

## 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  ${}_{17}^{37}\text{Cl}^{-1}$
- 2.44  ${}_{26}^{56}\text{Fe}^{3+}$
- 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 2.5 bar
- 5.2 0.8 bar
- 5.4 70 g/mol
- 5.5  $M_B = 4M_A$
- 5.6 203.2 mL
- 5.7  $8.314 \times 10^4 \text{ Pa}$
- 5.8 1.8 bar
- 5.9  $3\text{g}/\text{dm}^3$
- 5.10  $1249.8 \text{ g mol}^{-1}$
- 5.11  $3/5$
- 5.12 50 K

- 5.13  $4.2154 \times 10^{23}$  electrons  
 5.14  $1.90956 \times 10^6$  year  
 5.15 56.025 bar  
 5.16 3811.1 kg  
 5.17 5.05 L  
 5.18  $40 \text{ g mol}^{-1}$   
 5.19 0.8 bar

## UNIT 6

- 6.1 (ii)  
 6.2 (iii)  
 6.3 (ii)  
 6.4 (iii)  
 6.5 (i)  
 6.6 (iv)  
 6.7  $q = + 701 \text{ J}$   
 $w = - 394 \text{ J}$ , since work is done by the system  
 $\Delta U = 307 \text{ J}$   
 6.8  $-743.939 \text{ kJ}$   
 6.9  $1.067 \text{ kJ}$   
 6.10  $\Delta H = -7.151 \text{ kJ mol}^{-1}$   
 6.11  $- 314.8 \text{ kJ}$   
 6.12  $\Delta_r H = -778 \text{ kJ}$   
 6.13  $- 46.2 \text{ kJ mol}^{-1}$   
 6.14  $- 239 \text{ kJ mol}^{-1}$   
 6.15  $326 \text{ kJ mol}^{-1}$   
 6.16  $\Delta S > 0$   
 6.17  $2000 \text{ K}$   
 6.18  $\Delta H$  is negative (bond energy is released) and  $\Delta S$  is negative (There is less randomness among the molecules than among the atoms)  
 6.19  $0.164 \text{ kJ}$ , the reaction is not spontaneous.  
 6.20  $-5.744 \text{ kJ mol}^{-1}$   
 6.21  $\text{NO(g)}$  is unstable, but  $\text{NO}_2(\text{g})$  is formed.  
 6.22  $q_{\text{surr}} = + 286 \text{ kJ mol}^{-1}$   
 $\Delta S_{\text{surr}} = 959.73 \text{ J K}^{-1}$

## UNIT 7

- 7.2 12.229  
 7.3  $2.67 \times 10^4$   
 7.5 (i)  $4.33 \times 10^{-4}$  (ii) 1.90  
 7.6  $1.59 \times 10^{-15}$   
 7.8  $[\text{N}_2] = 0.0482 \text{ molL}^{-1}$ ,  $[\text{O}_2] = 0.0933 \text{ molL}^{-1}$ ,  $[\text{N}_2\text{O}] = 6.6 \times 10^{-21} \text{ molL}^{-1}$

- 7.9 0.0352mol of NO and 0.0178mol of Br<sub>2</sub>
- 7.10  $7.47 \times 10^{11} \text{ M}^{-1}$
- 7.11 4.0
- 7.12  $Q_c = 2.379 \times 10^3$ . No, reaction is not at equilibrium.
- 7.14 0.44
- 7.15  $0.068 \text{ molL}^{-1}$  each of H<sub>2</sub> and I<sub>2</sub>
- 7.16  $[I_2] = [Cl_2] = 0.167 \text{ M}$ ,  $[ICl] = 0.446 \text{ M}$
- 7.17  $[C_2H_6]_{eq} = 3.62 \text{ atm}$
- 7.18 (i)  $[CH_3COOC_2H_5][H_2O] / [CH_3COOH][C_2H_5OH]$   
 (ii) 3.92 (iii) value of  $Q_c$  is less than  $K_c$  therefore equilibrium is not attained.
- 7.19  $0.02 \text{ molL}^{-1}$  for both.
- 7.20  $[P_{CO}] = 1.739 \text{ atm}$ ,  $[P_{CO_2}] = 0.461 \text{ atm}$ .
- 7.21 No, the reaction proceeds to form more products.
- 7.22  $3 \times 10^{-4} \text{ molL}^{-1}$
- 7.23 0.149
- 7.24 a)  $-35.0 \text{ kJ}$ , b)  $1.365 \times 10^6$
- 7.27  $[P_{H_2}]_{eq} = [P_{Br_2}]_{eq} = 2.5 \times 10^{-2} \text{ bar}$ ,  $[P_{HBr}] = 10.0 \text{ bar}$
- 7.30 b) 120.48
- 7.31  $[H_2]_{eq} = 0.96 \text{ bar}$
- 7.33  $2.86 \times 10^{-28} \text{ M}$
- 7.34  $5.85 \times 10^{-2}$
- 7.35 NO<sub>2</sub><sup>-</sup>, HCN, ClO<sub>4</sub><sup>-</sup>, HF, H<sub>2</sub>O, HCO<sub>3</sub><sup>-</sup>, HS<sup>-</sup>
- 7.36 BF<sub>3</sub>, H<sup>+</sup>, NH<sub>4</sub><sup>+</sup>
- 7.37 F<sup>-</sup>, HSO<sub>4</sub><sup>-</sup>, CO<sub>3</sub><sup>2-</sup>
- 7.38 NH<sub>3</sub>, NH<sub>4</sub><sup>+</sup>, HCOOH
- 7.41 2.42
- 7.42  $1.7 \times 10^{-4} \text{ M}$
- 7.43 F<sup>-</sup> =  $1.5 \times 10^{-11}$ , HCOO<sup>-</sup> =  $5.6 \times 10^{-11}$ , CN<sup>-</sup> =  $2.08 \times 10^{-6}$
- 7.44 [phenolate ion] =  $2.2 \times 10^{-6}$ ,  $\alpha = 4.47 \times 10^{-5}$ ,  $\alpha$  in sodium phenolate =  $10^{-8}$
- 7.45  $[HS^-] = 9.54 \times 10^{-5}$ , in 0.1M HCl  $[HS^-] = 9.1 \times 10^{-8} \text{ M}$ ,  $[S^{2-}] = 1.2 \times 10^{-13} \text{ M}$ , in 0.1M HCl  $[S^{2-}] = 1.09 \times 10^{-19} \text{ M}$
- 7.46  $[Ac^-] = 0.00093$ , pH = 3.03
- 7.47  $[A^-] = 7.08 \times 10^{-5} \text{ M}$ ,  $K_a = 5.08 \times 10^{-7}$ ,  $pK_a = 6.29$
- 7.48 a) 2.52 b) 11.70 c) 2.70 d) 11.30
- 7.49 a) 11.65 b) 12.21 c) 12.57 c) 1.87
- 7.50 pH = 1.88,  $pK_a = 2.70$
- 7.51  $K_b = 1.6 \times 10^{-6}$ ,  $pK_b = 5.8$
- 7.52  $\alpha = 6.53 \times 10^{-4}$ ,  $K_a = 2.35 \times 10^{-5}$
- 7.53 a) 0.0018 b) 0.00018
- 7.54  $\alpha = 0.0054$
- 7.55 a)  $1.48 \times 10^{-7} \text{ M}$ , b) 0.063 c)  $4.17 \times 10^{-8} \text{ M}$  d)  $3.98 \times 10^{-7}$
- 7.56 a)  $1.5 \times 10^{-7} \text{ M}$ , b)  $10^{-5} \text{ M}$ , c)  $6.31 \times 10^{-5} \text{ M}$  d)  $6.31 \times 10^{-3} \text{ M}$
- 7.57  $[K^+] = [OH^-] = 0.05 \text{ M}$ ,  $[H^+] = 2.0 \times 10^{-13} \text{ M}$

- 7.58  $[\text{Sr}^{2+}] = 0.1581\text{M}$ ,  $[\text{OH}^-] = 0.3162\text{M}$ ,  $\text{pH} = 13.50$
- 7.59  $\alpha = 1.63 \times 10^{-2}$ ,  $\text{pH} = 3.09$ . In presence of  $0.01\text{M HCl}$ ,  $\alpha = 1.32 \times 10^{-3}$
- 7.60  $K_a = 2.09 \times 10^{-4}$  and degree of ionization =  $0.0457$
- 7.61  $\text{pH} = 7.97$ . Degree of hydrolysis =  $2.36 \times 10^{-5}$
- 7.62  $K_b = 1.5 \times 10^{-9}$
- 7.63  $\text{NaCl}$ ,  $\text{KBr}$  solutions are neutral,  $\text{NaCN}$ ,  $\text{NaNO}_2$  and  $\text{KF}$  solutions are basic and  $\text{NH}_4\text{NO}_3$  solution is acidic.
- 7.64 (a)  $\text{pH}$  of acid solution =  $1.9$  (b)  $\text{pH}$  of its salt solution =  $7.9$
- 7.65  $\text{pH} = 6.78$
- 7.66 a)  $12.6$  b)  $7.00$  c)  $1.3$
- 7.67 Silver chromate  $S = 0.65 \times 10^{-4}\text{M}$ ; Molarity of  $\text{Ag}^+ = 1.30 \times 10^{-4}\text{M}$   
Molarity of  $\text{CrO}_4^{2-} = 0.65 \times 10^{-4}\text{M}$ ; Barium Chromate  $S = 1.1 \times 10^{-5}\text{M}$ ; Molarity of  $\text{Ba}^{2+}$  and  $\text{CrO}_4^{2-}$  each is  $1.1 \times 10^{-5}\text{M}$ ; Ferric Hydroxide  $S = 1.39 \times 10^{-10}\text{M}$ ;  
Molarity of  $\text{Fe}^{3+} = 1.39 \times 10^{-10}\text{M}$ ; Molarity of  $[\text{OH}^-] = 4.17 \times 10^{-10}\text{M}$   
Lead Chloride  $S = 1.59 \times 10^{-2}\text{M}$ ; Molarity of  $\text{Pb}^{2+} = 1.59 \times 10^{-2}\text{M}$   
Molarity of  $\text{Cl}^- = 3.18 \times 10^{-2}\text{M}$ ; Mercurous Iodide  $S = 2.24 \times 10^{-10}\text{M}$ ;  
Molarity of  $\text{Hg}_2^{2+} = 2.24 \times 10^{-10}\text{M}$  and molarity of  $\text{I}^- = 4.48 \times 10^{-10}\text{M}$
- 7.68 Silver chromate is more soluble and the ratio of their molarities =  $91.9$
- 7.69 No precipitate
- 7.70 Silver benzoate is  $3.317$  times more soluble at lower  $\text{pH}$
- 7.71 The highest molarity for the solution is  $2.5 \times 10^{-9}\text{M}$
- 7.72  $2.43$  litre of water
- 7.73 Precipitation will take place in cadmium chloride solution