M - N)$ equals
(a) $\frac{3}{\pi+2}$ (b) $\frac{2}{\pi-4}$
(c) $\frac{4}{\pi-2}$ (d) $\frac{2}{\pi+4}$

189. For any two real numbers θ and ϕ, we define $\theta R\phi$, if and only if $\sec^2\theta - \tan^2\phi = 1$. The relation R is
(a) reflexive but not transitive
(b) symmetric but not reflexive
(c) both reflexive and symmetric but not transitive
(d) an equivalence relation

190. The minimum value of $2^{\sin x} + 2^{\cos x}$ is
(a) $2^{1-1/\sqrt{2}}$ (b) $2^{1+1/\sqrt{2}}$
(c) $2^{\sqrt{2}}$ (d) 2

191. We define a binary relation $\sim$ on the set of all 3×3 real matrices as $A \sim B$, if and only if there exist invertible matrices P and Q such that $B = PAQ^{-1}$. The binary relation $\sim$ is.
(a) neither reflexive nor symmetric
(b) reflexive and symmetric but not transitive
(c) symmetric and transitive but not reflexive
(d) an equivalence relation

192. Let α, β denote the cube roots of unity other than 1 and $\alpha \neq \beta$. Let $S =$

$\sum_{n=0}^{302} (-1)^n \left(\frac{\alpha}{\beta}\right)^n$. Then, the value of S is.
(a) either -2ω or $-2\omega^2$
(c) either 2ω or $-2\omega^2$
(b) either -2ω or $2\omega^2$
(d) either 2ω or $2\omega^2$

193. Let t_n denotes the nth term of the infinite series $\frac{1}{1!} + \frac{10}{2!} + \frac{21}{3!} + \frac{34}{4!} + \frac{49}{5!} + \cdots$ Then, $\lim_{n\to\infty} t_n$ Is.

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

194. A particle starting from a point A and moving with a positive constant acceleration along a straight line reaches another point B in time T. Suppose that the initial velocity of the particle is $u > 0$ and P is the mid-point of the line AB. If the velocity of the particle at point P is un mond of of the velocity at time $\frac{T}{2}$ is v_2, then.

(a) $v_1 = v_2$ (b) $v_1 > v_2$
(c) $v_1 < v_2$ (d) $v_1 = \frac{1}{2}v_2$

195. A poker hand consists of 5 cards drawn at random from a well-shuffled pack of 52 cards. Then, the probability that a poker hand consists of a pair and a triple of equal face values (for example, 2 sevens and 3 kings or 2 aces and 3 queens, etc.) is.

(a) $\frac{6}{4165}$ (b) $\frac{23}{4165}$
(c) $\frac{1797}{4165}$ (d) $\frac{1}{4165}$

196. If $u(x)$ and $v(x)$ are two independent solutions of the differential Equation $\frac{d^2y}{dx^2} + b\frac{dy}{dx} + cy = 0$ then additional solution(s) of the given differential equation is(are)

(a) $y = 5u(x) + 8v(x)$
(b) $y = c_1\{u(x) - v(x)\} + c_2 v(x), c_1$ and c_2 are arbitrary constants
(c) $y = c_1 u(x)v(x) + c_2 u(x)/v(x), c_1$ and c_2 are arbitrary constants
(d) $y = u(x)v(x)$

197. The angle of intersection between the curves $y = [|\sin x| + |\cos x|]$ and $x^2 + y^2 = 10$, where $[x]$ denotes the greatest integer $\leq x$, is.

(a) $\tan^{-1} 3$
(b) $\tan^{-1}(-3)$
(c) $\tan^{-1}\sqrt{3}$
(d) $\tan^{-1}(1/\sqrt{3})$

198. Let $f(x) = \begin{cases} \int_0^x |1-t|dt, & x > 0 \\ x - \frac{1}{2}, & x \leq 1 \end{cases}$. Then,

(a) $f(x)$ is continuous at $x = 1$
(b) $f(x)$ is not continuous at $x = 1$
(c) $f(x)$ is differentiable at $x = 1$
(d) $f(x)$ is not differentiable at $x = 1$

199. If the circle $x^2 + y^2 + 2gx + 2fy + c = 0$ cuts the three circles $x^2 + y^2 - 5 = 0$, $x^2 + y^2 - 8x - 6y + 10 = 0$ and $x^2 + y^2 - 4x + 2y - 2 = 0$ at the extremities of their diameters, then

(a) $c = -5$
(b) $fg = 147/25$
(c) $g + 2f = c + 2$
(d) $4f = 3g$

200. For two events A and B, let $P(A) = 0.7$ and $P(B) = 0.6$. The necessarily false statement(s) is/are.

(a) $P(A \cap B) = 0.35$
(b) $P(A \cap B) = 0.45$
(c) $P(A \cap B) = 0.65$
(d) $P(A \cap B) = 0.28$