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WBJEE (Medical) : 2016

(Detail Solutions)

Booklet Code

PHYSICS

Category – I (Q.1 to Q.30)

Only one answer is correct. Correct answer will fetch full marks 1. Incorrect answser or any combination of more than one answer will fetch –¼ marks.

1. If a Young's double slit experiment were conducted inside water instead of air, the fringe width would

(A) increase (B) decrease (C) remain same (D) become zero

Solution : (B)

$$\beta = \frac{D\lambda}{d}, \ \mu = \frac{c}{v} = \frac{\lambda_{air}}{\lambda_{water}}, \ \lambda_{water} = \frac{\lambda_{air}}{\mu}$$

$\lambda \downarrow \quad \beta \downarrow$

2. A photon of energy 8eV is incident on a metal plate with threshold frequency 1.6×10^{15}Hz. The maximum kinetic energy of the emitted photo electrons is (given $h = 6 \times 10^{-34}$Js)

(A) 6 eV (B) 1.6 eV (C) 1.2 eV (D) 2 eV

Solution : (D)

$$\omega = h\gamma = \frac{6\times10^{-34}\times1.6\times10^{15}}{1.6\times10^{-19}}eV = 6eV$$

$KE_{max} = 8 - 6 = 2eV$

3. Light is a electromagnetic wave whose

(A) $\vec{E}$ and $\vec{B}$ are parallel and both are perpendicular to the direction of propagation

(B) $\vec{E}$ and $\vec{B}$ are mutually perpendicular and the direction of propagation is parallel to $\vec{E}$

(C) $\vec{E}$ and $\vec{B}$ and the direction of propagation are mutually perpendicular

(D) $\vec{E}$ and $\vec{B}$ are mutually perpendicular and the direction of propagation is parallel to $\vec{B}$

Solution : (C)

4. In Bohr model of an atom, two electrons move round the nucleus in circular orbits of radii in the ratio 1 : 4. The ratio of their kinetic energies are

(A) 1 : 4 (B) 4 : 1 (C) 8 : 1 (D) 1 : 8

Solution : (B)

$$KE = \frac{1}{2}mv^2 = \frac{ze^2}{2Kr} \qquad \because \frac{mv^2}{r} = \frac{ze^2}{Kr^2}$$

$$KE_1 : KE_2 = \frac{1}{r_1} : \frac{1}{r_2} = r_2 : r_1 = 4 : 1$$

5. The dimension of co-efficient of viscosity η is

(A) $[MLT^{-2}]$ (B) $[M^{-1}LT^{-1}]$ (C) $[M^{-1}LT^{-2}]$ (D) $[ML^{-1}T^{-1}]$

Solution : (D)

$$F = 6\pi\eta rv;\ \eta = \frac{F}{6\pi rv} = \left[\frac{MLT^{-2}}{L\,LT^{-1}}\right] = \left[ML^{-1}T^{-1}\right]$$

6. The ratio of the masses of two planets is 2 : 3 and the ratio of their radii is 3 : 2. The ratio of acceleration due to gravity on these two planets is

(A) 9 : 4 (B) 4 : 9 (C) 2 : 3 (D) 3 : 2

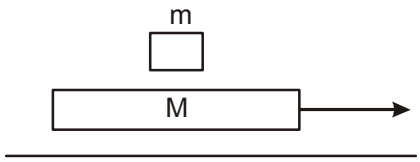
Solution : (No Option Matches)

$$g = \frac{GM}{R^2};\ g_1 : g_2 = \frac{M_1}{M_2} \times \left(\frac{R_2}{R_1}\right)^2 = \frac{2}{3} \times \left(\frac{2}{3}\right)^2 = 8 : 27$$

7. A mass m rest on another mass M. The co-efficient of static friction between the surfaces of m and M is μ. M rests on a smooth frictionless horizontal plane. The maximum force applied horizontally on M for which m will move alongwith M without slipping is,

(A) $mg + \mu mg$ (B) $(M + m)\mu g$ (C) $\frac{mM}{M+m}\mu g$ (D) μmg

Solution : (B)



Maximum acceleration of m = μg

$\therefore$ F = (M + m). μg

8. A particle of mass m is moving in a circular orbit of radius r in a force field given by $\vec{F} = -\frac{k}{r^2}\hat{r}$. The angular momentum L of the particle about the centre varies as

(A) $L \propto \sqrt{r}$ (B) $L \propto r^{3/2}$ (C) $L \propto \frac{1}{\sqrt{r}}$ (D) $L \propto r^{1/3}$

Solution : (A)

$$\vec{F} = -\frac{K}{r^2}\hat{r}\ ;\ F = \frac{K}{r^2} = \frac{mv^2}{r}$$

$mv^2r = K$; $m^2v^2r^2 = Kmr$; $L = K^{\frac{1}{2}}m^{\frac{1}{2}}r^{\frac{1}{2}}$

9. An explosive of mass 9kg is divided in two parts. One part of mass 3kg moves with velocity of 16m/s. The kinetic energy of other part will be

(A) 192 J (B) 162 J (C) 150 J (D) 200 J

Solution : (A)

$m_1v_1 + m_2v_2 = 0$

$3 \times 16 + (9 - 3)\, v_2 = 0$

$v_2 = -8$

$$\frac{1}{2}m_2v_2^2 = \frac{1}{2} \times 6 \times 64 = 192J$$

10. The length of a wire is l_1 when tension is T_1 and is l_2 when tension is T_2. The length of the wire without any tension is

(A) $\frac{l_2T_1 - l_1T_2}{T_1 - T_2}$ (B) $\frac{l_1T_1 - l_2T_2}{T_1 - T_2}$ (C) $\frac{l_1T_1}{T_2 - T_1}$ (D) $\frac{l_2T_2}{T_1 - T_2}$

Solution : (A)

$$l_1 = l + \frac{T_1}{K};\ l_2 = l + \frac{T_2}{K};\ \frac{l_1 - l}{l_2 - l} = \frac{T_1}{T_2}$$

$$l_1T_2 - lT_2 = l_2T_1 - T_1l;\ l = \frac{l_2T_1 - l_1T_2}{T_1 - T_2}$$

11. Air is expanded from 50 litre to 150 litre at 2 atmospheric pressure (1 atm. pressure = 10^5 kgm^{-2}). The external work done is

(A) 200 J (B) 2000 J (C) 2×10^4 J (D) 2×10^{-12} J

Solution : (C) ; [Atmospheric pressure should be 10^5Nm^{-2}]

$W = P(V_2 - V_1) = 2 \times 10^5 (150 \times 10^{-3} - 50 \times 10^{-3})$J

$= 2\times 10^5 \times 10^{-1}$ J $= 2 \times 10^4$ J

12. The Young's modulus of a metal is 2×10^{12} dyne/cm^2 and its breaking stress is 11000 kg/cm^2. In case of longitudinal strain the maximum energy that can be stored per cubic metre of this metal is approximately (Assume g = 10 m/s^2)

(A) 58.28×10^5 J (B) 30.25×10^5 J (C) 37.15×10^5 J (D) 15.15×10^5 J

Solution : (B)

$$\frac{E_{max}}{\text{Volume}} = \frac{1}{2} \times (\text{stress})_{max} \times (\text{strain})_{max} = \frac{1}{2} \times (\text{stress})_{max} \times \frac{(\text{stress})_{max}}{Y}$$

$$(\text{stress})_{max} = \frac{11000\text{kg}}{\text{cm}^2} = \frac{11000 \times 10\text{N}}{\text{cm}^2} = \frac{110000\text{N}}{10^{-4}\text{m}^2} = 11 \times 10^8 \frac{\text{N}}{\text{m}^2}$$

$$Y = 2 \times 10^{12} \frac{\text{dyne}}{\text{cm}^2} = \frac{2 \times 10^7 \text{N}}{10^{-4}\text{m}^2} = 2 \times 10^{11} \frac{\text{N}}{\text{m}^2}$$

$$\therefore \frac{E_{max}}{\text{volume}} = \frac{1}{2} \times \frac{(11 \times 10^8)^2}{2 \times 10^{11}} \text{Jm}^{-3} = \frac{121}{4} \times 10^5 \text{Jm}^{-3} = 30.25 \times 10^5 \text{Jm}^{-3}$$

13. When a body moves in a circular orbit its total energy is

(A) positive (B) negative (C) zero (D) infinite

Solution : (B)

Total energy must negative for bound particle.

14. A sphere, a cube and a thin circular plate, all made of the same material and having the same mass, are initially heated to a temperature of 200°C. When left in air at room temperature, the following cools fastest.

(A) Sphere (B) Cube (C) Plate (D) All of these

Solution : (C)

Plate has maximum surface area.

Radiation will be the greatest.

Cooling will be the fastest.

15. Two sound waves of wavelengths 50cm and 51cm produce 12 beats per second. The velocity of sound is

(A) 306 ms^{-1} (B) 331 ms^{-1} (C) 340 ms^{-1} (D) 360 ms^{-1}

Solution : (A)

Velocity = v cm/s

$$\therefore \frac{v}{50}-\frac{v}{51}=12\ ;\ v\left[\frac{51-50}{50\times 51}\right]=12$$

v = 50 × 12 × 51 = 600 × 51 = 30600

Velocity = 30600 cm/s = 306 m/s

16. The minium and maximum capacitances, which may be obtained by the combination of three capacitors each of capacitance 6 μF are

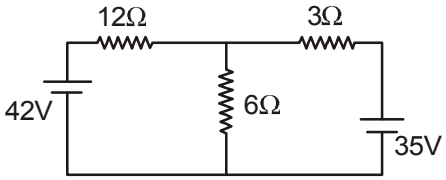
(A) 6 μF and 18 μF (B) 2 μF and 18 μF (C) 2 μF and 12 μF (D) 6 μF and 12 μF

Solution : (B)

C_{max} = connected in parallel = 18 μf

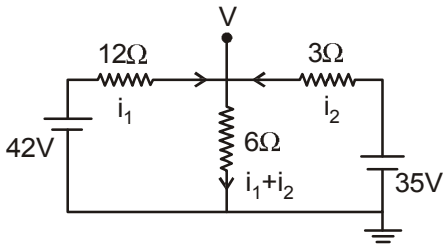
C_{min} = connected in series $=\left(\frac{1}{6}+\frac{1}{6}+\frac{1}{6}\right)^{-1}=2\mu F$

17. The current flowing through the 3Ω resistor in the circuit is,



(A) 4.2 A (B) 3.0 A (C) 3.5 A (D) 1.6 A

Solution : (B)



$$V=\frac{\frac{E_1}{r_1}+\frac{E_2}{r_2}}{\frac{1}{r_1}+\frac{1}{r_2}+\frac{1}{R}}=\frac{\frac{42}{12}+\frac{35}{3}}{\frac{1}{12}+\frac{1}{3}+\frac{1}{6}}=\frac{42+140}{1+4+2}=26$$

$35 - 3i_2 = 26$; $3i_2 = 9$; $i_2 = 3$

18. A body attached to the lower end of a vertical spring oscillated with time period of 1 sec. The time period when two such springs are connected one below another is approximately

(A) 0.7 sec (B) 1 sec (C) 1.4 sec (D) 2 sec

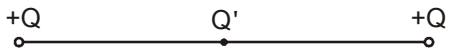
Solution : (C)

$$T_1=2\pi\sqrt{\frac{m}{K_1}}=1 \text{ sec.};\ T_2=2\pi\sqrt{\frac{m}{K_2}}=2\pi\sqrt{\frac{m}{(\frac{K_1}{2})}}=2\pi\sqrt{\frac{m}{K_1}}.\sqrt{2}=1.4 \text{ sec.}$$

19. Two charges of equal amount +Q are placed on a line. Another charge q is placed at the mid-point of the line. The system will be in equilibrium if the value of q is

(A) $-\frac{Q}{4}$ (B) $-\frac{Q}{2}$ (C) $+\frac{Q}{2}$ (D) $+\frac{Q}{4}$

Solution : (A)



$$\frac{Q^2}{Kr^2}+\frac{Q'Q}{\left(\frac{r}{2}\right)^2}=0 \; ; \; Q'=\frac{-Q}{4}.$$

20. The increase in electrostatic potential energy of a dipole of moment p when it is taken from parallel to anti-parallel orientation in an electric field E is

(A) 2pE (B) 3pE (C) 5pE (D) 6pE

Solution : (A)

Potential energy, $U = -PE\cos\theta$

$U_{min} = -PE, \theta = 0$

$U_{max} = +PE, \theta = 180°$

$\Delta U = 2PE$

21. An n-p-n transistor of current gain 80 in common emitter mode gives emitter current equal to 8.1mA. The base current is

(A) 0.1 μA (B) 0.01 mA (C) 0.1 mA (D) 0.01 μA

Solution : (C)

Common emitter $\Rightarrow$ input is base, output is collector

Current gain $= \frac{I_c}{I_b} = 80 \; ; \; I_c = 80\, I_b$

Now $I_e = I_c + I_b = 81\, I_b$

$\therefore 81\, I_b = 8.1$ mA, $I_b = 0.1$ mA

22. A Zener diode has breakdown voltage of 5.0 V. The resistance required to allow a current of 100 mA through the Zener in reverse bias when connected to a battery of emf 12V is

(A) 50 Ω (B) 70 Ω (C) 100 Ω (D) 150 Ω

Solution : (B)

IR = 12 – 5 = 7

$$R=\frac{7}{100\times10^{-3}}=70\Omega$$

23. A series LCR circuit resonates at 10 kHz. If the capacitor is 0.01 μF, the inductance used is approximately

(A) 10 mH (B) 25 mH (C) 50 mH (D) 100 mH

Solution : (B)

$$\omega_0=\frac{1}{\sqrt{LC}} \; ; \; 2\pi f_0=\frac{1}{\sqrt{LC}} \; ; \; 4\pi^2 f_0^2=\frac{1}{LC}$$

$$L=\frac{1}{4\pi^2 f_0^2 C}=\frac{1}{4\pi^2\times10^8\times10^{-8}}$$

$$\simeq\frac{1}{40}H\simeq\frac{1000}{40}mH\simeq25mH \quad [\pi^2\simeq10]$$

24. If a bar magnet of magnetic moment M is kept in a uniform magnetic field B, its time period of oscillation is T. In the same magnetic field, the time period or another magnet of same dimension and same mass but of moment M/4 is,

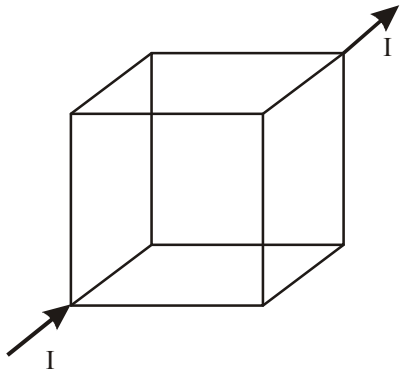
(A) T (B) 2T (C) T/2 (D) T/4

Solution : (B)

$$T = 2\pi\sqrt{\frac{I}{MB}}$$

$$T' 2\pi\sqrt{\frac{I}{\left(\frac{M}{4}\right)B}} = 2\pi\sqrt{\frac{I}{BM}}.2 = 2T$$

25. The magnetic field intensity at the centre of a cubical case of identical wires of length 'a' due to a current I flowing as shown in the figure is



(A) $\frac{2I}{a}$ (B) $\frac{\sqrt{2}I}{a}$ (C) 0 (D) I/2a

Solution : (C)

From symmetry, magnetic field at centre will be zero.

26. If I_1 & I_2 be the sizes of real images for two positions of a convex lens between object and screen, then the size of the object is

(A) I_1/I_2 (B) I_1I_2 (C) $\sqrt{I_1 I_2}$ (D) $\sqrt{I_1 / I_2}$

Solution : (C)

$$\frac{I_1}{ob} = \frac{\text{Image distance\_1}}{\text{object distance\_1}}; \frac{I_2}{ob} = \frac{\text{Image distance\_2}}{\text{object distance\_2}}$$

Image distance_2 = object distance_1

Object distance_2 = image distance_1

$$\therefore \frac{I_1I_2}{ob^2} = 1; \; ob = \sqrt{I_1I_2}$$

27. Impedance of a coil having inductance 0.4 H at frequency of 50 Hz will be

(A) $20\pi\ \Omega$ (B) $40\pi\ \Omega$ (C) $2\pi\ \Omega$ (D) $4\pi\ \Omega$

Solution : (B)

$X_L = \omega L = 2\pi fL = 2\pi \times 50 \times 0.4\ \Omega = 40\pi\ \Omega$

28. 1000 drops of water of radius 1 cm each carrying a charge of 10 esu combine to form a single drop. The capacitance increases thereby

(A) 1 time (B) 10 times (C) 100 times (D) 1000 times

Solution : (B)

$10^3 \times \frac{4}{3}\pi r^3 = \frac{4}{3}\pi R^3 \Rightarrow R = 10r$; $C \propto r$

Hence capacitance of large drop will be ten times to that of each small drop.

29. A micro-ammeter gives full scale deflection at 100 μA. Its resistance is 2 kΩ. The resistance required to convert it to a voltmeter reading 1V is

(A) 1 kΩ in series (B) 8 kΩ in series (C) 1 kΩ in parallel (D) 8 kΩ in parallel

Solution : (B)

$i_g (r_g + R) = V$; $100 \times 10^{-6} (2000 + R) = 1$

$2000 + R = 10000$; $R = 8000\Omega = 8\ k\Omega$

30. An electron of mass 'm' is accelerated by a potential difference V and the corresponding de-Broglie wavelength is λ. The de Broglie wavelength of a proton of mass M if it is accelerated by the same potential difference is,

(A) $\lambda\left(\frac{m}{M}\right)$ (B) $\lambda\left(\frac{M}{m}\right)$ (C) $\lambda\sqrt{\frac{m}{M}}$ (D) $\lambda\sqrt{\frac{M}{m}}$

Solution : (C)

$eV = \frac{1}{2}mv^2$; $m^2v^2 = 2eVm$

$mv = \sqrt{2eVm} = \frac{h}{\lambda}$

Now $eV = \frac{1}{2}Mv_1^2$; $Mv_1 = \sqrt{2eVM} = \frac{h}{\lambda_1}$

$\sqrt{\frac{2eVm}{2eVM}} = \frac{h}{\lambda} \times \frac{\lambda_1}{h}$; $\lambda_1 = \lambda\sqrt{\frac{m}{M}}$

Category – II (Q.31 to Q.35)

Only one answer is correct. Correct answer will fetch full marks 2. Incorrect answer or any combination of more than one answer will fetch –½ marks.

31. For the following set(s) of forces (in the same unit) the resultant can never be zero

(A) 10, 10, 10 (B) 10, 10, 20 (C) 10, 20, 30 (D) 10, 20, 40

Solution : (D)

32. A particle of mass 'm' and carrying a charge 'q' enters with a velocity 'v' perpendicular to a uniform magnetic field. The time period of rotation of the particle

(A) decreases with increase of velocity v. (B) increases with increase of radius of the orbit

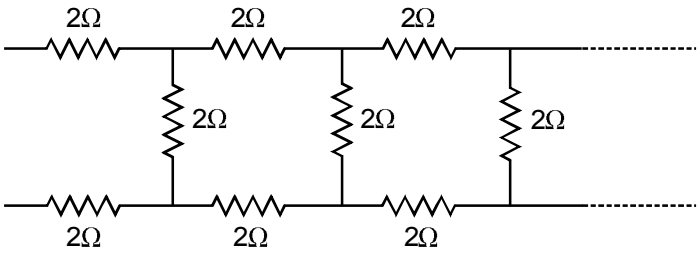
(C) depends only on magnetic field

(D) depends on magnetic field and (q/m) of the particle

Solution : (D)

$Bqv = \frac{mv^2}{r}$; $Bq = m\omega = m\frac{2\pi}{T}$; $T = \frac{2\pi m}{Bq}$

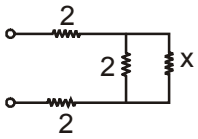
33. Equivalent resistance of the given infinite circuit is



(A) 4Ω (B) 2Ω

(C) infinity (D) greater than 4Ω but less than 6Ω

Solution : (D)



$$x = 2 + \frac{2x}{2+x} + 2 \; ; \; (x-4) = \frac{2x}{2+x}$$

$(x - 4)(x + 2) = 2x$; $x^2 - 4x + 2x - 8 = 2x$

$$x^2 - 4x - 8 = 0; \; x = \frac{4 + \sqrt{16+32}}{2} = \frac{4+4\sqrt{3}}{2} = 2\sqrt{3} + 2$$

$$1 < \sqrt{3} < 2 \; ; \; 2 < 2\sqrt{3} < 4 \; ; \; 4 < 2\sqrt{3} + 2 < 6$$

34. The ionization potential of hydrogen is –13.6 eV. The energy required to excite the electron from the first to the third orbit is approximately

(A) 10.2 J (B) 12.09×10^{-6} J (C) 19.94 J (D) 19.34×10^{-19} J

Solution : (D)

K L

$-13.6 \qquad \frac{-13.6}{9}$

$$\Delta E = 13.6 \times \frac{8}{9} \text{eV} = 13.6 \times \frac{8}{9} \times 1.6 \times 10^{-19} \text{J} = 19.34 \times 10^{-19} \text{J}$$

35. Assume that the Earth rotates in a circular orbit round the Sun in 365 days. If the mass of the sun gets doubled but the radius of the orbit remains unchanged, the length of the year would be approximately

(A) 183 days (B) 258 days (C) 516 days (D) 730 days

Solution : (B)

$$T^2 = \frac{4\pi^2}{GM} r^3 \; , \; \left(\frac{T_2}{T_1}\right)^2 = \left(\frac{M_1}{M_2}\right) = \frac{1}{2}$$

$$T_2 = \frac{T_1}{\sqrt{2}} \cong 365 \times 0.7 \text{ days} \cong 255.5 \text{ days}$$

Category – III (Q.36 to Q.40)

One or more answer(s) is (are) correct. Correct answer(s) will fetch marks 2. Any combination containing one or more incorrect answer will fetch 0 marks. If all correct answers are not marked and also no incorrect answer is marked then score = 2 × number of correct answers marked / actual number of correct answers.

36. Equation of a wave is given by $y = 10^{-4}\sin(60t + 2x)$, x & y in metre and t is in second. Then

(A) Wave is propagating along the negative x direction with velocity 30 m/s

(B) Wavelength is π metre

(C) frequency is $30/\pi$ Hz.

(D) Wave is propagating along positive x direction with velocity 60 m/s.

Solution : (A,B,C)

$y = 10^{-4}\sin(60t + 2x)$ propagates along – x-axis

$a = 10^{-4};\ \omega = 60 = 2\pi f\ ;\ \frac{2\pi}{\lambda} = 2$

$2\pi f \times \frac{\lambda}{2\pi} = 60 \times \frac{1}{2};\ f\lambda = 30$

$\Rightarrow$ option (A) is correct.

$\lambda = \pi \Rightarrow$ option (B) is correct.

$f = \frac{30}{\pi} \Rightarrow$ option (C) is correct.

37. An electric dipole is placed in a non-uniform electric field $\vec{E}$. The electric field is along x direction. The dipole will experience

(A) a torque when the dipole is parallel to $\vec{E}$.

(B) a torque when the dipole makes an angle with $\vec{E}$.

(C) a force perpendicular to $\vec{E}$.

(D) a force when the dipole is parallel to $\vec{E}$.

Solution : (B,D)

38. At any instant t current i through a coil of self inductance 2 mH is given by $i = t^2e^{-t}$. The induced e.m.f. will be zero at time

(A) 1 sec (B) 2 sec (C) 3 sec (D) 4 sec

Solution : (B)

$i = t^2e^{-t};\ \ln i = 2\ln t - t;\ \frac{1}{i}\frac{di}{dt} = \frac{2}{t} - 1$

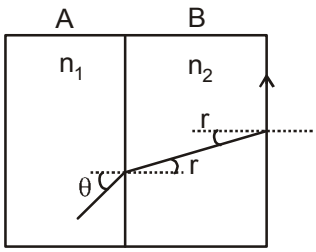
When induced emf = 0

$\frac{di}{dt} = 0\ ;\ \frac{2}{t} - 1 = 0\ ;\ t = 2$ sec.

39. A and B are two parallel sided transparent slabs of refractive indices n_1 and n_2 respectively. A ray is incident at an angle θ on the surface of separation of A and B, and after refraction from B into air grazes the surface of B. Then

(A) $\sin\theta = \frac{1}{n_2}$ (B) $\sin\theta = \frac{1}{n_1}$ (C) $\sin\theta = \frac{n_2}{n_1}$ (D) $\sin\theta = \frac{n_1}{n_2}$

Solution : (B)



$n_1 \sin\theta = n_2 \sin r = 1 \sin 90°$

40. The pair of parameters temperature T, pressure P, volume V and work W characterises the thermodynamic state of matter

(A) T, P (B) T, V (C) T, W (D) P, W

Solution : (A,B)

CHEMISTRY

Category – I (Q.40 to Q.70)

Only one answer is correct. Correct answer will fetch full marks 1. Incorrect answser or any combination of more than one answer will fetch –¼ marks.

41. Which of the following is true in respect of adsorption?

(A) $\Delta G < 0; \Delta S > 0; \Delta H < 0$ (B) $\Delta G < 0; \Delta S < 0; \Delta H < 0$

(C) $\Delta G > 0; \Delta S > 0; \Delta H < 0$ (D) $\Delta G < 0; \Delta S < 0; \Delta H > 0$

Solution : (B)

$\Delta G < 0, \Delta S < 0, \Delta H < 0$

42. Which property that polyacetylene exhibits is unusual for an organic polymer?

(A) Electrical conductivity (B) Flexibility

(C) High boiling point (D) Solubility

Solution : (A)

Polyacetylene has been discovered as a conducting organic polymer and this leads to many development in material seciens.

43. Which statement is incorrect?

(A) Borazine has a 3D-layer structure like that of graphite

(B) Boric acid has a hydrogen bonded layer structure in the solid state

(C) Borazine molecule is $(BN)_3$

(D) $[Al_6O_{18}]^{18-}$ contains a non-planar Al_6O_6-ring

Solution : (A,C)

$B_3N_3H_6 \rightarrow$ Barazine molecule.

44. Which one of the following does not produce O_2 as the only gaseous product on heating?

(A) Lead Nitrate (B) Potassium chlorate (C) Mercuric Oxide (D) Potassium Nitrate

Solution : (A)

$$2Pb(NO_3)_2 \rightarrow 2PbO + 4NO_2 + O_2$$

45. Consider the following reaction :

$6NaOH + 3Cl_2 \longrightarrow 5NaCl + A + 3H_2O$

What is the oxidation number of chlorine in A?

(A) +5 (B) –1 (C) +3 (D) +1

Solution : (A)

$$\overset{0}{NaOH} + 3\overset{\overset{+5e}{\frown}}{Cl_2} \rightarrow 5\overset{\underset{-1}{\frown}}{NaCl} + \overset{+5}{NaClO_3} + 3H_2O$$

$$\underbrace{\qquad\qquad}_{-5e} \; A$$

46. A sudden large difference between the values of second and third ionization energies of elements would be associated with which of the following electronic configurations?

(A) $1s^2\ 2s^2\ 2p^6\ 2s^1$ (B) $1s^2\ 2s^2\ 2p^6\ 3s^2$

(C) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^1$ (D) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^2$

Solution : (B)

$1s^2 2s^2 2p^6 3s^2$

2nd electron is removed from $3s^1$ and 3rd electron is removed from …$2p^6$ (inert structure)

47. Na_2O_2 is produced in reaction between H_2O_2 and NaOH. Here the role of H_2O_2 is

(A) as an oxidising agent (B) as an acid

(C) as a base (D) as a reducing agent

Solution : (B)

$H_2O_2 + 2NaOH \rightarrow Na_2O_2 + 2H_2O$

It is an acid base reaction in which H_2O_2 is an acid.

48. Which statement is incorrect about complexes formed by the lanthanoids?

(A) Hard donor ligands are favoured

(B) High coordination numbers (more than six) are often observed

(C) The 4f atomic orbitals do not play a significant part in metal-ligand bonding

(D) Aqua ions are typically 6-coordinate

Solution : (D)

49. In the alumino-thermite process, aluminium acts as

(A) a reducing agent (B) an oxidizing agent (C) an additive agent (D) a flux

Solution : (A)

Al acts as a reducing agent. $Fe_2O_3 + 2Al \rightarrow Al_2O_3 + 2Fe$

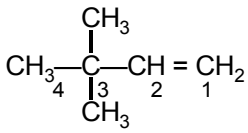
50. The correct IUPAC name of

$H_3C—C(CH_3)_2—CH = CH_2$ is

(A) 3, 3, 3—trimethyl prop–1–ene (B) 1, 1, 1–trimethyl α–propene

(C) 3, 3–dimethyl but–1–ene (D) 2, 2–dimethyl but–3–ene

Solution : (C)



51. Amongst the following compounds, the one which would not form a white precipitate with ammonical silver nitrate solution is

(A) $HC \equiv CH$ (B) $H_3C—C \equiv C—CH_3$

(C) $H_3C—C \equiv CH$ (D) $CH_3CH_2CH_2C \equiv CH$

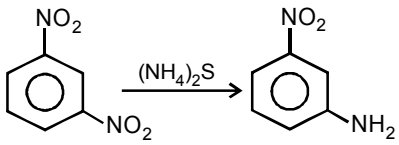
Solution : (B)

$CH_3 — C \equiv C — CH_3$ will not form any white ppt. as there is no acidic hydrogen.

52. m-dinitrobenzene can be converted to m-nitroaniline by reduction with

(A) Raney Nickel (B) $LiAlH_4$ (C) $(NH_4)_2S$ (D) Na/C_2H_5OH

Solution : (C)



53. Which combination of reagents used in the indicated order will give m-nitropropylbenzene from benzene?

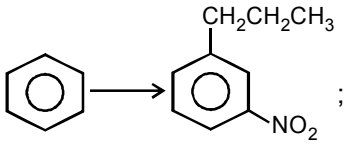
(A) 1) conc. HNO_3/conc. H_2SO_4 , 2) $CH_3CH_2CH_2/AlCl_3$

(B) 1) $CH_3CH_2CH_2Cl/AlCl_3$, 2) conc. HNO_3/conc. H_2SO_4

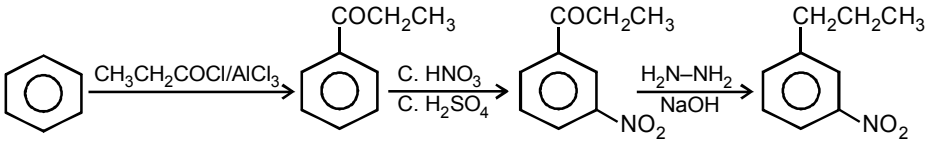
(C) 1) $CH_3CH_2COCl/AlCl_3$, 2) conc. HNO_3/conc. H_2SO_4 , 3) $H_2NNH_2/NaOH$

(D) 1) conc. HNO_3/conc.H_2SO_4 , 2) $CH_3CH_2COCl/AlCl_3$ 3) $H_2NNH_2/NaOH$

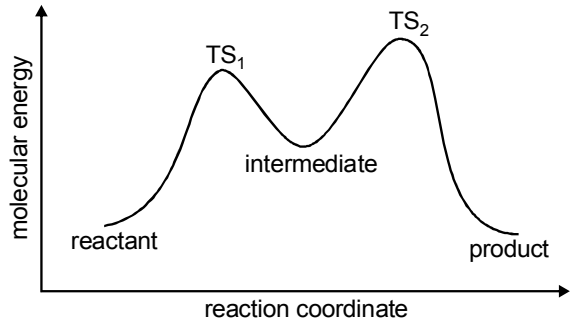
Solution : (C)



;



54. Which of the statements (A) – (D) about the reaction profile below is false?



(A) The product is more stable than the reactant.

(B) The second step is rate determining.

(C) The reaction is exothermic.

(D) The equilibrium constant is greater than 1 if the molar entropy change is negligible.

Solution : (B)

(A), (C), (D) all are correct

$\Delta G^\circ = -RT \ln K$

$\Delta H^\circ - T\Delta S^\circ = -RT \ln K$

$\Rightarrow \quad \Delta H^\circ = -RT \ln K \qquad [\because \Delta S^\circ = 0]$

Here $\Delta H^\circ < 0$

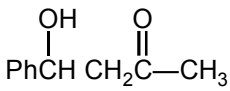
$\therefore \quad \ln K > 0$

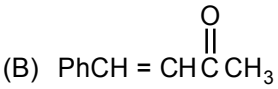
$\Rightarrow \quad \log K > 0$

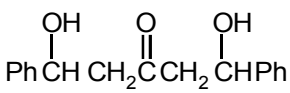
$\therefore \quad \log K > \log 1$

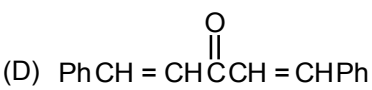
$\therefore \quad K > 1$

55. Which of the following is the major product when one mole of propanone and two moles of benzaldehyde react in presence of catalystic amount of NaOH?

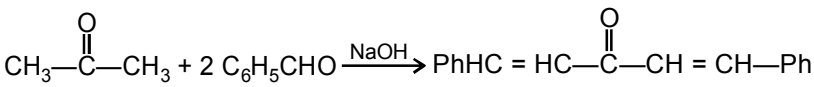
(A) 

(B) 

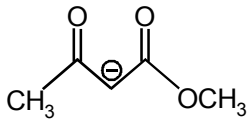
(C) 

(D) 

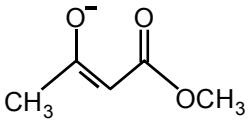
Solution : (D)

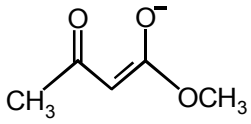


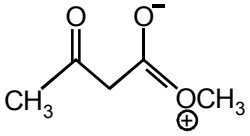
56. For the following anion,

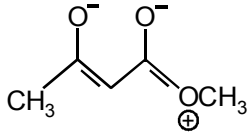


the resonance structure that contributes most is

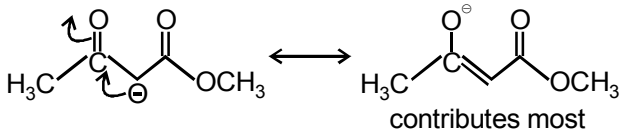
(A) 

(B) 

(C) 

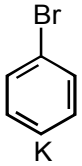
(D) 

Solution : (A)

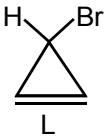


contributes most

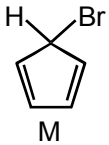
57. Consider the following compounds :



K



L



M

Which one of the following statements is correct ?

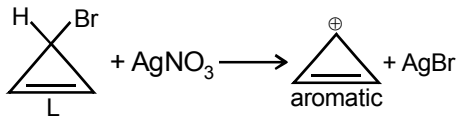
(A) Only K forms a precipitate on treatment with alcoholic $AgNO_3$ solution

(B) Only L forms a precipitate on treatment with alcoholic $AgNO_3$ solution

(C) Only M forms a precipitate on treatment with alcoholic $AgNO_3$ solution

(D) K, L and M form precipitates with alcoholic $AgNO_3$ solution

Solution : (B)



aromatic

58. Consider the following nuclear reactions :

$${}^{238}_{92}M \longrightarrow {}^{Y}_{X}N + 2\alpha; \quad {}^{Y}_{X}N \longrightarrow {}^{A}_{B}L + 2\beta^{+};$$

The number of neutrons in the element L is :

(A) 142 (B) 144 (C) 140 (D) 146

Solution : (B)

$${}^{238}_{92}M \longrightarrow {}^{230}_{88}N + 2{}_2He^4; \; {}^{230}_{88}N \longrightarrow {}_{86}L^{230} + 2\beta^{(+)}$$

$\therefore$ No. of neutron in L = (230 – 86) = 144

59. Among the following groupings, which one represents the set of iso-electronic species ?

(A) $NO^+, C_2^{2-}, O_2^-, CO$ (B) $NO^+, C_2^{2-}, O_2^-, CO$ (C) CO, NO^+, CN^-, C_2^{2-} (D) NO, CN^-, N_2, O_2^-

Solution : (C)

In CO, $NO^{\oplus}, CN^{\ominus}$, C_2^{2-} contain 14 e.

60. In the complex ion $[Cu(CN)_4]^{3-}$ the hybridization state, oxidation state and number of unpaired electrons of copper are respectively

(A) dsp^2, +1, 1 (B) sp^3, +1, zero (C) sp^3, +2, 1 (D) dsp^3, +2, zero

Solution : (B)

In $[Cu(CN)_4]^{3-}$ oxidation state of cu is + 1.

$Cu^{\oplus} \rightarrow [Ar]3d^{10}$

So hybridisation of Cu in $[Cu(CN)_4]^{3-}$ is sp^3 and no. of unpaired electrons = 0.

61. The maximum number of 2p electrons with electronic spin = $-\frac{1}{2}$ are

(A) 6 (B) 0 (C) 2 (D) 3

Solution : (D)

Maximum 2p electrons with $\frac{-1}{2}$ spin = 3

62. For N^{3-}, O^{2-}, F^- and Na^+, the order in which their ionic radii varies is

(A) $N^{3-} > O^{2-} > F^- > Na^+$ (B) $N^{3-} > Na^+ > O^{2-} > F^-$

(C) $Na^+ > O^{2-} > N^{3-} > F^-$ (D) $O^{2-} > F^- > Na^+ > N^{3-}$

Solution : (A)

For iso electronic specis, radius $\propto \frac{1}{\text{atomic number}}$

63. Of the following atoms, which one has the highest n/p ratio ?

(A) Ne^{16} (B) O^{16} (C) F^{16} (D) N^{16}

Solution : (D)

In $_{10}Ne^{16}\,(p=10, n=6)$ $\therefore n/p = \frac{6}{10} = 0.6$

$_8O^{16}\,(p=8, n=8)$ $\therefore n/p = \frac{8}{8} = 1$

$_9F^{16}\,(p=9, n=7)$ $\therefore n/p = \frac{7}{9} = 0.77$

$_7N^{16}\,(p=7, n=9)$ $\therefore n/p = \frac{9}{7} = 1.28$

64. The spin-only magnetic moment of $[CrF_6]^{4-}$ (atomic number of Cr is 24) is

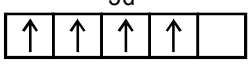
(A) 0 (B) 1.73 BM (C) 2.83 BM (D) 4.9 BM

Solution : (D)

$[CrF_6]^{4-}$ the oxidation state of Cr is + 2.

$\therefore$ $Cr^{2+} \rightarrow [Ar]3d^4 4s^0$

$F^{\ominus}$ is a weak field ligand. So $3d^4$ present as



$\therefore$ Spin only magnetic moment = $\sqrt{n(n+2)} = \sqrt{4(4+2)} = \sqrt{24} = 4.9$ BM

65. Which of the following is the correct option for free expansion of an ideal gas under adiabatic condition?

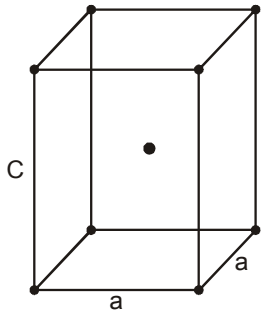
(A) $q = 0, \Delta T \neq 0, W = 0$ (B) $Q = 0, \Delta T \neq 0, W \neq 0$

(C) $q = 0, \Delta T = 0, W = 0$ (D) $q = 0, \Delta T = 0, W \neq 0$

Solution : (C)

For free expansion $q = 0, \Delta T = 0$ are $W = 0$

66. Assign the Bravais lattice type of the following unit cell structure.



(A) cubic I (B) Orthorhombic I

(C) Tetragonal I (D) Monoclinic

Solution : (C)

Tetragonal; $a = b \neq c$. and $\alpha = \beta = \gamma = 90^\circ$

67. The equilibrium constant for the reaction $N_2 + 3H_2 \rightleftharpoons 2NH_3$ is 'K'. Then, the equilibrium constant for the reaction $2N_2 + 6H_2 \rightleftharpoons 4NH_3$ will be

(A) K (B) K^2

(C) $\sqrt{K}$ (D) 2K

Solution : (B)

$$N_2 + 3H_2 \rightleftharpoons 2NH_3 \quad \ldots K = \frac{[NH_3]^2}{[N_2][H_2]^3}$$

For $2N_2 + 6H_2 \rightleftharpoons 4NH_3$

$$K_1 = \frac{[NH_3]^4}{[N_2]^2[H_2]^6} = \left\{\frac{[NH_3]^2}{[N_2][H_2]^3}\right\}^2 = K^2$$

68. Which of the following compounds is least effective in precipitating $Fe(OH)_3$ solution ?

(A) $K_4[Fe(CN)_6]$ (B) K_2CrO_4

(C) KBr (D) K_2SO_4

Solution : (C)

$Fe(OH)_3$ is precipitated by anion. Lower the charge of anion least effective in precipititation.

69. 75% of a first order reaction was completed in 32 min. When would 50% of the reaction be completed?

(A) 24 min (B) 16 min

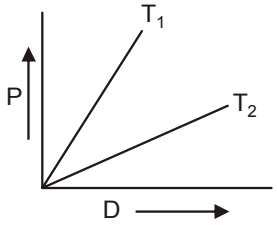
(C) 8 min (D) 64 min

Solution : (B)

For First order reaction $t_{75\%} = 2 \times t_{50\%}$.

$$\therefore \quad t_{50\%} = \frac{t_{75\%}}{2} = \frac{32}{2} = 16 \text{ min}$$

70. Pressure (P) vs. density (D) curve for an ideal gas at two different temperatures T_1 and T_2 is shown below.



(A) $T_1 > T_2$ (B) $T_1 < T_2$ (C) $T_1 = T_2$ (D) Cannot be said

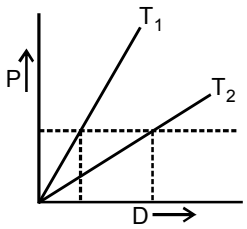
Solution : (A)

$$PV = \frac{W}{M}RT$$

$$P = \frac{W}{V}\frac{RT}{M} = \frac{DRT}{M}$$

At constant pressure DT = Constant.

$\therefore$ $T_1 > T_2$



Category – II (Q.71 to Q.75)

Only one answer is correct. Correct answer will fetch full marks 2. Incorrect answser or any combination of more than one answer will fetch –½ marks.

71. The emf of a Daniel cell at 298 K is E_1. The cell is

$Zn \mid ZnSO_4\ (0.01M) \parallel CuSO_4(1M) \mid Cu$

When the concentration of $ZnSO_4$ is changed to 1M and that of $CuSO_4$ to 0.01 M, the emf changes to E_2. The relationship between E_1 and E_2 will be

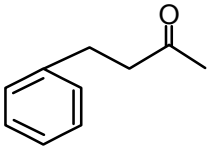
(A) $E_1 - E_2 = 0$ (B) $E_1 < E_2$ (C) $E_1 > E_2$ (D) $E_1 = 10^2 E_2$

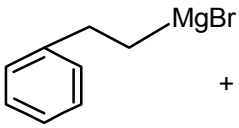
Solution : (C)

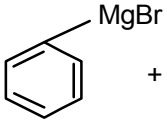
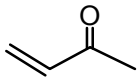
$$E_1 = E^0 - \frac{0.059}{2}\log\frac{.01}{1} = E^0 + 0.059$$

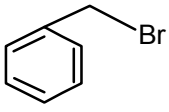
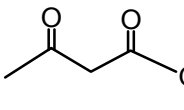
$$E_2 = E^0 - \frac{0.059}{2}\log\frac{1}{.01} = E^0 - 0.059 \qquad \therefore\ E_1 > E_2$$

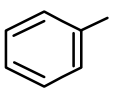
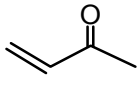
72. Which reaction is not appropriate for the synthesis of the following ?



(A)  $+ CH_3CN \xrightarrow[2)\ E_3O^+]{1)\ Et_2O}$

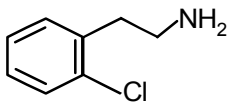
(B)  $+$  $\xrightarrow[2)\ E_3O^+]{1)\ Et_2O}$

(C)  $+$  $\xrightarrow[2)\ H_2SO_4,\ H_2O,\ \Delta]{1)\ NaOEt,\ EtOH}$

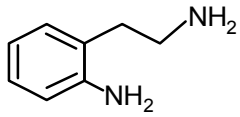
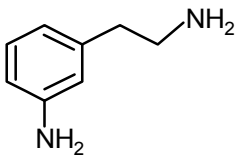
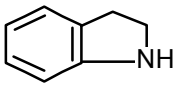
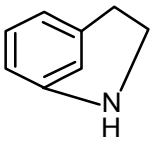
(D)  $+$  $\xrightarrow[2)\ H_3O^+]{1)\ THF}$

Solution : (D) ; 1, 2-addition takes place.

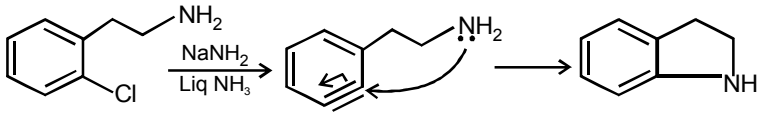
73. The major product obtained upon treatment of



with $NaNH_2$ and liquid NH_3 is

(A)  (B)  (C)  (D) 

Solution : (C)



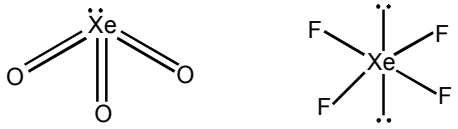
74. Which structures for XeO_3 and XeF_4 are consistent with the VSEPR model ?

(A) XeO_3, trigonal pyramidal; XeF_4, square planar

(B) XeO_3, trigonal planar; XeF_4, square planar

(C) XeO_3, trigonal pyramidal; XeF_4, tetrahedral (D) XeO_3, trigonal planar; XeF_4, tetrahedral

Solution : (A)



75. If CO_2 gas is passed through 500 ml of 0.5(M) $Ca(OH)_2$, the amount of $CaCO_3$ produced is

(A) 10 g (B) 20 g (C) 50 g (D) 25 g

Solution : (D)

500 ml of 0.5(M) $Ca(OH)_2 \equiv \frac{500 \times 0.5}{1000}$ mole = 0.25 mole

$CaCO_3$ formed = 25 g

Category – III (Q.76 to Q.80)

One or more answer(s) is (are) correct. Correct answer(s) will fetch marks 2. Any combination containing one or more incorrect answer will fetch 0 marks. If all correct answers are not marked and also no incorrect answer is marked then score = 2 × number of correct answers marked / actual number of correct answers.

76. Equal quantities of electricity are passed through 3 voltameters containing $FeSO_4$, $Fe_2(SO_4)_3$ and $Fe(NO_3)_3$

Consider the following statements :

(1) The amounts of iron deposited in $FeSO_4$ and $Fe_2(SO_4)_3$ are equal

(2) The amount of iron deposited in $Fe(NO_3)_3$ is 2/3rd of the amount deposited in $FeSO_4$

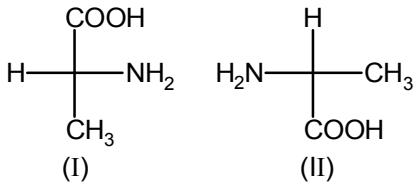
(3) The amount of iron deposited in $Fe_2(SO_4)_3$ and $Fe(NO_3)_3$ are equal

(A) (1) is correct (B) (2) is correct

(C) (3) is correct (D) Both (1) and (2) are correct

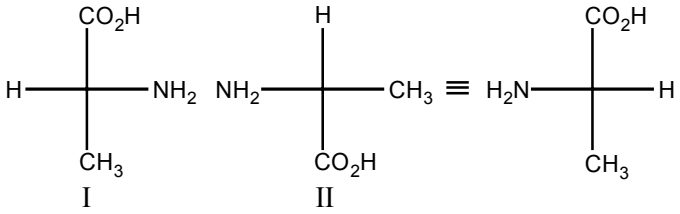
Solution : (B,C)

77. Which of the following statements are correct for the following isomeric compounds I and II :



(A) I and II are enantiomers
(B) I and II are both optically active
(C) I is D-alanine while II is L-alanine
(D) I and II are diastereomers

Solution : (A,B,C)



D-alanine L-alanine

78. Which of the following statements are correct with reference to isoelectric point of alanine ?

(A) At the isoelectric point, alanine bears no net charge
(B) At the isoelectric point, the concentration of the zwitterion is maximum
(C) It is not the average of pKa_1 and pKa_2 values
(D) Alanine will have a net positive charge at pH below the isoelectric point

Solution : (A,B,D)

79. Consider the proposed mechanism for the destruction of ozone in the stratosphere

$O_3 + Cl \rightarrow ClO + O_2$ $\quad ClO + O_3 \rightarrow Cl + 2O_2$

Which of the statements about this mechanism is/are correct ?

(A) Cl is a catalyst
(B) O_2 is an intermediate
(C) Equal amounts of Cl and ClO are present at any time
(D) The number of moles of O_2 produced equals the number of moles of O_3 consumed

Solution : (A,C)

80. Which of the following statement(s) is (are) correct ?

(A) The electronic configuration of Cr (at no : 24) is [Ar] $3d^5\ 4s^1$
(B) The magnetic quantum number may have a negative value
(C) In Ag (at. no: 47), 23 electrons have spins of one type and 24 electrons have spins of opposite type
(D) The oxidation state of nitrogen in HN_3 is – 3

Solution : (A,B,C)