

## Answer to Some Selected Problems

### UNIT 1

- 1.17  $\sim 15 \times 10^{-4} \text{ g}$ ,  $1.25 \times 10^{-4} \text{ m}$
- 1.18 (i)  $4.8 \times 10^{-3}$  (ii)  $2.34 \times 10^5$  (iii)  $8.008 \times 10^3$  (iv)  $5.000 \times 10^2$   
(v) 6.0012
- 1.19 (i) 2 (ii) 3 (iii) 4 (iv) 3  
(v) 4 (vi) 5
- 1.20 (i) 34.2 (ii) 10.4 (iii) 0.0460 (iv) 2810
- 1.21 (a) law of multiple proportion (b) (i) Ans : ( $10^6 \text{ mm}$ ,  $10^{15} \text{ pm}$ )  
(ii) Ans : ( $10^{-6} \text{ kg}$ ,  $10^6 \text{ ng}$ )  
(iii) Ans : ( $10^{-3} \text{ L}$ ,  $10^{-3} \text{ dm}^3$ )
- 1.22  $6.00 \times 10^{-1} \text{ m} = 0.600 \text{ m}$
- 1.23 (i) B is limiting (ii) A is limiting  
(iii) Stoichiometric mixture –No (iv) B is limiting  
(v) A is limiting
- 1.24 (i)  $2.43 \times 10^3 \text{ g}$  (ii) Yes  
(iii) Hydrogen will remain unreacted;  $5.72 \times 10^2 \text{ g}$
- 1.26 Ten volumes
- 1.27 (i)  $2.87 \times 10^{-11} \text{ m}$  (ii)  $1.515 \times 10^{-11} \text{ m}$  (iii)  $2.5365 \times 10^{-2} \text{ kg}$
- 1.30  $1.99265 \times 10^{-23} \text{ g}$
- 1.31 (i) 3 (ii) 4 (iii) 4
- 1.32  $39.948 \text{ g mol}^{-1}$
- 1.33 (i)  $3.131 \times 10^{25} \text{ atoms}$  (ii) 13 atoms (iii)  $7.8286 \times 10^{24} \text{ atoms}$
- 1.34 Empirical formula CH, molar mass  $26.0 \text{ g mol}^{-1}$ , molecular formula  $\text{C}_2\text{H}_2$
- 1.35  $0.94 \text{ g CaCO}_3$
- 1.36  $8.40 \text{ g HCl}$

### UNIT 2

- 2.1 (i)  $1.099 \times 10^{27} \text{ electrons}$  (ii)  $5.48 \times 10^{-7} \text{ kg}$ ,  $9.65 \times 10^4 \text{ C}$
- 2.2 (i)  $6.022 \times 10^{24} \text{ electrons}$   
(ii) (a)  $2.4088 \times 10^{21} \text{ neutrons}$  (b)  $4.0347 \times 10^{-6} \text{ kg}$   
(iii) (a)  $1.2044 \times 10^{22} \text{ protons}$  (b)  $2.015 \times 10^{-5} \text{ kg}$
- 2.3 7,6: 8,8: 12,12: 30,26: 50, 38
- 2.4 (i) Cl (ii) U (iii) Be
- 2.5  $5.17 \times 10^{14} \text{ s}^{-1}$ ,  $1.72 \times 10^6 \text{ m}^{-1}$
- 2.6 (i)  $1.988 \times 10^{-18} \text{ J}$  (ii)  $3.98 \times 10^{-15} \text{ J}$

- 2.7  $6.0 \times 10^{-2} \text{ m}$ ,  $5.0 \times 10^9 \text{ s}^{-1}$  and  $16.66 \text{ m}^{-1}$
- 2.8  $2.012 \times 10^{16}$  photons
- 2.9 (i)  $4.97 \times 10^{-19} \text{ J}$  (3.10 eV); (ii) 0.97 eV (iii)  $5.84 \times 10^5 \text{ m s}^{-1}$
- 2.10  $494 \text{ kJ mol}^{-1}$
- 2.11  $7.18 \times 10^{19} \text{ s}^{-1}$
- 2.12  $4.41 \times 10^{14} \text{ s}^{-1}$ ,  $2.91 \times 10^{-19} \text{ J}$
- 2.13 486 nm
- 2.14  $8.72 \times 10^{-20} \text{ J}$
- 2.15 15 emission lines
- 2.16 (i)  $8.72 \times 10^{-20} \text{ J}$  (ii) 1.3225 nm
- 2.17  $1.523 \times 10^6 \text{ m}^{-1}$
- 2.18  $2.08 \times 10^{-11} \text{ ergs}$ , 950 Å
- 2.19 3647 Å
- 2.20  $3.55 \times 10^{-11} \text{ m}$
- 2.21 8967 Å
- 2.22  $\text{Na}^+$ ,  $\text{Mg}^{2+}$ ,  $\text{Ca}^{2+}$ ; Ar,  $\text{S}^{2-}$  and  $\text{K}^+$
- 2.23 (i) (a)  $1s^2$  (b)  $1s^2 2s^2 2p^6$ ; (c)  $1s^2 2s^2 2p^6$  (d)  $1s^2 2s^2 2p^6$
- 2.24  $n = 5$
- 2.25  $n = 3$ ;  $l = 2$ ;  $m_l = -2, -1, 0, +1, +2$  (any one value)
- 2.26 (i) 29 protons
- 2.27 1, 2, 15
- 2.28 (i)  $l$   $m_l$   
           0     0  
           1     -1, 0, +1  
           2     -2, -1, 0, +1, +2  
 (ii)  $l = 2$ ;  $m_l = -2, -1, 0, +1, +2$   
 (iii) 2s, 2p
- 2.29 (a) 1s, (b) 3p, (c) 4d and (d) 4f
- 2.30 (a), (c) and (e) are not possible
- 2.31 (a) 16 electrons (b) 2 electrons
- 2.33  $n = 2$  to  $n = 1$
- 2.34  $8.72 \times 10^{-18} \text{ J}$  per atom
- 2.35  $1.33 \times 10^9$
- 2.36 0.06 nm
- 2.37 (a)  $1.3 \times 10^2 \text{ pm}$  (b)  $6.15 \times 10^7 \text{ pm}$
- 2.38 1560
- 2.39 8
- 2.40 More number of K-particles will pass as the nucleus of the lighter atoms is small, smaller number of K-particles will be deflected as a number of positive charges is less than on the lighter nuclei.
- 2.41 For a given element the number of protons is the same for the isotopes, whereas the mass number can be different for the given atomic number.
- 2.42  $^{81}_{35}\text{Br}$
- 2.43  $^{37}_{17}\text{Cl}^{-1}$

- 2.44  ${}^{56}_{26}\text{Fe}^{3+}$
- 2.45 Cosmic rays > X-rays > amber colour > microwave > FM
- 2.46  $3.3 \times 10^6 \text{ J}$
- 2.47 (a)  $4.87 \times 10^{14} \text{ s}^{-1}$  (b)  $9.0 \times 10^9 \text{ m}$  (c)  $32.27 \times 10^{-20} \text{ J}$   
(d)  $6.2 \times 10^{18}$  quanta
- 2.48 10
- 2.49  $8.28 \times 10^{-10} \text{ J}$
- 2.50  $3.45 \times 10^{-22} \text{ J}$
- 2.51 (a) Threshold wave length 652.46 nm (b) Threshold frequency of radiation  $4.598 \times 10^{14} \text{ s}^{-1}$   
(c) Kinetic energy of ejected photoelectron  $9.29 \times 10^{-20} \text{ J}$ , Velocity of photoelectron  $4.516 \times 10^5 \text{ ms}^{-1}$
- 2.52 530.9 nm
- 2.53 4.48 eV
- 2.54  $7.6 \times 10^3 \text{ eV}$
- 2.55 infrared, 5
- 2.56 434 nm
- 2.57 455 pm
- 2.58  $494.5 \text{ ms}^{-1}$
- 2.59 332 pm
- 2.60  $1.516 \times 10^{-38} \text{ m}$
- 2.61 Cannot be defined as the actual magnitude is smaller than uncertainty.
- 2.62 (v) < (ii) = (iv) < (vi) = (iii) < (i)
- 2.63 4p
- 2.64 (i) 2s (ii) 4d (iii) 3p
- 2.65 Si
- 2.66 (a) 3 (b) 2 (c) 6  
(d) 4 (e) zero
- 2.67 16

## UNIT 5

- 5.1 (ii)
- 5.2 (iii)
- 5.3 (ii)
- 5.4 (iii)
- 5.5 (i)
- 5.6 (iv)
- 5.7  $q = +701 \text{ J}$   
 $w = -394 \text{ J}$ , since work is done by the system  
 $\Delta U = 307 \text{ J}$
- 5.8  $-743.939 \text{ kJ}$
- 5.9  $1.067 \text{ kJ}$
- 5.10  $\Delta H = -7.151 \text{ kJ mol}^{-1}$

- 5.11  $-314.8 \text{ kJ}$   
 5.12  $\Delta_r H = -778 \text{ kJ}$   
 5.13  $-46.2 \text{ kJ mol}^{-1}$   
 5.14  $-239 \text{ kJ mol}^{-1}$   
 5.15  $326 \text{ kJ mol}^{-1}$   
 5.16  $\Delta S > 0$   
 5.17  $2000 \text{ K}$   
 5.18  $\Delta H$  is negative (bond energy is released) and  $\Delta S$  is negative (There is less randomness among the molecules than among the atoms)  
 5.19  $0.164 \text{ kJ}$ , the reaction is not spontaneous.  
 5.20  $-5.744 \text{ kJ mol}^{-1}$   
 5.21  $\text{NO(g)}$  is unstable, but  $\text{NO}_2(\text{g})$  is formed.  
 5.22  $q_{\text{surr}} = +286 \text{ kJ mol}^{-1}$   
 $\Delta S_{\text{surr}} = 959.73 \text{ J K}^{-1}$

## UNIT 6

- 6.2  $12.229$   
 6.3  $2.67 \times 10^4$   
 6.5 (i)  $4.33 \times 10^{-4}$  (ii)  $1.90$   
 6.6  $1.59 \times 10^{-15}$   
 6.8  $[\text{N}_2] = 0.0482 \text{ mol L}^{-1}$ ,  $[\text{O}_2] = 0.0933 \text{ mol L}^{-1}$ ,  $[\text{N}_2\text{O}] = 6.6 \times 10^{-21} \text{ mol L}^{-1}$   
 6.9  $0.0352 \text{ mol}$  of  $\text{NO}$  and  $0.0178 \text{ mol}$  of  $\text{Br}_2$   
 6.10  $7.47 \times 10^{11} \text{ M}^{-1}$   
 6.11  $4.0$   
 6.12  $Q_c = 2.379 \times 10^3$ . No, reaction is not at equilibrium.  
 6.14  $0.44$   
 6.15  $0.068 \text{ mol L}^{-1}$  each of  $\text{H}_2$  and  $\text{I}_2$   
 6.16  $[\text{I}_2] = [\text{Cl}_2] = 0.167 \text{ M}$ ,  $[\text{ICl}] = 0.446 \text{ M}$   
 6.17  $[\text{C}_2\text{H}_6]_{\text{eq}} = 3.62 \text{ atm}$   
 6.18 (i)  $[\text{CH}_3\text{COOC}_2\text{H}_5][\text{H}_2\text{O}] / [\text{CH}_3\text{COOH}][\text{C}_2\text{H}_5\text{OH}]$   
 (ii)  $3.92$  (iii) value of  $Q_c$  is less than  $K_c$  therefore equilibrium is not attained.  
 6.19  $0.02 \text{ mol L}^{-1}$  for both.  
 6.20  $[\text{P}_{\text{CO}}] = 1.739 \text{ atm}$ ,  $[\text{P}_{\text{CO}_2}] = 0.461 \text{ atm}$ .  
 6.21 No, the reaction proceeds to form more products.  
 6.22  $3 \times 10^{-4} \text{ mol L}^{-1}$   
 6.23  $0.149$   
 6.24 a)  $-35.0 \text{ kJ}$ , b)  $1.365 \times 10^6$   
 6.27  $[\text{P}_{\text{H}_2}]_{\text{eq}} = [\text{P}_{\text{Br}_2}]_{\text{eq}} = 2.5 \times 10^{-2} \text{ bar}$ ,  $[\text{P}_{\text{HBr}}] = 10.0 \text{ bar}$   
 6.30 b)  $120.48$   
 6.31  $[\text{H}_2]_{\text{eq}} = 0.96 \text{ bar}$   
 6.33  $2.86 \times 10^{-28} \text{ M}$   
 6.34  $5.85 \times 10^{-2}$   
 6.35  $\text{NO}_2^-$ ,  $\text{HCN}$ ,  $\text{ClO}_4^-$ ,  $\text{HF}$ ,  $\text{H}_2\text{O}$ ,  $\text{HCO}_3^-$ ,  $\text{HS}^-$   
 6.36  $\text{BF}_3$ ,  $\text{H}^+$ ,  $\text{NH}_4^+$

- 6.37  $F^-$ ,  $HSO_4^-$ ,  $CO_3^{2-}$
- 6.38  $NH_3$ ,  $NH_4^+$ ,  $HCOOH$
- 6.41 2.42
- 6.42  $1.7 \times 10^{-4}M$
- 6.43  $F^- = 1.5 \times 10^{-11}$ ,  $HCOO^- = 5.6 \times 10^{-11}$ ,  $CN^- = 2.08 \times 10^{-6}$
- 6.44 [phenolate ion] =  $2.2 \times 10^{-6}$ ,  $\alpha = 4.47 \times 10^{-5}$ ,  $\alpha$  in sodium phenolate =  $10^{-8}$
- 6.45  $[HS^-] = 9.54 \times 10^{-5}$ , in 0.1M HCl  $[HS^-] = 9.1 \times 10^{-8}M$ ,  $[S^{2-}] = 1.2 \times 10^{-13}M$ , in 0.1M HCl  $[S^{2-}] = 1.09 \times 10^{-19}M$
- 6.46  $[Ac^-] = 0.00093$ , pH = 3.03
- 6.47  $[A^-] = 7.08 \times 10^{-5}M$ ,  $K_a = 5.08 \times 10^{-7}$ ,  $pK_a = 6.29$
- 6.48 a) 2.52 b) 11.70 c) 2.70 d) 11.30
- 6.49 a) 11.65 b) 12.21 c) 12.57 c) 1.87
- 6.50 pH = 1.88,  $pK_a = 2.70$
- 6.51  $K_b = 1.6 \times 10^{-6}$ ,  $pK_b = 5.8$
- 6.52  $\alpha = 6.53 \times 10^{-4}$ ,  $K_a = 2.35 \times 10^{-5}$
- 6.53 a) 0.0018 b) 0.00018
- 6.54  $\alpha = 0.0054$
- 6.55 a)  $1.48 \times 10^{-7}M$ , b) 0.063 c)  $4.17 \times 10^{-8}M$  d)  $3.98 \times 10^{-7}$
- 6.56 a)  $1.5 \times 10^{-7}M$ , b)  $10^{-5}M$ , c)  $6.31 \times 10^{-5}M$  d)  $6.31 \times 10^{-3}M$
- 6.57  $[K^+] = [OH^-] = 0.05M$ ,  $[H^+] = 2.0 \times 10^{-13}M$
- 6.58  $[Sr^{2+}] = 0.1581M$ ,  $[OH^-] = 0.3162M$ , pH = 13.50
- 6.59  $\alpha = 1.63 \times 10^{-2}$ , pH = 3.09. In presence of 0.01M HCl,  $\alpha = 1.32 \times 10^{-3}$
- 6.60  $K_a = 2.09 \times 10^{-4}$  and degree of ionization = 0.0457
- 6.61 pH = 7.97. Degree of hydrolysis =  $2.36 \times 10^{-5}$
- 6.62  $K_b = 1.5 \times 10^{-9}$
- 6.63 NaCl, KBr solutions are neutral, NaCN,  $NaNO_2$  and KF solutions are basic and  $NH_4NO_3$  solution is acidic.
- 6.64 (a) pH of acid solution = 1.9 (b) pH of its salt solution = 7.9
- 6.65 pH = 6.78
- 6.66 a) 12.6 b) 7.00 c) 1.3
- 6.67 Silver chromate  $S = 0.65 \times 10^{-4}M$ ; Molarity of  $Ag^+ = 1.30 \times 10^{-4}M$   
Molarity of  $CrO_4^{2-} = 0.65 \times 10^{-4}M$ ; Barium Chromate  $S = 1.1 \times 10^{-5}M$ ; Molarity of  $Ba^{2+}$  and  $CrO_4^{2-}$  each is  $1.1 \times 10^{-5}M$ ; Ferric Hydroxide  $S = 1.39 \times 10^{-10}M$ ;  
Molarity of  $Fe^{3+} = 1.39 \times 10^{-10}M$ ; Molarity of  $[OH^-] = 4.17 \times 10^{-10}M$   
Lead Chloride  $S = 1.59 \times 10^{-2}M$ ; Molarity of  $Pb^{2+} = 1.59 \times 10^{-2}M$   
Molarity of  $Cl^- = 3.18 \times 10^{-2}M$ ; Mercurous Iodide  $S = 2.24 \times 10^{-10}M$ ;  
Molarity of  $Hg_2^{2+} = 2.24 \times 10^{-10}M$  and molarity of  $I^- = 4.48 \times 10^{-10}M$
- 6.68 Silver chromate is more soluble and the ratio of their molarities = 91.9
- 6.69 No precipitate
- 6.70 Silver benzoate is 3.317 times more soluble at lower pH
- 6.71 The highest molarity for the solution is  $2.5 \times 10^{-9}M$
- 6.72 2.43 litre of water
- 6.73 Precipitation will take place in cadmium chloride solution

## NOTES

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