1. Which one of the following represents the correct dimensions of the coefficient of viscosity ?
   (a) $[ML^{-1}T^{-2}]$ (b) $[ML^{1}T^{-1}]$
   (c) $[ML^{-1}T^{-1}]$ (d) $[ML^{-2}T^{-2}]$

2. A particle moves in a straight line with retardation proportional to its displacement. Its loss of kinetic energy for any displacement x is proportional to :
   (a) x^2 (b) e^x
   (c) x (d) $\log_e x$

3. A ball is released from the top of a tower of height h m. It takes T s to reach the ground. What is the position of the ball in $T/3$ s ?
   (a) $h/9$ m from the ground
   (b) $7h/9$ m from the ground
   (c) $8h/9$ m from the ground
   (d) $17h/18$ m from the ground

4. If $\vec{A} \times \vec{B} = \vec{B} \times \vec{A}$, then the angle between A and B is :
   (a) π (b) $\pi/3$
   (c) $\pi/2$ (d) $\pi/4$

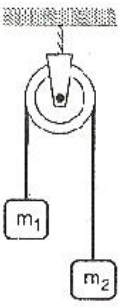
5. A projectile can have the same range R for two angles of projection. If T_1 and T_2 be the times of flights in the two cases, then the product of the two times of flights is directly proportional to :
   (a) $\frac{1}{R^2}$ (b) $\frac{1}{R}$
   (c) R (d) R^2

6. Which of the following statements is false for a particle moving in a circle with a constant angular speed ?
   (a) The velocity vector is tangent to the circle
   (b) The acceleration vector is tangent to the circle
   (c) The acceleration vector points to the centre of the circle
   (d) The velocity and acceleration vectors are perpendicular to each other

7. An automobile travelling with a speed of 60 km/h, can brake to stop within a distance of 20 m. If the car is going twice as fast, i. e., 120 km/h, the stopping distance will be :
   (a) 20 m (b) 40 m
   (c) 60 m (d) 80 m

8. A machine gun fires a bullet of mass 40 g with a velocity 1200 ms^{-1}. The man holding it, can exert a maximum force of 144 N on the gun. How many bullets can he fire per second at the most ?
   (a) One (b) Four
   (c) Two (d) Three

9. Two masses $m_1 = 5$ kg and $m_2 = 4.8$ kg tied to a string are hanging over a light frictionless pulley. What is the acceleration of the masses when lift is free to move ? ($g = 9.8$ m/s^2)
   (a) 0.2 m/s^2
   (b) 9.8 m/s^2
   (c) 5 m/s^2
   (d) 4.8 m/s^2



10. A uniform chain of length 2 m is kept on a table such that a length of 60 cm hangs freely from the edge of the table. The total mass of the chain is 4 kg. What is the work done in pulling the entire chain on the table ?
    (a) 7.2 J (b) 3.6 J
    (c) 120 J (d) 1200 J

11. A block rests on a rough inclined plane making an angle of 30° with the horizontal. The coefficient of static friction between the block and the plane is 0.8. If the frictional force on the block is 10 N, the mass of the block (in kg) is : (take $g = 10$ m/s^2)
    (a) 2.0 (b) 4.0
    (c) 1.6 (d) 2.5

12. A force $\vec{F} = (5\hat{i} + 3\hat{j} + 2\hat{k})$N is applied over a particle which displaces it from its origin to the point $\vec{r} = (2\hat{i} - \hat{j})$ m. The work done on the particle in joules is :

(a) − 7 (b) + 7
(c) + 10 (d) + 13

13. A body of mass m accelerates uniformly from rest to v_1 in time t_1. The instantaneous power delivered to the body as a function of time t is :

(a) $\frac{mv_1t}{t_1}$ (b) $\frac{mv_1^2t}{t_1^2}$
(c) $\frac{mv_1t^2}{t_1}$ (d) $\frac{mv_1^2t}{t_1}$

14. A particle is acted upon by a force of constant magnitude which is always perpendicular to the velocity of the particle. The motion of the particle takes place in a plane, it follows that :
(a) its velocity is constant
(b) its acceleration is constant
(c) its kinetic energy is constant
(d) it moves in a straight line

15. A solid sphere is rotating in free space. If the radius of the sphere is increased keeping mass same which one of the following will not be affected ?
(a) Moment of inertia
(b) Angular momentum
(c) Angular velocity
(d) Rotational kinetic energy

16. A ball is thrown from a point with a speed v_0 at an angle of projection 0. From the same point and at the same instant, a person starts running with a constant speed $\frac{v_0}{2}$ to catch the ball. Will the person be able to catch the ball ? If yes, what should be the angle of projection ?
(a) Yes, 60° (b) Yes, 30°
(c) No (d) Yes, 45°

17. One solid sphere A and another hollow sphere B are of same mass and same outer radii. Their moment of inertia about their diameters are respectively I_A and I_B such that :

(a) $I_A = I_B$ (b) $I_A > I_B$
(c) $I_A < I_B$ (d) $\frac{I_A}{I_B} = \frac{d_A}{d_B}$

where d_A and d_B are their densities.

18. A satellite of mass m revolves around the earth of radius R at a height x from its surface. If g is the acceleration due to gravity on the surface of the earth, the orbital speed of the satellite is :

(a) gx (b) $\frac{gR}{R-x}$
(c) $\frac{gR^2}{R+x}$ (d) $\left(\frac{gR^2}{R+x}\right)^{1/2}$

19. The time period of an earth satellite in circular orbit is independent of :
(a) the mass of the satellite
(b) radius of its orbit
(c) both the mass and radius of the orbit
(d) neither the mass of the satellite nor the radius of its orbit

20. If g is the acceleration due to gravity on the earth's surface, the gain in the potential energy of an object of mass m raised from the surface of the earth to a height equal to the radius R of the earth, is :

(a) $2mgR$ (b) $\frac{1}{2}mgR$
(c) $\frac{1}{4}mgR$ (d) mgR

21. Suppose the gravitational force varies inversely as the nth power of distance. Then the time period of a planet in circular orbit of radius R around the sun will be proportional to :

(a) $R^{\left(\frac{n+1}{2}\right)}$ (b) $R^{\left(\frac{n-1}{2}\right)}$
(c) R^n (d) $R^{\left(\frac{n-2}{2}\right)}$

22. A wire fixed at the upper end stretches by length l by applying a force F. The work done in stretching is :

(a) $\frac{F}{2l}$ (b) Fl
(c) $2Fl$ (d) $\frac{Fl}{2}$

23. Spherical balls of radius R are falling in a viscous fluid of viscosity η with a velocity v. The retarding viscous force acting on the spherical ball is :
(a) directly proportional to R but inversely proportional to v
(b) directly proportional to both radius R and velocity v
(c) inversely proportional to both radius R and velocity v
(d) inversely proportional to R but directly proportional to velocity v

24. If two soap bubbles of different radii are connected by a tube :

(a) air flows from the bigger bubble to the smaller bubble till the sizes become equal

(b) air flows from bigger bubble to the smaller bubble till the sizes are interchanged

(c) air flows from the smaller bubble to the bigger

(d) there is no flow of air

25. The bob of a simple pendulum executes simple harmonic motion in water with a period t, while the period of oscillation of the bob is t_0 in air. Neglecting frictional force of water and given that the density of the bob is $(4/3) \times 1000\ kg/m^3$. What relationship between t and t_0 is true ?

(a) $t = t_0$ (b) $t = t_0/2$

(c) $t = 2t_0$ (d) $t = 4t_0$

26. A particle at the end of a spring executes simple harmonic motion with a period t_1, while the corresponding period for another spring is t_2. If the period of oscillation with the two springs in series is T, then :

(a) $T = t_1 + t_2$ (b) $T^2 = t_1^2 + t_2^2$

(c) $T^{-1} = t_1^{-1} + t_2^{-1}$ (d) $T^{-2} = t_1^{-2} + t_2^{-2}$

27. The total energy of a particle, executing simple harmonic motion is :

(a) $\propto x$ (b) $\propto x^2$

(c) independent of x (d) $\propto x^{1/2}$

where x is the displacement from the mean position.

28. The displacement y of a particle in a medium can be expressed as :

$y = 10^{-6} \sin\left(100t + 20x + \frac{\pi}{4}\right)$m, where t is in second and x in metre. The speed of the wave is :

(a) 2000 m/s (b) 5 m/s

(c) 20 m/s (d) 5π m/s

29. A particle of mass m is attached to a spring (of spring constant k) and has a natural angular frequency ω_0. An external force $F(t)$ proportional to $\cos \omega t$ $(\omega \neq \omega_0)$ is applied to the oscillator. The time displacement of the oscillator will be proportional to :

(a) $\frac{m}{\omega_0^2 - \omega^2}$ (b) $\frac{1}{m(\omega_0^2 - \omega^2)}$

(c) $\frac{1}{m(\omega_0^2 + \omega^2)}$ (d) $\frac{m}{\omega_0^2 + \omega^2}$

30. In forced oscillation of a particle, the amplitude is maximum for a frequency ω_1 of the force, while the energy is maximum for a frequency ω_2 of the force, then :

(a) $\omega_1 = \omega_2$

(b) $\omega_1 > \omega_2$

(c) $\omega_1 < \omega_2$ when damping is small and $\omega_1 > \omega_2$ when damping is large

(d) $\omega_1 < \omega_2$

31. One mole of ideal monoatomic gas $(\gamma = 5/3)$ is mixed with one mole of diatomic gas $(\gamma = 7/5)$. What is γ for the mixture ? γ denotes the ratio of specific heat at constant pressure, to that at constant volume :

(a) 3/2 (b) 23/15

(c) 35/23 (d) 4/3

32. If the temperature of the sun were to increase from T to $2T$ and its radius from R to $2R$, then the ratio of the radiant energy received on earth to what it was previously, will be :

(a) 4 (b) 16

(c) 32 (d) 64

33. Which of the following statements is correct for any thermodynamic system ?

(a) The internal energy changes in all processes

(b) Internal energy and entropy are state functions

(c) The change in entropy can never be zero

(d) The work done in an adiabatic process is always zero

34. Two thermally insulated vessels 1 and 2 are filled with air at temperatures (T_1, T_2), volume (V_1, V_2) and pressure (P_1, P_2) respectively. If the valve joining the two vessels is opened, the temperature inside the vessel at equilibrium will be :

(a) $T_1 + T_2$

(b) $\frac{(T_1 + T_2)}{2}$

(c) $\frac{T_1 T_2 (P_1 V_1 + P_2 V_2)}{P_1 V_1 T_2 + P_2 V_2 T_1}$

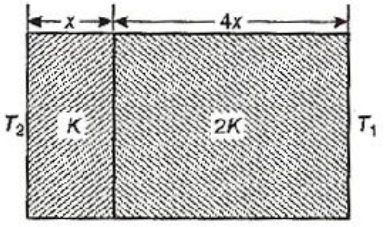
(d) $\frac{T_1 T_2 (P_1 V_1 + P_2 V_2)}{P_1 V_1 T_1 + P_2 V_2 T_2}$

35. A radiation of energy E falls normally on a perfectly reflecting surface. The momentum transferred to the surface is :

(a) E/c (b) $2E/c$

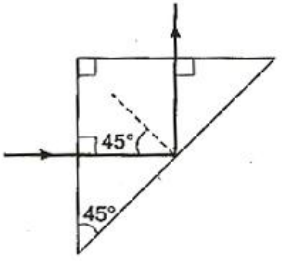
(c) Ec (d) E/c^2

36. The temperature of the two outer surfaces of a composite slab, consisting of two materials having coefficients of thermal conductivity K and $2K$ and thickness x and $4x$, respectively are T_2 and T_1 $(T_2 > T_1)$. The rate of heat transfer through the slab, in a steady state is $\left(\frac{A(T_2 - T_1)K}{x}\right) f$, with f equals to :



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

37. A light ray is incident perpendicular to one face of a 90° prism and is totally internally reflected at the glass-air interface. If the angle of reflection is 45°, we conclude that the refractive index n :



(a) $n < \frac{1}{\sqrt{2}}$ (b) $n > \sqrt{2}$
(c) $n > \frac{1}{\sqrt{2}}$ (d) $n < \sqrt{2}$

38. A plano-convex lens of refractive index 1.5 and radius of curvature 30 cm is silvered at the curved surface. Now, this lens has been used to form the image of an object. At what distance from this lens, an object be placed in order to have a real image of the size of the object ?

(a) 20 cm (b) 30 cm
(c) 60 cm (d) 80 cm

39. The angle of incidence at which reflected light is totally polarized for reflection from air to glass (refractive index n), is :

(a) $\sin^{-1}(n)$ (b) $\sin^{-1}(1/n)$
(c) $\tan^{-1}(1/n)$ (d) $\tan^{-1}(n)$

40. The maximum number of possible interference maxima for slit-separation equal to twice the wavelength in Young's double-slit experiment, is :

(a) infinite (b) five
(c) three (d) zero

41. An electromagnetic wave of frequency $\nu = 3.0$ MHz passes from vacuum into a dielectric medium with permittivity $\varepsilon = 4.0$. Then :

(a) wavelength is doubled and the frequency remains unchanged
(b) wavelength is doubled and frequency becomes half
(c) wavelength is halved and frequency remains unchanged
(d) wavelength and frequency both remain unchanged

42. Two spherical conductors B and C having equal radii and carrying equal charges in them repel each other with a force F when kept apart at some distance. A third spherical conductor having same radius as that of B but uncharged, is brought in contact with B, then brought in contact with C and finally removed away from both. The new force of repulsion between B and C is :

(a) $\frac{F}{4}$ (b) $\frac{3F}{4}$
(c) $\frac{F}{8}$ (d) $\frac{3F}{8}$

43. A charged particle q is shot towards another charged particle Q which is fixed, with a speed v. It approaches Q upto a closest distance r and then returns. If q was given a speed $2v$, the closest distance of approach would be :

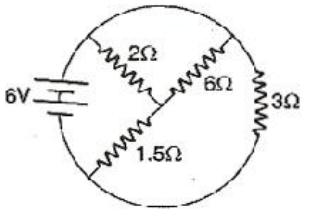
(a) r (b) $2r$
(c) $r/2$ (d) $r/4$

44. Four charges equal to $-Q$ are placed at the four corners of a square and a charge q is at its centre. If the system is in equilibrium, the value of q is :

(a) $-\frac{Q}{4}(1 + 2\sqrt{2})$ (b) $\frac{Q}{4}(1 + 2\sqrt{2})$
(c) $-\frac{Q}{2}(1 + 2\sqrt{2})$ (d) $\frac{Q}{2}(1 + 2\sqrt{2})$

45. Alternating current can not be measured by DC ammeter because :
(a) AC cannot pass through DC ammeter
(b) AC changes direction
(c) average value of current for complete cycle is zero
(d) DC ammeter will get damaged

46. The total current supplied to the circuit by the battery is :



(a) 1 A (b) 2 A
(c) 4 A (d) 6 A

47. The resistance of the series combination of two resistances is S. When they are joined in parallel, the total resistance is P. If $S = nP$, then the minimum possible value of n is :
(a) 4 (b) 3
(c) 2 (d) 1

48. An electric current is passed through a circuit containing two wires of the same material, connected in parallel. If the lengths and radii of the wires are in the ratio of 4/3 and 2/3, then the ratio of the currents passing through the wire will be :
(a) 3 (b) 1/3
(c) 8/9 (d) 2

49. In a metre bridge experiment, null point is obtained at 20 cm from one end of the wire when resistance X is balanced against another resistance Y. If $X < Y$, then where will be the new position of the null point from the same end, if one decides to balance a resistance of $4X$ against Y ?
(a) 50 cm (b) 80 cm
(c) 40 cm (d) 70 cm

50. The thermistors are usually made of :
(a) metals with low temperature coefficient of resistivity
(b) metals with high temperature coefficient of resistivity
(c) metal oxides with high temperature coefficient of resistivity
(d) semiconducting materials having low temperature coefficient of resistivity

51. Time taken by a 836 W heater to heat one litre of water from 10°C to 40°C is :
(a) 50 s (b) 100 s
(c) 150 s (d) 200 s

52. The thermo-emf of a thermocouple varies with the temperature θ of the hot junction as $E = a\theta + b\theta^2$ in volts where the ratio a/b is 700°C. If the cold junction is kept at 0°C, then the neutral temperature is :
(a) 700°C
(b) 350°C
(c) 1400°C
(d) no neutral temperature is possible for this thermocouple

53. The electrochemical equivalent of metal is 3.3×10^{-7} kg per coulomb. The mass of the metal liberated at the cathode when a 3A current is passed for 2 s, will be :
(a) 19.8×10^{-7} kg
(b) 9.9×10^{-7} kg
(c) 6.6×10^{-7} kg
(d) 1.1×10^{-7} kg

54. A current i A flows along an infinitely long straight thin walled tube, then the magnetic induction at any point inside the tube is :
(a) infinite (b) zero
(c) $\frac{\mu_0}{4\pi} \cdot \frac{2i}{r}$ T (d) $\frac{2i}{r}$ T

55. A long wire carries a steady current. It is bent into a circle of one turn and the magnetic field at the centre of the coil is B. It is then bent into a circular loop of n turns. The magnetic field at the centre of the coil will be :
(a) nB (b) n^2B
(c) $2nB$ (d) $2n^2B$

56. The magnetic field due to a current carrying circular loop of radius 3 cm at a point on the axis at a distance of 4 cm from the centre is 54 μT. What will be its value at the centre of the loop ?
(a) 250 μT (b) 150 μT
(c) 125 μT (d) 75 μT

57. Two long conductors, separated by a distance d carry currents I_1 and I_2 in the same direction. They exert a force F on each other. Now the current in one of them is increased to two times and its direction is reversed. The distance is also increased to $3d$. The new value of the force between them is :
(a) $-2F$ (b) $F/3$
(c) $-2F/3$ (d) $-F/3$

58. The length of a magnet is large compared to its width and breadth. The time period of its oscillation in a vibration magnetometer is 2 s. The magnet is cut along its length into three equal parts and three parts are then placed on each other with their like poles together. The time period of this combination will be :
(a) 2 s (b) 2/3 s
(c) $2\sqrt{3}$ s (d) $2/\sqrt{3}$ s

59. The materials suitable for making electromagnets should have :
(a) high retentivity and high coercivity
(b) low retentivity and low coercivity
(c) high retentivity and low coercivity
(d) low retentivity and high coercivity

60. In an *LCR* series ac circuit, the voltage across each of the components, *L*, *C* and *R* is 50 V. The voltage across the *LC* combination will be :
(a) 50 V (b) $50\sqrt{2}$ V
(c) 100 V (d) 0 (zero)

61. A coil having n turns and resistance $R\ \Omega$ is connected with a galvanometer of resistance $4R\ \Omega$. This combination is moved in time t seconds from a magnetic field W_1 weber to W_2 weber. The induced current in the circuit is :
(a) $\frac{W_2 - W_1}{5Rnt}$ (b) $-\frac{n(W_2 - W_1)}{5Rt}$
(c) $-\frac{(W_2 - W_1)}{Rnt}$ (d) $-\frac{n(W_2 - W_1)}{Rt}$

62. In a uniform magnetic field of induction B, a wire in the form of semicircle of radius r rotates about the diameter of the circle with angular frequency ω. If the total resistance of the circuit is R, the mean power generated per period of rotation is :
(a) $\frac{B\pi r^2\omega}{2R}$ (b) $\frac{(B\pi r^2\omega)^2}{8R}$
(c) $\frac{(B\pi r\omega)^2}{2R}$ (d) $\frac{(B\pi r\omega^2)^2}{8R}$

63. In an *LCR* circuit, capacitance is changed from C to $2C$. For the resonant frequency to remain unchanged, the inductance should be changed from L to :
(a) $4L$ (b) $2L$
(c) $L/2$ (d) $L/4$

64. A metal conductor of length 1m rotates vertically about one of its ends at angular velocity 5 radians per second. If the horizontal component of earth's magnetic field is 0.2×10^{-4} T, then the emf developed between the two ends of the conductor is :
(a) 5 μV (b) 50 μV
(c) 5 mV (d) 50 mV

65. According to Einstein's photoelectric equation, the plot of the kinetic energy of the emitted photoelectrons from a metal *Vs* the frequency, of the incident radiation gives a straight line whose slope :
(a) depends on the nature of the metal used
(b) depends on the intensity of the radiation
(c) depends both on the intensity of the radiation and the metal used
(d) is the same for all metals and independent of the intensity of the radiation

66. The work function of a substance is 4.0 eV. The longest wavelength of light that can cause photoelectron emission from this substance is approximately :
(a) 540 nm (b) 400 nm
(c) 310 nm (d) 220 nm

67. A charged oil drop is suspended in uniform field of 3×10^4 V/m so that it neither falls nor rises. The charge on the drop will be :
(take the mass of the charge = 9.9×10^{-15} kg and $g = 10\ m/s^2$)
(a) 3.3×10^{-18} C (b) 3.2×10^{-18} C
(c) 1.6×10^{-18} C (d) 4.8×10^{-18} C

68. A nucleus disintegrates into two nuclear parts which have their velocities in the ratio 2 : 1. The ratio of their nuclear sizes will be :
(a) $2^{1/3} : 1$ (b) $1 : 3^{1/2}$
(c) $3^{1/2} : 1$ (d) $1 : 2^{1/3}$

69. The binding energy per nucleon of deuteron ($_1^2H$) and helium nucleus ($_2^4He$) is 1.1 MeV and 7 MeV respectively. If two deuteron nuclei react to form a single helium nucleus, then the energy released is :
(a) 13.9 MeV (b) 26.9 MeV
(c) 23.6 MeV (d) 19.2 MeV

70. An α-particle of energy 5 MeV is scattered through 180° by a fixed uranium nucleus. The distance of the closest approach is of the order of :
(a) 1 Å (b) 10^{-10} cm
(c) 10^{-12} cm (d) 10^{-15} cm

71. When *npn* transistor is used as an amplifier :
(a) electrons move from base to collector
(b) holes move from emitter to base
(c) electrons move from collector to base
(d) holes move from base to emitter

72. For a transistor amplifier in common emitter configuration for load impedance of 1 kΩ (h_{fe} = 50 and h_{oe} = 25 μ A/V), the current gain is :
(a) – 5.2 (b) – 15.7
(c) – 24.8 (d) – 48.78

73. A piece of copper and another of germanium are cooled from room temperature to 77 K, the resistance of :
(a) each of them increases
(b) each of them decreases
(c) copper decreases and germanium increases
(d) copper increases and germanium decreases

74. The manifestation of band structure in solids is due to :
(a) Heisenberg's uncertainty principle
(b) Pauli's exclusion principle
(c) Bohr's correspondence principle
(d) Boltzmann's law

75. When *p-n* junction diode is forward biased, then :
(a) the depletion region is reduced and barrier height is increased
(b) the depletion region is widened and barrier height is reduced
(c) both the depletion region and barrier height are reduced
(d) both the depletion region and barrier height are increased

Chemistry

76. Which of the following sets of quantum numbers is correct for an electron in 4*f* orbital ?
(a) $n = 4, l = 3, m = +4, s = +1/2$
(b) $n = 4, l = 4, m = -4, s = -1/2$
(c) $n = 4, l = 3, m = +1, s = +1/2$
(d) $n = 3, l = 2, m = -2, s = +1/2$

77. Consider the ground state of Cr atom (Z = 24). The numbers of electrons with the azimuthal quantum numbers, l = 1 and 2 are, respectively :
(a) 12 and 4 (b) 12 and 5
(c) 16 and 4 (d) 16 and 5

78. Which one of the following ions has the highest value of ionic radius ?
(a) Li^+ (b) B^{3+}
(c) O^{2-} (d) F^-

79. The wavelength of the radiation emitted, when in a hydrogen atom electron falls from infinity to stationary state 1, would be (Rydberg constant $= 1.097 \times 10^7\ m^{-1}$) :
(a) 91 nm (b) 192 nm
(c) 406 nm (d) 9.1×10^{-8} nm

80. The correct order of bond angles (smallest first) in H_2S, NH_3, BF_3 and SiH_4 is :
(a) $H_2S < SiH_4 < NH_3 < BF_3$
(b) $NH_3 < H_2S < SiH_4 < BF_3$
(c) $H_2S < NH_3 < SiH_4 < BF_3$
(d) $H_2S < NH_3 < BF_3 < SiH_4$

81. Which one of the following sets of ions represents the collection of isoelectronic species ?
(a) $K^+, Ca^{2+}, Sc^{3+}, Cl^-$
(b) $Na^+, Ca^{2+}, Sc^{3+}, F^-$
(c) $K^+, Cl^-, Mg^{2+}, Sc^{3+}$
(d) $Na^+, Mg^{2+}, Al^{3+}, Cl^-$
(Atomic numbers F = 9, Cl = 17, Na = 11, Mg = 12, Al = 13, K = 19, Ca = 20, Sc = 21)

82. Among Al_2O_3, SiO_2, P_2O_3 and SO_2 the correct order of acid strength is :
(a) $SO_2 < P_2O_3 < SiO_2 < Al_2O_3$
(b) $SiO_2 < SO_2 < Al_2O_3 < P_2O_3$
(c) $Al_2O_3 < SiO_2 < SO_2 < P_2O_3$
(d) $Al_2O_3 < SiO_2 < P_2O_3 < SO_2$

83. The bond order in NO is 2.5 while that in NO^+ is 3. Which of the following statements is true for these two species ?
(a) Bond length in NO^+ is greater than in NO
(b) Bond length in NO is greater than in NO^+
(c) Bond length in NO^+ is equal to that in NO
(d) Bond length is unpredictable

84. The formation of the oxide ion $O^{2-}(g)$ requires first an exothermic and then an endothermic step as shown below
$O(g) + e^- = O^-(g)$; $\Delta H° = -142\ kJ\ mol^{-1}$
$O(g)^- + e^- = O^{2-}(g)$; $\Delta H° = 844\ kJ\ mol^{-1}$