WBJEEM - 2015

Answer Keys by

Aakash Institute, Kolkata Centre

PHYSICS & CHEMISTRY

Q.No.	⇈	⇊	⇉	⇇
01	B	B	C	B
02	B	C	B	B
03	C	D	A	A
04	B	B	B	C
05	C	C	B	B
06	D	*	C	A
07	B	C	D	D
08	B	B	A	A
09	A	A	B	D
10	B	C	C	B
11	C	C	D	B
12	*	B	C	C
13	B	B	C	B
14	A	C	B	C
15	C	C	B	*
16	C	B	B	D
17	C	B	A	A
18	B	C	D	B
19	A	B	A	C
20	D	B	D	C
21	A	A	B	B
22	C	B	C	C
23	C	A	*	D
24	B	C	B	B
25	D	C	C	A
26	A	D	C	C
27	D	A	B	C
28	B	D	A	C
29	C	A	C	C
30	C	D	C	B
31	C	C	B	D
32	D	B	C	D
33	D	C	D	C
34	C	D	D	B
35	B	D	C	C
36	A, B, D	B, C	B, C, D	B, D
37	A,C, D	B, C, D	B, C	A,C, D
38	B, D	A, B, D	B, D	A, B, D
39	B, C	A,C, D	A,C, D	B, C, D
40	B, C, D	B, D	A, B, D	B, C
41	B	C	A	A
42	C	B	A	A
43	C	B	A	A
44	B	B	B	B
45	B	A	C	D
46	B	A	A	A
47	C	A	A	A
48	B	C	A	A
49	C	C	C	B
50	A	A	C	D
51	A	A	B	C
52	A	A	B	A
53	B	A	B	B
54	D	C	C	C
55	B	B	A	C
56	D	C	A	B
57	C	B	A	C
58	A	C	A	A
59	C	B	C	A
60	A	D	B	A
61	A	C	C	C
62	A	A	A	C
63	A	A	A	A
64	A	A	A	A
65	A	A	B	A
66	A	A	D	A
67	C	A	B	C
68	A	A	D	B
69	A	B	C	B
70	A	D	A	B
71	A	C	A	C
72	C	A	A	A
73	C	A	C	A
74	A	A	C	A
75	A	C	A	C
76	B	A, D	A, C	A
77	A	A, B, D	A, B, D	B
78	A, D	A, C	A, D	A, C
79	A, B, D	B	A	A, B, D
80	A, C	A	B	A, D

* None of the options is correct

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ANSWERS & HINT
for
WBJEEM - 2015
SUB : PHYSICS & CHEMISTRY

PHYSICS

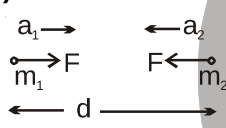
CATEGORY - I (Q1 to Q30)

Each question has one correct option and carries 1 mark, for each wrong answer 1/4 mark will be deducted.

1. Two particles of mass m_1 and m_2 ,approach each other due to their mutual gravitational attraction only. Then
   (A) accelerations of both the particles are equal
   (B) acceleration of the particle of mass m_1 is proportional to m_1
   (C) acceleration of the particle of mass m_1 is proportional to m_2
   (D) acceleration of the particle of mass m_1 is inversely proportional to m_1

   Ans : (C)

   Hint :



$$F = \frac{Gm_1m_2}{d_2} \Rightarrow a_1 = \frac{F}{m_1} = \frac{Gm_2}{d^2}$$

$\therefore a_1 \propto m_2$

2. Three bodies of the same material and having masses m, m and 3m are at temperatures 40^0C, 50^0C and 60^0C respectively. If the bodies are brought in thermal contact, the final temperature will be
   (A) 45^0C (B) 54^0C
   (C) 52^0C (D) 48^0C

   Ans : (B)

   Hint : Heat lost by bodies = Heat gained by bodies

$$\frac{m_1S_1T_1 + m_2S_2T_2 + m_3S_3T_3}{m_1S_1 + m_2S_2 + m_3S_3} = T \Rightarrow T = \frac{(m\times 40 + m\times 50 + 3m\times 60)\times S}{mS + mS + 3mS} = \frac{270}{5} = 54^\circ C$$

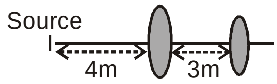
3. A satellite has kinetic energy *K*, potential energy *V* and total energy *E*. Which of the following statements is true ?
   (A) $K = -V/2$ (B) $K = V/2$
   (C) $E = K/2$ (D) $E = -K/2$

   Ans : (A)

   Hint : $K = \frac{GMm}{2r}$ and $V = \frac{-GMm}{r}$ $\therefore E = K + V = -\frac{GMm}{2r}$

$$\Rightarrow K = -\frac{V}{2}$$

4. An object is located 4 m from the first of two thin converging lenses of focal lengths 2m and 1m respectively. The lenses are separated by 3 m. The final image formed by the second lens is located from the source at a distance of



(A) 8.0 m (B) 7.5 m

(C) 6.0 m (D) 6.5 m

Ans : (B)

Hint : Using lens formula $\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$, for first lens u = –4m, f_1 = 2m $\therefore$ v_1 = 4m. So u for 2nd lens is equal to +1m. Again using lens formula for second lens putting u_2 = 1m and f_2 = 1m we get v_2 = 0.5. Therefore distance from object = 7+0.5=7.5 m

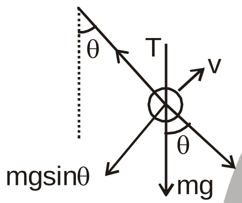
5. A simple pendulum of length L swings in a vertical plane. The tension of the string when it makes an angle θ with the vertical and the bob of mass m moves with a speed v is (g is the gravitational acceleration

(A) mv^2/L (B) $mg\cos\theta + mv^2/L$

(C) $mg\cos\theta - mv^2/L$ (D) $mg\cos\theta$

Ans : (B)

Hint :



mgcosθ. From the figure $T = mg\cos\theta + mv^2/L$

6. The length of a metal wire is L_1 when the tension is T_1 and L_2 when the tension is T_2. The unstretched length of the wire is

(A) $\frac{L_2+L_2}{2}$ (B) $\sqrt{L_1L_2}$

(C) $\frac{T_2L_1-T_1L_2}{T_2-T_1}$ (D) $\frac{T_2L_1+T_1L_2}{T_2+T_1}$

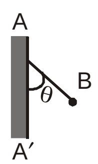
Ans : (C)

Hint : $Y=\frac{T_1\times\ell}{A\times(L_1-\ell)}$ and $Y=\frac{T_2\times\ell}{A\times(L_2-\ell)}$ therefore $T_2(L_1-\ell) = T_1(L_2-\ell)$ and hence $\ell=\frac{T_2L_1-T_1L_2}{T_2-T_1}$

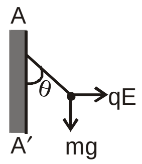
7. The line AA′ is on a charged infinite conducting plane which is perpendicular to the plane of the paper. The plane has a surface density of charge σ and B is a ball of mass m with a like charge of magnitude q. B is connected by a string from a point on the line AA′. The tangent of the angle (θ) formed between the line AA′ and the string is

(A) $\frac{q\sigma}{2\epsilon_0 mg}$ (B) $\frac{q\sigma}{4\pi\epsilon_0 mg}$

(C) $\frac{q\sigma}{2\pi\epsilon_0 mg}$ (D) $\frac{q\sigma}{\epsilon_0 mg}$

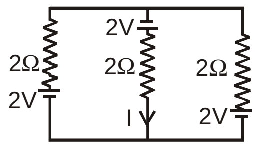


Ans : (D)

Hint : $\tan\theta = \dfrac{qE}{mg} = \dfrac{q\sigma}{mg\,\epsilon_0}$ 

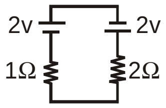
8. The current *I* in the circuit shown is

(A) 1.33 A (B) Zero (C) 2.00 A (D) 1.00 A



Ans : (A)

Hint : $E_{eq} = \dfrac{\dfrac{2}{2}+\dfrac{2}{2}}{\dfrac{1}{2}+\dfrac{1}{2}} = 2v$, $\dfrac{1}{r_{eq}} = \dfrac{1}{2}+\dfrac{1}{2} = 1$



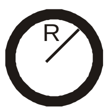
$\therefore I = \dfrac{4}{3} = 1.33A$

9. A hollow sphere of external radius *R* and thickness t (<< R) is made of a metal of density ρ, sphere will float in water if

(A) $t \le \dfrac{R}{\rho}$ (B) $t \le \dfrac{R}{3\rho}$

(C) $t \le \dfrac{R}{2\rho}$ (D) $t \ge \dfrac{R}{2\rho}$

Ans : (B)

Hint : 

Assuming ρ to be specific gravity, $(4\pi R^2 t)\rho \le \dfrac{4}{3}\pi R^3$. Therefore $t \le \dfrac{R}{3\rho}$

10. A metal wire of circular cross-section has a resistance R_1. The wire is now stretched without breaking so that its length is doubled and the density is assumed to remain the same. If the resistance of the wire now becomes R_2 then $R_2 : R_1$ is

(A) 1 : 1 (B) 1 : 2

(C) 4 : 1 (D) 1 : 4

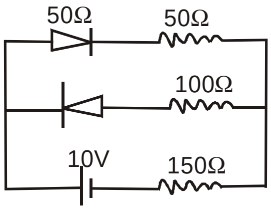
Ans : (C)

Hint : $R = n^2 R_0$. If $\ell \to n\ell$

11. Assume that each diode shown in the figure has a forward bias resistance of 50Ω and an infinite reverse bias resistance. The current through the resistance 150Ω is

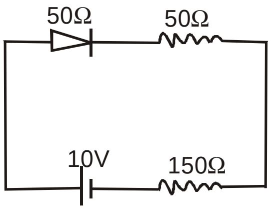
(A) 0.66 A (B) 0.05 A

(C) Zero (D) 0.04 A



Ans : (D)

Hint : Since the diode in reverse bias offers infinite resistance, the equivalent circuit becomes.



$$i = \frac{10}{250} = 0.04 \text{ A}$$

12. The r.m.s speed of oxygen is *v* at a particular temperature. If the temperature is doubled and oxygen molecules dissociate into oxygen atoms, the r.m.s speed becomes

(A) *v* (B) $\sqrt{2}v$

(C) 2v (D) 4v

Ans : (C)

Hint : $V_{rms} = \sqrt{\frac{3RT}{M}}$

$$V'_{rms} = \sqrt{\frac{3R(2T)}{M/2}} = 2\,V_{rms}$$

13. Two particles, A and B, having equal charges, after being accelerated through the same potential difference enter a region of uniform magnetic field and the particles describe circular paths of radii R_1 and R_2 respectively. The ratio of the masses of A and B is

(A) $\sqrt{R_1/R_2}$ (B) R_1/R_2

(C) $(R_1/R_2)^2$ (D) $(R_2/R_1)^2$

Ans : (C)

Hint : $r = \frac{\sqrt{2mqV}}{qB}$

$r \propto \sqrt{m}$

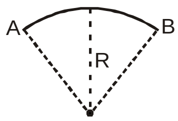
$$\therefore \frac{m_1}{m_2} = \left(\frac{R_1}{R_2}\right)^2$$

14. A large number of particles are placed around the origin, each at a distance R from the origin. The distance of the center of mass of the system from the origin is

(A) = R
(B) $\leq$ R
(C) > R
(D) $\geq$ R

Ans : (B)

Hint : If arc AB $\rightarrow$ 0 centre of mass is at a distance R from the origin as the arc length AB increases, centre of mass starts moving down



15. A straight conductor 0.1m long moves in a uniform magnetic field 0.1T. The velocity of the conductor is 15 m/s and is directed perpendicular to the field. The e.m.f. induced between the two ends of the conductor is

(A) 0.10 V
(B) 0.15 V
(C) 1.50 V
(D) 15.00 V

Ans : (B)

Hint : $\varepsilon = Bvl = 0.1\times15\times0.1 = .15V$ (considering B, ℓ and v are mutually perpendicular)

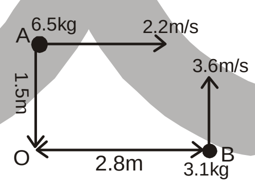
16. A ray of light is incident at an angle i on a glass slab of refractive index μ. The angle between reflected and refracted light is 90°. Then the relationship between i and μ is

(A) $i = \tan^{-1}\left(\frac{1}{\mu}\right)$
(B) $\tan i = \mu$
(C) $\sin i = \mu$
(D) $\cos i = \mu$

Ans : (B)

Hint : $\tan i = \mu$ (by Snell's Law)

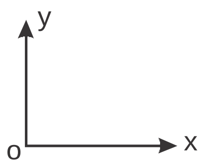
17. Two particles A and B are moving as shown in the figure. Their total angular momentum about the point O is



(A) 9.8 kg m²/s
(B) Zero
(C) 52.7 kg m²/s
(D) 37.9 kg m²/s

Ans : (A)

Hint : $\vec{L} = (6.5)(2.2)(1.5)\left(-\hat{k}\right) + (2.8)(3.1)(3.6)\left(\hat{k}\right) = 9.8\,(\hat{k})\ \text{kgm}^2/\text{s}$



18. A 20 cm long capillary tube is dipped vertically in water and the liquid rises upto 10 cm. If the entire system is kept in a freely falling platform, the length of water column in the tube will be

(A) 5 cm
(B) 10 cm
(C) 15 cm
(D) 20 cm

Ans : (D)

Hint : $g_{eff} = 0$

19. A train is moving with a uniform speed of 33 m/s and an observer is approaching the train with the same speed. If the train blows a whistle of frequency 1000 Hz and the velocity of sound is 333 m/s then the apparent frequency of the sound that the observer hears is

(A) 1220 Hz (B) 1099 Hz

(C) 1110 Hz (D) 1200 Hz

Ans : (A)

Hint : $f_{app} = \frac{V+V_o}{V-V_s} f_{source}$

$= 1220$ Hz

20. A photon of wavelength 300 nm interacts with a stationary hydrogen atom in ground state. During the interaction, whole energy of the photon is transferred to the electron of the atom. State which possibility is correct. (Consider, Planck's constant = 4×10^{-15} eVs, velocity of light = 3×10^{8} m/s, ionization energy of hydrogen = 13.6eV)

(A) Electron will be knocked out of the atom

(B) Electron will go to any excited state of the atom

(C) Electron will go only to first excited state of the atom

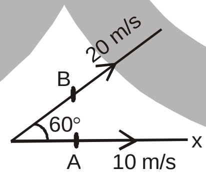
(D) Electron will keep orbiting in the ground state of atom

Ans : (D)

Hint : $E_{photon} = \frac{hc}{\lambda e}(\text{in eV}) = \frac{4\times10^{-15}\times3\times10^{8}}{300\times10^{-9}} = 4\text{eV}$

first excitation energy is 10.2 eV for an electron in the ground state of hydrogen atom. Since $E_{photon} < 10.2$ eV no excitation is possible

21. Particle A moves along X-axis with a uniform velocity of magnitude 10 m/s. Particle B moves with uniform velocity 20 m/s along a direction making an angle of 60° with the positive direction of X-axis as shown in the figure. The relative velocity of B with respect to that of A is

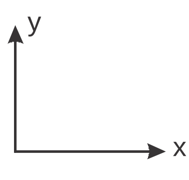


(A) 10 m/s along X-axis (B) $10\sqrt{3}$ m/s along Y-axis (perpendicular to X-axis)

(C) $10\sqrt{5}$ along the bisection of the velocities of A and B (D) 30 m/s along negative X-axis

Ans : (B)

Hint : $\overrightarrow{V_{BA}} = \overrightarrow{V_B} - \overrightarrow{V_A} = \left(20\times\cos60^\circ\hat{i} + 20\sin60^\circ\hat{j}\right) - 10\hat{i} = 10\sqrt{3}\,\hat{j}$



22. When light is refracted from a surface, which of its following physical parameters does not change ?

(A) velocity (B) amplitude

(C) frequency (D) wavelength

Ans : (C)

23. A solid maintained at t_1° C is kept in an evacuated chamber at temperature t_2°C ($t_2 >> t_1$). The rate of heat absorbed by the body is proportional to

(A) $t_2^4 - t_1^4$

(B) $(t_2^4 + 273) - (t_1^4 + 273)$

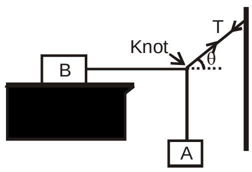
(C) $t_2 - t_1$

(D) $t_2^2 - t_1^2$

Ans : (None of the option is correct)

Hint : If temperature is given in kelvin, then answer is (A) and if given in °C then answer is $(t_2+273)^4-(t_1+273)^4$

24. Block B lying on a table weighs W. The coefficient of static friction between the block and the table is μ. Assume that the cord between B and the knot is horizontal. The maximum weight of the block A for which the system will be stationary is



(A) $\dfrac{W\tan\theta}{\mu}$

(B) $\mu W \tan\theta$

(C) $\mu W\sqrt{1+\tan^2\theta}$

(D) $\mu W \sin\theta$

Ans : (B)

Hint : $T\sin\theta = W_A$

$T\cos\theta = \mu W$

$\therefore W_A = \mu W\tan\theta$

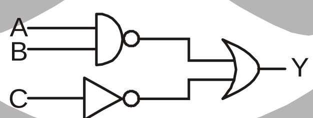
25. The inputs to the digital circuit are shown below. The output Y is

(A) $A+B+\overline{C}$

(B) $(A+B)\overline{C}$

(C) $\overline{A}+\overline{B}+\overline{C}$

(D) $\overline{A}+\overline{B}+C$



Ans : (C)

Hint : $\left(\overline{A.B}\right)+\overline{C}=\left(\overline{A}+\overline{B}+\overline{C}\right)$

26. Two particles A and B having different masses are projected from a tower with same speed. A is projected vertically upward and B vertically downward. On reaching the ground

(A) velocity of A is greater than that of B

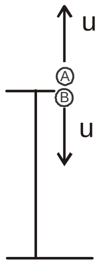
(B) velocity of B is greater than that of A

(C) both A and B attain the same velocity

(D) the particle with the larger mass attains higher velocity

Ans : (C)

Hint :



$$V_A^2 = u^2 - 2g(-h) = u^2 + 2gh$$

$$V_B^2 = u^2 + 2gh = u^2 + 2gh$$

$V_A = V_B$ (Attain the same final velocity)

27. The work function of metals is in the range of 2 eV to 5eV. Find which of the following wavelength of light cannot be used for photoelectric effect. (Consider, Planck constant = 4×10^{-15}eVs, velocity of light = 3×10^{8}m/s)

(A) 510 nm (B) 650 nm

(C) 400 nm (D) 570 nm

Ans : (B)

Hint : $\lambda_{min} = \dfrac{1242\,\text{ev}\times\text{nm}}{5\text{ev}} = 248.4\,\text{nm}$, $\lambda_{max} = \dfrac{1242\,\text{ev}\times\text{nm}}{2\text{ev}} = 621\,\text{nm}$

therefore the answer is 650 nm.

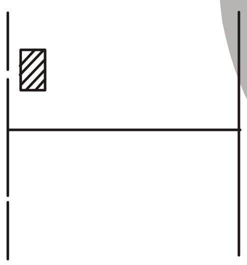
28. A thin plastic sheet of refractive index 1.6 is used to cover one of slits of a double slit arrangement. The central point on the screen is now occupied by what would have been the 7th bright fringe before the plastic was used. If the wavelength of light is 600 nm, what is the thickness (in μm) of the plastic?

(A) 7 (B) 4

(C) 8 (D) 6

Ans : (A)

Hint :



$(\mu - 1)t = \dfrac{xd}{D}$ t = thickness of sheet

$$(\mu-1)t = \frac{7\times\lambda\cancel{D}}{\cancel{d}}\times\frac{\cancel{d}}{\cancel{D}}$$

$$t = \frac{7\lambda}{(\mu-1)}$$

$$t = \frac{7\times600\times10^{-9}}{(1.6-1)} = 7\ \mu\text{m}$$

29. The length of an open organ pipe is twice the length of another closed organ pipe. The fundamental frequency of the open pipe is 100 Hz. The frequency of the third harmonic of the closed pipe is

(A) 100 Hz (B) 200 Hz

(C) 300 Hz (D) 150 Hz

Ans : (C)

Hint : $f_0 = \frac{V}{2l_0}$

$$f_C = 3 \times \frac{V}{4l_C}$$

$$f_C = 3 \times \frac{V}{4 \times \frac{l_0}{2}} \quad = 3 \times \left(\frac{V}{2l_0}\right) = 3 \times 100 \quad = 300\,\text{Hz}$$

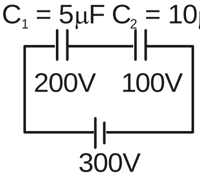
30. A 5 μF capacitor is connected in series with a 10 μF capacitor. When a 300 Volt potential difference is applied across this combination, the energy stored in the capacitors is

(A) 15 J (B) 1.5 J

(C) 0.15 J (D) 0.10 J

Ans : (C)

Hint : C_1 = 5μF C_2 = 10μF



$$C_{eq} = \frac{5 \times 10}{15} = \frac{10}{3}\,\mu F$$

$$U = \frac{1}{2} C_{eq} V^2 = 0.15\text{ J}$$

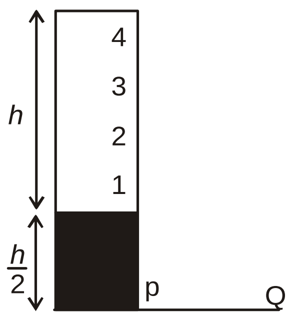
Category II (Q31 to Q35)

Each question has one correct option and carries 2 marks, for each wrong answer 1/2 mark will be deducted.

31. A cylinder of height *h* is filled with water and is kept on a block of height *h*/2. The level of water in the cylinder is kept constant. Four holes numbered 1,2,3 and 4 are at the side of the cylinder and at heights 0, *h*/4 and 3*h*/4 respectively. When all four holes are opened together, the hole from which water will reach farthest distance on the plane PQ is the hole no.

(A) 1 (B) 2

(C) 3 (D) 4



Ans : (B)

Hint : for maximum range , Height of the hole $= \dfrac{\text{Total height}}{2} = \dfrac{h+\dfrac{h}{2}}{2} = \dfrac{3h}{4}$

32. The pressure p, volume *v* and temperature *T* for a certain gas are releted by p = $\dfrac{AT - BT^2}{v}$, where *A* and *B* are constants. The work done by the gas when the temperature changes from T_1 to T_2 while the pressure remains constant, is given by

(A) $A(T_2 - T_1) + B(T_2^2 - T_1^2)$

(B) $\dfrac{A(T_2 - T_1)}{v_2 - v_1} - \dfrac{B(T_2^2 - T_1^2)}{v_2 - v_1}$

(C) $A(T_2 - T_1) - B(T_2^2 - T_1^2)$

(D) $\dfrac{A(T_2 - T_2^2)}{v_2 - v_1}$

Ans : (C)

Hint : $v = \dfrac{AT - BT^2}{p}$

$W = p\Delta v = p\,[v_2 - v_1]$

$= p\left[\dfrac{AT_2 - BT_2^2}{p} - \left(\dfrac{AT_1 - BT_1^2}{p}\right)\right]$

$= \left[A(T_2 - T_1) - B(T_2^2 - T_1^2)\right]$

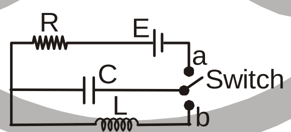
33. In the circuit shown below, the switch is kept in position 'a' for a long time and is then thrown to position 'b'. The amplitude of the resulting oscillating current is given by

(A) $E\sqrt{L/C}$

(B) E/R

(C) Infinity

(D) $E\sqrt{C/L}$



Ans : (D)

Hint : $q_0 = CE$

now by conservation of energy

$$\frac{q_0^2}{2c} = \frac{1}{2}LI_0^2 \Rightarrow \frac{C^2E^2}{2C} = \frac{1}{2}LI_0^2 \quad I_0 = E\sqrt{\frac{C}{L}}$$

34. A charge q is placed at one corner of a cube. The electric flux through any of the three faces adjacent to the charge is zero. The flux through any one of the other three faces is

(A) $q/3\in_0$

(B) $q/6\in_0$

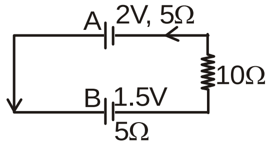
(C) $q/12\in_0$

(D) $q/24\in_0$

Ans : (D)

35. Two cells A and B of e.m.f 2V and 1.5V respectively, are connected as shown in figure through an external resistance 10Ω. The internal resistance of each cell is 5Ω. The potential difference E_A and E_B across the terminals of the cells A and B respectively are

(A) E_A = 2.0V, E_B = 1.5V
(B) E_A = 2.12V, E_B = 1.375V
(C) E_A = 1.875V, E_B = 1.625V
(D) E_A = 1.875V, E_B = 1.375V



Ans : (C)

Hint : $i = \frac{2-1.5}{20} = \frac{1}{40}\text{A}$

$$E_A = 2 - ir = 2 - \frac{1}{40}\times 5 = 1.875\text{V}$$

E_B = 1.5 + ir = 1.625 V

Category III (Q36 to Q40)

Each question has one or more correct option(s), choosing which will fetch maximum 2 marks on pro rata basis. However, choice of any wrong options(s) will fetch zero mark for the question.

36. Two charges +q and –q are placed at a distance 'a' in a uniform electric field. The dipole moment of the combination is $2qa\left(\cos\theta\,\hat{i} + \sin\theta\,\hat{j}\right)$, where θ is the angle between the direction of the field and the line joining the two charges.

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

(A) The torque exerted by the field on the dipole vanishes
(B) The net force on the dipole vanishes
(C) The torque is independent of the choice of coordinates
(D) The net force is independent of 'd'.

Ans : (B,C,D)

Hint : In a uniform electric field, force on electric dipole is always zero. But torque $\tau = pE\sin\theta \neq 0$ If dipole is not kept along the electric field.

37. Find the right condition(s) for Fraunhoffer diffraction due to a single slit.

(A) Source is at infinite distance and the incident beam has converged at the slit.
(B) Source is near to the slit and the incident beam is parallel.
(C) Source is at infinity and the incident beam is parallel.
(D) Source is near to the slit and the incident beam has converged at the slit.

Ans : (B,C)

Hint : In Fraunhoffer diffreaction, the source has to be kept at infinite distance effectively from the slit due to which the incident rays are parallel. This can be achieved if

(i) Point source is kept at the focus of a converging lens
(ii) Point source is at infinite distance

38. A conducting loop in the form of a circle is placed in a uniform magnetic field with its plane perpendicular to the direction of the field. An e.m.f. will be induced in the loop if

(A) it is translated parallel to itself.

(B) it is rotated about one of its diameters.

(C) it is rotated about its own axis which is parallel to the field.

(D) the loop is deformed from the original shape.

Ans : (B,D)

Hint : Flux changes only in option (B) and (D)

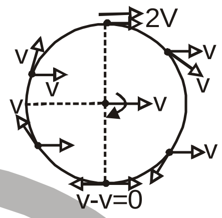
39. A circular disc rolls on a horizontal floor without slipping and the centre of the disc moves with a uniform velocity v. Which of the following values the velocity at a point on the rim of the disc can have?

(A) v (B) –v

(C) 2v (D) Zero

Ans : (A,C,D)

If "Value of velocity" is interpreted as the magnitude then (A,C,D) are correct



Note : If velocity is considered as vector then from the diagram it is clear that velocity vector –v and v is not possible at any point of the rim. The velocity vector 2v and o are possible hence correct answers will become (C,D).

40. Consider two particles of different masses. In which of the following situations the heavier of the two particles will have smaller de Broglie wavelength?

(A) Both have a free through the same height. (B) Both move with the same kinetic energy.

(C) Both move with the same linear momentum. (D) Both move with the same speed.

Ans : (A,B,D)

Hint : $\lambda = \frac{h}{p} = \frac{h}{mv} = \frac{h}{\sqrt{2mE}}$

If allowed to fall through same height, $v = \sqrt{2gh}$ is same for both

$\therefore \lambda \propto \frac{1}{m}$ for same v.

CHEMISTRY

CATEGORY - I (Q41 to Q70)

Each question has one correct option and carries 1 mark, for each wrong answer 1/4 mark will be deducted.

41. Match the flame colours of the alkaline earth metal salts in the Bunsen burner.

(a) Calcium (p) brick red

(b) Strontium (q) apple green

(c) Barium (r) crimson

(A) a-p, b-r, c-q (B) a-r, b-p, c-q

(C) a-q, b-r, c-p (D) a-p, b-q, c-r

Ans : (A)

Hint : The correct flame coloration is

$$\begin{array}{l} \text{Ca} \\ \text{Sr} \\ \text{Ba} \end{array} \text{ as} \left\{ \begin{array}{c} \text{p} \\ \text{r} \\ \text{q} \end{array} \right\} \Rightarrow \begin{array}{c} \text{Brick red} \\ \text{Crimson red} \\ \text{Apple green} \end{array}$$

42. Extraction of gold (Au) involves the fomation of complex ions 'X' and 'Y'.

$$\text{Gold ore} \xrightarrow[CN^-,\, H_2O,\, O_2]{\text{Roasting}} HO^- + 'X' \xrightarrow{Zn} 'Y' + Au$$

'X' and 'Y' are respectivley

(A) $Au(CN)_2^-$ and $Zn(CN)_4^{2-}$
(B) $Au(CN)_4^{3-}$ and $Zn(CN)_4^{2-}$
(C) $Au(CN)_3^-$ and $Zn(CN)_6^{4-}$
(D) $Au(CN)_4^-$ and $Zn(CN)_3^-$

Ans : (A)

Hint : $2\,Au + 4\,NaCN \rightarrow 2Na\left[\underset{X}{Au(CN)_2}\right] + Na_2S$

$$\downarrow Zn$$

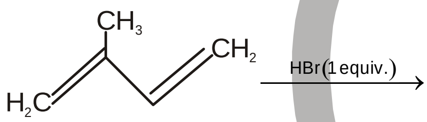
$$Na_2\left[\underset{Y}{Zn(CN)_4}\right] + 2Au$$

43. The atomic number of cerium (Ce) is 58. The correct electronic configuration of Ce^{3+} ion is
(A) $[Xe]4f^1$
(B) $[Kr]4f^1$
(C) $[Xe]4f^{13}$
(D) $[Kr]4d^1$

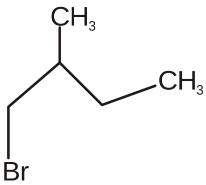
Ans : (A)

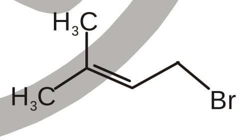
Hint : The correct electronic configuration of Ce is [54] $4f^1\,5d^1 6s^2$

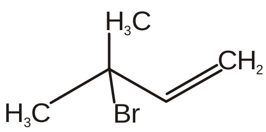
$\therefore$ Ce^{3+} is [54] $4f^1$ i.e. $[Xe]4f^1$

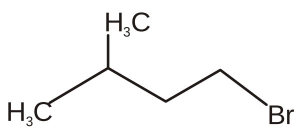
44. 

The major product of the above reaction is

(A) 

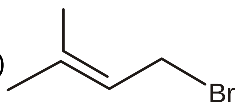
(B) 

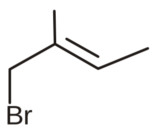
(C) 

(D) 

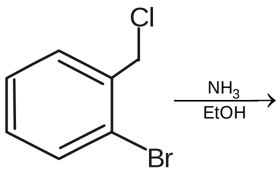
Ans : (B)

Hint : For 1, 3-butadiene at room temp there is formation of 1,4- addition product. So, the product is

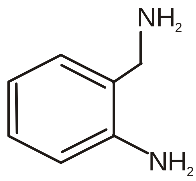
(I) 

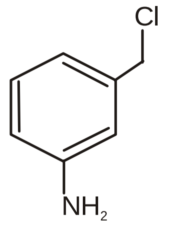
or (II) 

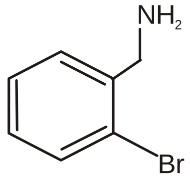
and the most stable one is (I) so, (b) is the correct option.

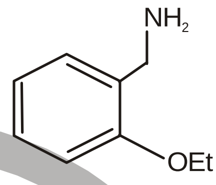
45. 

The product of the above reaction is

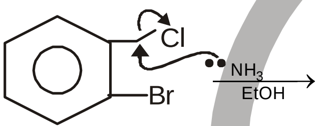
(A) 

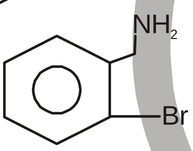
(B) 

(C) 

(D) 

Ans : (C)

Hint :  it's a substitution reaction so, product is



46. Sulphuryl chloride (SO_2Cl_2) reacts with white phosphorus (P_4) to give

(A) PCl_5, SO_2

(B) $OPCl_3$, $SOCl_2$

(C) PCl_5, SO_2, S_2Cl_2

(D) $OPCl_3$, SO_2, S_2Cl_2

Ans : (A)

Hint : $P_4 + 10SO_2Cl_2 \rightarrow 4\,PCl_5 + 10SO_2$

47. The number of lone pair of electrons on the central atoms of H_2O, $SnCl_2$, PCl_3 and XeF_2 respectively, are

(A) 2,1,1,3

(B) 2,2,1,3

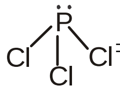
(C) 3,1,1,2

(D) 2,1,2,3

Ans : (A)

Hint : $H_2\ddot{O} \Rightarrow$ No. of lone pairs=2

$Cl — \ddot{S}n — Cl \Rightarrow$ No. of lone pairs=1

 $\Rightarrow$ No.of lone pairs $= 1$

 $\Rightarrow$ No.of lone pairs $= 3$

48. Consider the following salts: NaCl, $HgCl_2$, Hg_2Cl_2, $CuCl_2$, CuCl and AgCl. Identify the correct set of insoluble salts in water

(A) Hg_2Cl_2, CuCl, AgCl
(B) $HgCl_2$, CuCl, AgCl
(C) Hg_2Cl_2, $CuCl_2$, AgCl
(D) Hg_2Cl_2, CuCl, NaCl

Ans : (A)

Hint : Insoluble salts are Hg_2Cl_2, CuCl and AgCl

49. In the following compound, the number of 'sp' hybridized carbon is

$$CH_2 = C = CH - \underset{\displaystyle CN}{\underset{|}{C}H} - C \equiv CH$$

(A) 2
(B) 3
(C) 4
(D) 5

Ans : (C)

Hint : $H_2C = \overset{sp}{C} = CH - \underset{\displaystyle \underset{sp}{C\equiv N}}{\underset{|}{C}H} - \overset{sp}{C} \equiv \overset{sp}{C}H \quad \Rightarrow$ No. of sp hybridized C = 4

50. For the reaction $A + 2B \rightarrow C$, the reaction rate is doubled if the concentration of A is doubled. The rate is increased by four times when concentrations of both A and B are increased by four times. The order of the reaction is

(A) 3
(B) 0
(C) 1
(D) 2

Ans : (C)

Hint : Rate is doubled when concentration of 'A' is doubled. Again rate is quadrapled when concentration of 'A' is raised four times means there is no effect on rate of reaction on raising the concentration of B.

Order with respect to A is 1.

Order with respect to B is 0.

Total order of reaction is 1.

51. At a certain temperature, the value of the slope of the plot of osmotic pressure (π) against concentration (C in mol L^{-1}) of a certain polymer solution is 291R. The temperature at which osmotic pressure is measured is (R is gas constant)

(A) 271°C
(B) 18°C
(C) 564 K
(D) 18 K

Ans : (B)

Hint : Slope, 291R = RT $\therefore$ T = 291K $\therefore$ Temperature = 18°C

52. The rms velocity of CO gas molecules at 27°C is approximately 1000 m/s. For N_2 molecules at 600 K the rms velocity is approximately

(A) 2000 m/s
(B) 1414 m/s
(C) 1000 m/s
(D) 1500 m/s

Ans : (B)

Hint : $U_{rms} = \sqrt{\dfrac{3RT}{M}}$

$$\frac{(U_{rms})_{CO}}{(U_{rms})_{N_2}} = \sqrt{\frac{T_{CO}}{M_{CO}} \times \frac{M_{N_2}}{T_{N_2}}}, \quad \frac{1000}{(U_{rms})_{N_2}} = \sqrt{\frac{300}{600} \times \frac{28}{28}} = \frac{1}{\sqrt{2}}$$

$$\therefore (U_{rms})_{N_2} = 1000 \times 1.414 = 1414 \text{ m/s}$$

53. A gas can be liquefied at temperature T and pressure P provided

(A) $T = T_c$ and $P < P_c$ (B) $T < T_c$ and $P > P_c$

(C) $T > T_c$ and $P > P_c$ (D) $T > T_c$ and $P < P_c$

Ans : (B)

Hint : A gas can be liquefied when $T < T_C$ and pressure $P > P_C$

54. The dispersed phase and dispersion medium of fog respectively are

(A) solid, liquid (B) liquid, liquid

(C) liquid, gas (D) gas, liquid

Ans : (C)

Hint : For fog the disperion medium is liquid and dispersed phase is gas.

55. The decreasing order of basic character of K_2O, BaO, CaO and MgO is

(A) K_2O > BaO > CaO > MgO (B) K_2O > CaO > BaO > MgO

(C) MgO > BaO > CaO > K_2O (D) MgO > CaO > BaO > K_2O

Ans : (A)

Hint : The order of basic character is K_2O > BaO > CaO > MgO on basis of electropositivity of metal.

56. In aqueous alkaline solution, two electron reduction of HO_2^- gives

(A) HO^- (B) H_2O

(C) O_2 (D) O_2^-

Ans : (A)

Hint : $H_2O_2 \rightarrow H^+ + HO_2^-$

$HO_2^- + H_2O + 2e^{\ominus} \rightarrow 3OH^{\ominus}$

57. Cold ferrous sulphate solution on absorption of NO develops brown colour due to the formation of

(A) paramagnetic $[Fe(H_2O)_5(NO)]SO_4$ (B) diamagnetic $[Fe(H_2O)_5(N_3)]SO_4$

(C) paramagnetic $[Fe(H_2O)_5(NO_3)](SO_4)_2$ (D) diamagnetic $[Fe(H_2O)_4(SO_4)]NO_3$

Ans : (A)

Hint : $FeSO_4 + NO + 5H_2O \rightarrow [Fe(H_2O)_5(NO)]SO_4$ [Brown ring Complex]

There is presence of three unpaired electrons

58. Amongst Be, B, Mg and Al the second ionization potential is maximum for

(A) B (B) Be

(C) Mg (D) Al

Ans : (A)

Hint : Gr (2) Gr-13

Be B

Mg Al

The electronic configuration for boron is $2s^2 2p^1$.

Configuration of $B^{\oplus}$ is $2s^2$.

So, it is difficult to remove 2^{nd} e^-.

59. In a mixture, two enantiomers are found to be present in 85% and 15% respectively. The enantiomeric excess (e, e) is

(A) 85% (B) 15%

(C) 70% (D) 60%

Ans : (C)

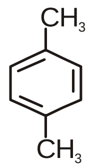
Hint : 15% will form racemic mixture with another 15% so, excess is (85 – 15) = 70%

60. 1,4-dimethylbenzene on heating with anhydrous $AlCl_3$ and HCl produces

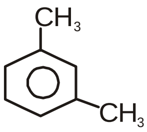
(A) 1,2-dimethylbenzene (B) 1,3-dimethylbenzene

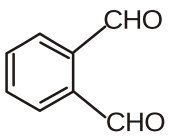
(C) 1,2,3-trimethylbenzene (D) Ethylbenzene

Ans : (B)

Hint : 

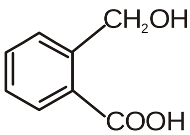
$+ AlCl_3 + HCl \xrightarrow{\Delta}$

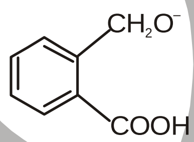
It produces 

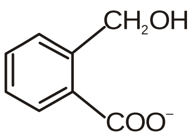
61. 

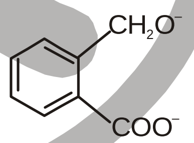
$\xrightarrow{OH^-}$

The product of the above reaction is (Unique set of options is provided for both English and Bengali versions)

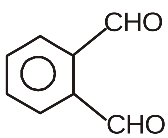
(A) 

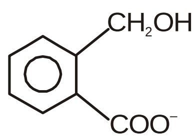
(B) 

(C) 

(D) 

Ans : (C)

Hint : 

$\xrightarrow{OH^-}$ its an intramolecular Cannizzarro's reaction. So answer is 

62. Suppose the mass of a single Ag atom is 'm'. Ag metal crystallizes in fcc lattice with unit cell of length 'a'. The density of Ag metal in terms of 'a' and 'm' is

(A) $\frac{4m}{a^3}$ (B) $\frac{2m}{a^3}$

(C) $\frac{m}{a^3}$ (D) $\frac{m}{4a^3}$

Ans : (A)

Hint : $\rho = \frac{4m(\text{mass of unit cell})}{a^3(\text{volume of unit cell})}$

63. For the reaction $2SO_2\,(g) + O_2\,(g) \rightleftharpoons 2SO_3\,(g)$ at 300K, the value of ΔG^0 is – 690.9R. The equilibrium constant value for the reaction at that temperature is (R is gas constant)

(A) $10\ atm^{-1}$ (B) 10 atm

(C) 10 (D) 1

Ans : (A)

Hint : $2SO_2(g)+O_2(g) \rightleftharpoons 2SO_3(g)$, $\Delta G^{\ominus} = -690.9R$ T = 300K

$\Delta G^{\ominus} = -RT \ln K$

or, – 690.9 R = – R × 300 × ln K

or, $\ln K = \dfrac{690.9}{300} = 2.303$

2.303 log K = 2.303

$K = 10^1 = 10$

Unit of K

$K = (atm)^{\Delta n}$

$= (atm)^{2-3}$

$= atm^{-1}$

$\therefore K = 10\ atm^{-1}$

64. At a particular temperature the ratio of equivalent conductance to specific conductance of a 0.01 (N) NaCl solution is

(A) $10^5\ cm^3$ (B) $10^3\ cm^3$

(C) $10\ cm^3$ (D) $10^5\ cm^2$

Ans : (A)

Hint : $\lambda = \dfrac{K \times 1000}{C}$

$\dfrac{\lambda}{K} = \dfrac{10^3}{0.01} = 10^5 cm^3 eq^{-1}$ $\therefore \lambda = \dfrac{\Omega^{-1} cm^2 eq^{-1}}{\Omega^{-1} cm^{-1}} = cm^3\ eq^{-1}$

65. The units of surface tension and viscosity of liquids are respectively

(A) $kg\ m^{-1}s^{-1}$, $N\ m^{-1}$ (B) $kg\ s^{-2}$, $kg\ m^{-1}\ s^{-1}$

(C) $N\ m^{-1}$, $kg\ m^{-1}s^{-2}$ (D) $kg\ s^{-1}$, $kg\ m^{-2}\ s^{-1}$

Ans : (B)

Hint : $\gamma = \dfrac{\Delta W}{\Delta A} = \dfrac{J}{m^2} = \dfrac{kgm^2s^{-2}}{m^2}$

$= kg\ s^{-2}$

$\left.\begin{array}{l} F \propto A \\ F \propto \dfrac{dv}{dx} \end{array}\right\} F = \text{viscous drag}$, $F = \eta.\ A.\ \dfrac{dv}{dx}$, $\eta = \dfrac{F}{A.\dfrac{dv}{dx}} = \dfrac{N}{m^2.\dfrac{ms^{-1}}{m}} = Nm^{-2}.s$

$= \dfrac{N}{m^2}.s = \dfrac{kgm.s^{-2}.s}{m^2}$

$= kg\ m^{-1}\ s^{-1}$

66. The ratio of volumes of CH_3COOH 0.1 (N) to CH_3COONa 0.1 (N) required to prepare a buffer solution of pH 5.74 is (given : pKa of CH_3COOH is 4.74)

(A) 10 : 1 (B) 5 : 1

(C) 1 : 5 (D) 1 : 10

Ans : (D)

Hint : pH = 5.74, pKa = 4.74, Let volume of acid solution = x L, volume of salt solution = yL

$$\text{pH} = \text{pka} + \log\frac{[\text{salt}]}{[\text{acid}]}$$

$$\log\frac{[CH_3COONa]}{[CH_3COOH]} = 5.74 - 4.74 = 1 \quad \text{or,} \quad \frac{[CH_3COONa]}{[CH_3COOH]} = 10$$

$$\text{or,} \quad \frac{[CH_3COONa]}{[CH_3COOH]} = \frac{1}{10} \Rightarrow \frac{\frac{0.1x}{x+y}}{\frac{0.1y}{x+y}} = \frac{1}{10} \therefore \frac{x}{y} = \frac{1}{10}$$

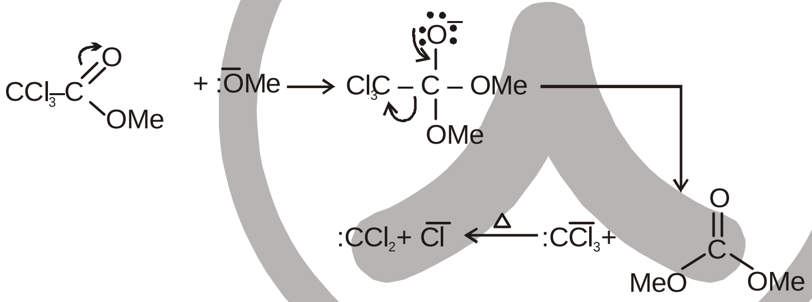
67. The reaction of methyltrichloroacetate (Cl_3CCO_2Me) with sodium methoxide (NaOMe) generates

(A) Carbocation (B) Cabene

(C) Carbanion (D) Carbon radical

Ans : (B)

Hint :



68. Best reagent for nuclear iodination of aromatic compounds is

(A) KI/CH_3COCH_3 (B) I_2/CH_3CN

(C) KI/CH_3COOH (D) I_2/HNO_3

Ans : (D)

69. In the Lassaigne's test for the detection of nitrogen in an organic compound, the appearance of blue coloured compound is due to

(A) ferric ferricyanide (B) ferrous ferricyanide

(C) ferric ferrocyanide (D) ferrous ferrocyanide

Ans : (C)

70. In the following reaction

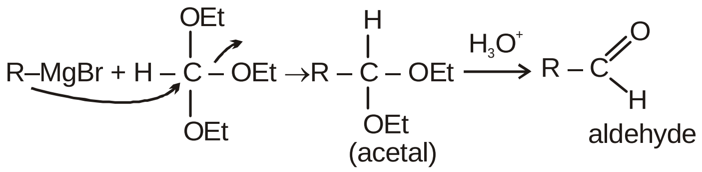
$$RMgBr + HC(OEt)_3 \xrightarrow{ether} \xrightarrow{H_3O^+} P$$

The product 'P' is

(A) RCHO
(B) R_2CHOEt
(C) R_3CH
(D) $RCH(OEt)_2$

Ans : (A)

Hint :



CATEGORY - II (Q71 to Q75)

Each question has one correct option and carries 2 marks, for each wrong answer 1/2 mark will be deducted.

71. Addition of sodium thiosulphate solution to a solution of silver nitrate gives 'X' as white percipitate, insoluble in water but soluble in excess thiosulphate solution to give 'Y'. On boiling in water, 'Y' gives 'Z'. 'X', 'Y' and 'Z' respectively, are

(A) $Ag_2S_2O_3$, $Na_3[Ag(S_2O_3)_2]$, Ag_2S
(B) Ag_2SO_4, $Na[Ag(S_2O_3)_2]$, Ag_2S_2
(C) $Ag_2S_2O_3$, $Na_5[Ag(S_2O_3)_3]$, AgS
(D) Ag_2SO_3, $Na_3[Ag(S_2O_3)_2]$, Ag_2O

Ans : (A)

Hint : $AgNO_3 + Na_2S_2O_3$

$\downarrow$

$Ag_2S_2O_3$ (white ppt)
(x)

$\downarrow$ $Na_2S_2O_3$ (excess)

$Na_3[Ag(S_2O_3)_2]$ soluble
(y)

$\downarrow$ H_2O / Δ

Ag_2S (z)

72. At temperature of 298 K the emf of the following electrochemical cell
Ag(s) | Ag^+ (0.1 M) | | Zn^{2+}(0.1M) | Zn(s) will be (given $E^o_{cell} = -1.562$ V)

(A) – 1.532 V
(B) – 1.503 V
(C) 1.532 V
(D) – 3.06 V

Ans : (A)

Hint : $E_{Cell} = E^0_{cell} - \frac{0.0591}{2}\log\frac{(0.1)^2}{(0.1)} \Rightarrow (-1.562) - \frac{0.0591}{2}\log 10^{-1} \Rightarrow -1.562 + \frac{0.0591}{2}$

$\Rightarrow -1.562 + 0.02955 \Rightarrow -1.532$ v

73. For the reaction $X_2Y_4(l) \rightarrow 2\,XY_2(g)$ at 300 K the values of ΔU and ΔS are 2 kCal and 20 Cal K^{-1} respectively. The value of ΔG for the reaction is

(A) – 3400 Cal
(B) 3400 Cal
(C) – 2800 Cal
(D) 2000 Cal

Ans : (C)

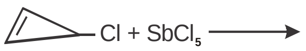
Hint : $X_2Y_4(\ell) \rightarrow 2XY_2(g)$

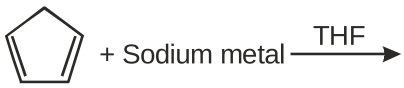
$\Delta n_g = 2$

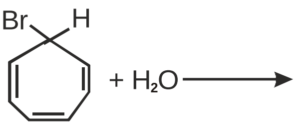
$\Delta H = \Delta U + \Delta n_g RT = 2 + \left(\dfrac{2 \times 2 \times 300}{1000}\right) = 3.2$ kcal

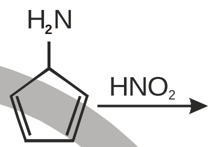
$\Delta G = 3.2 \times 10^3 - 300 \times 20 = 3.2 \times 10^3 - 6 \times 10^3 = -2800$ cal

74. The total number of aromatic species generated in the following reactions is

(I) 

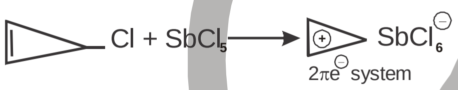
(II) 

(III) 

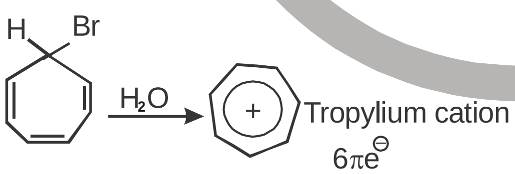
(IV) 

(A) Zero
(B) 2
(C) 3
(D) 4

Ans : (C)

Hint : (I) 

(II) 

(III) 

75. Roasted copper pyrite on smelting with sand produces

(A) $FeSiO_3$ as fusible slag and Cu_2S mattee′
(B) $CaSiO_3$ as infusible slag and Cu_2O mattee′
(C) $Ca_3(PO_4)_2$ as fusible slag and Cu_2S mattee′
(D) $Fe_3(PO_4)_2$ as infusible slag and Cu_2S mattee′

Ans : (A)

Hint : $FeSiO_3$ as fusible slag and Cu_2S as mattee`

CATEGORY - III (Q76 to Q80)

Each question has one or more correct option(s), choosing which will fetch maximum 2 marks on pro rata basis. However, choice of any worng option(s) will fetch zero mark for the question

76. Ionization potential values of noble gases decrease down the group with increase in atomic size. Xenon forms binary fluorides by the direct reaction of elements. Identify the correct statement(s) from below

(A) Only the heavier noble gases form such compounds

(B) It happens because the noble gases have higher ionization energies.

(C) It happens because the compounds are formed with electronegative ligands.

(D) Octet of electrons provide the stable arrangements.

Ans : (A, C)

Hint : (B) Not possible as that was the reason why inert gases will not form compund

(D) Not possible as the compounds are hypervalent

77. Optical isomerism is exhibited by (ox = oxalate anion; en = ethylenediamine)

(A) *cis*-$[CrCl_2(ox)_2]^{3-}$ (B) $[Co(en)_3]^{3+}$

(C) *trans*-$[CrCl_2(ox)_2]^{3-}$ (D) $[Co(ox)(en)_2]^{+}$

Ans : (A, B, D)

Hint : 'C' has plane of symmetry

78. The increase in rate constant of a chemical reaction with increasing temperature is (are) due to the fact(s) that

(A) the number of collisions among the reactant molecules increases with increasing temperature.

(B) the activation energy of the reaction decreases with increasing temperature.

(C) the concentration of the reactant molecules increases with increasing temeprature.

(D) the number of reactant molecules acquiring the activation energy increases with increasing temperature.

Ans : (A, D)

79. Within the list shown below, the correct pair of structures of alanine in pH ranges 2-4 and 9-11 is

(I) $H_3N^+ - CH(CH_3)CO_2H$ (II) $H_2N - CH(CH_3)CO_2^-$

(II) $H_3N^+ - CH(CH_3)CO_2^-$ (IV) $H_2N^+ - CH(CH_3)CO_2H$

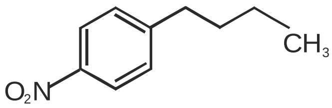
(A) I, II (B) I, III

(C) II, III (D) III, IV

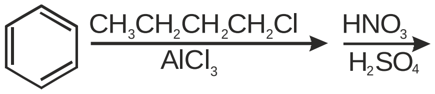
Ans : (A)

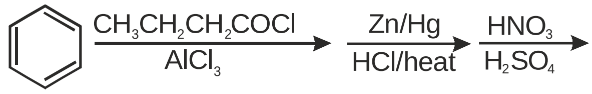
Hint : Acidic medium $H_3N^+ - CH(CH_3)CO_2H$

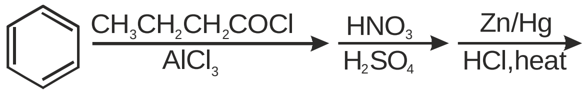
Basic medium $H_2N - CH\ (CH_3)CO_2^-$

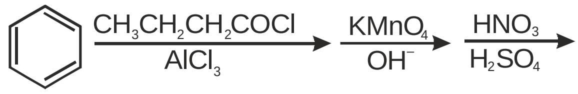
80. 

Identify the correct method for the synthesis of the compound shown above from the following alternatives

(A) 

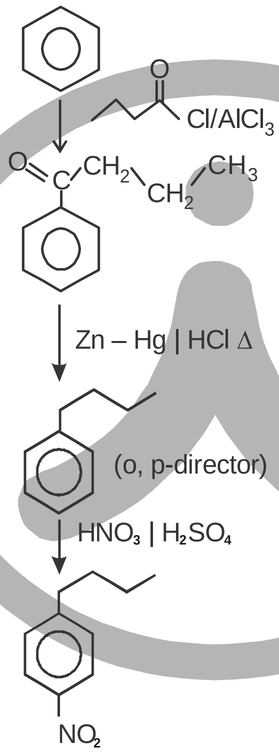
(B) 

(C) 

(D) 

Ans : (B)

Hint :



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