CHAPTER 1 QUANTITATIVE CHEMISTRY

Page 4 Ex

1. D
2. C
3. B
4 (a) element; (b) mixture; (c) compound; (d) element; (e) compound
5. (a) mixture; (b) compound; (c) mixture; (d) element; (e) compound.

Page 5 Ex 1.1

1. D
2. C
3. C
4. D
5. C
6. D
7. a) 0.20 b) $1.2\cdot10^{23}$ c) $3.6\cdot10^{23}$
8. a) $3.61\text{x}10^{24}$ b) $5.4\text{x}10^{23}$

Page 7 Ex 1.2

1. D
2. A
3 a) 127.9 b) 106.4 c) 132.1 d) 126.1 e) 152.0 f) 233.3

Page 7 Ex 1.2.3

1. B
2. D
3. A
4. B
5. A
6. a) 51.1 g, b) 7.47 g, c) 10.7 g, d) 68.7 g, e) 1.90 g
7. a) 1.00, b) 3.00, c) 25.8, d) 5.44
8. a) 150 g mol^{-1}, b) 128 g mol^{-1}
9. $1.245\text{x}10^{23}$ molecules
10. a) $3.41\text{x}10^{-4}$, b) $5.68\text{x}10^{-3}$, c) $2.05\text{x}10^{22}$

Page 12 Ex1.2.4

1. D
2. C
3. B

4. D
5. B
6. C
7. A
8. B
9. D
10. B
11. 36.3%
12. a) Fe_2O_3 b) SiF_4 c) $C_2H_2O_4$
13. SnO_2
14. $CuSO_4.5H_2O$
15. 66700 g mol^{-1}
16. $K_2Cr_2O_7$
17. 354.5; 47.4% carbon, 2.56% hydrogen, 50.0% chlorine
18. a) 0.409 g carbon and 0.0453 g hydrogen b) 0.545 g oxygen c) $C_3H_4O_3$
19. $C_2H_5N_3O_2$; $C_4H_{10}N_6O_4$
20. 56.7%

Page 14 Ex 1.3

1. A
2. C
3. D
4. a) H_2SO_4, b) NaOH, c) HNO_3, d) NH_3, e) HCl,
   f) CH_3COOH, g) $CuSO_4$, h) CO, i) SO_2, j) $NaHCO_3$
5. a) NaCl b) CuS c) $ZnSO_4$ d) Al_2O_3 e) $Mg(NO_3)_2$
   f) $Ca_3(PO_4)_2$ g) HI h) $(NH_4)_2CO_3$ i) CH_4 j) PCl_5

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Page 17 Ex 1.3.1

1. C
2. B
3. A
4. a) $CaO + 2\ HNO_3 \rightarrow Ca(NO_3)_2 + H_2O$

   b) $2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$

   c) $2HCl + ZnCO_3 \rightarrow ZnCl_2 + H_2O + CO_2$

   d) $SO_2 + 2\ Mg \rightarrow S + 2MgO$

   e) $Fe_3O_4 + 4\ H_2 \rightarrow 3Fe + 4H_2O$

   f) $2K + 2C_2H_5OH \rightarrow 2KC_2H_5O + H_2$

   g) $2Fe(OH)_3 \rightarrow Fe_2O_3 + 3H_2O$

   h) $CH_3CO_2H + 2\ O_2 \rightarrow 2CO_2 + 2\ H_2O$

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

   j) $2NaMnO_4 + 16HCl \rightarrow 2NaCl + 2MnCl_2 + 5Cl_2 + 8H_2O$

5. a) $CuCO_3 \rightarrow CuO + CO_2$

   b) $NiO + H_2SO_4 \rightarrow NiSO_4 + H_2O$

   c) $2\ Fe + 3\ Br_2 \rightarrow 2\ FeBr_3$

   d) $PbO_2 + 2\ CO \rightarrow Pb + 2\ CO_2$

   e) $2\ FeCl_2 + Cl_2 \rightarrow 2\ FeCl_3$

   f) $C_2H_5OH + 3\ O_2 \rightarrow 2\ CO_2 + 3\ H_2O$

   g) $Ag + 2\ HNO_3 \rightarrow AgNO_3 + NO_2 + H_2O$

   h) $MnO_2 + 4HCl \rightarrow MnCl_2 + Cl_2 + 2H_2O$

   i) $SO_2 + 2H_2S \rightarrow 3S + 2H_2O$

   j) $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$

Page 19 Ex 1.4

1. C
2. B
3. a) $2\ KClO_{3(s)} \rightarrow 2\ KCl_{(s)} + 3\ O_{2(g)}$

   b) 0.4 moles

   c) 2.45 g
4. 37.69 g
5. a) MnO_2 ; Mn_3O_4,

   b) $3\ MnO_2 \rightarrow Mn_3O_4 + O_2$,

   c) 0.353 g

CHAPTER 1 QUANTITATIVE CHEMISTRY

Page 21 Ex 1.4.1

1. a) Limiting reagent is Al, yield is 1.2 mol,

   b) Limiting reagent is I_2, yield is 2.57 g

   c) 1.03 g excess aluminium

2. a) Limiting reagent is SbF_3, CCl_4 is in excess

   b) 101.5 g

   c) 20.9 g

3. a) Limiting reagent is salicylic acid

   b) 1.30 kg

   c) 90.6%

Page 23 Ex 1.4.2

1. C
2. D
3. A
4. B
5. D
6. 30 cm^3 of oxygen remains unreacted
7. $1.20 \cdot 10^{23}$
8. 46.8 g mol^{-1}
9. 0.761 g dm^{-3}
10. 2.24×10^5 dm^3 (224 m^3)

Page 25 Ex 1.4.3

1. A
2. A
3. C
4. B
5. D
6. C
7. a) 0.0139 moles, b) 83.2%
8. a) 1100 dm^3 b) 100 g (n.b. H_2)
9. Mass of gas in flask = 4.685 g;

   Volume of flask (assuming density of water = 1 kg dm^{-3}) = 0.8043 dm^3;

   The flask contains 0.03193 moles at this T & P, hence the molar mass = 146.7 g mol^{-1}.
10. The pressure in both flasks must be equal, therefore

$$P = \frac{nRT}{V} = \frac{x \times R \times 600}{V} = \frac{(2-x) \times R \times 300}{V} \Rightarrow 600x = 600 - 300x \Rightarrow x = \frac{6}{7}$$

Therefore there is 8/7 mol in the flask at 27 K and 6/7 mol in the flask at 127 K.

$$P = \frac{nRT}{V} = \frac{\frac{6}{7} \times 8.31 \times 400}{5} = 570\text{kPa}$$

Page 28 Ex 1.5

1. A
2. D
3. B
4. a) 0.75 mol dm^{-3}

   b) 0.0250 mol dm^{-3}

   c) 0.0811 mol dm^{-3}
5. a) 2.1 moles,

   b) 0.0020 moles,

   c) 2.55×10^{-3} moles
6. a) 0.4 dm^{-3} b) 2.94 dm^{-3} c) 0.720 dm^{-3} (=720 cm^{-3})
7. Weigh out precisely 2.922 g of solid sodium chloride (0.0500 moles) and make it up to 500 cm^3 of solution in a 500 cm^3 volumetric flask.
8. Measure out 240 cm^3 of 2.0 mol dm^{-3} hydrochloric acid (0.48 moles) and make this up to 1.2 dm^3 of solution.
9. 1.25 mol dm^{-3}
10. $[NO_{3-}]$ = 0.8 mol dm^{-3}, [Cl–] = 0 mol dm^{-3}, $[H^+]$ = 0.4 mol dm^{-3},

    $[Pb^{2+}]$ = 0.2 mol dm^{-3}

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Page 31 Ex 1.5.1

1. C
2. A
3. D
4. a) 0.0125 moles, b) 0.0125 moles, c) 0.625 mol dm^{-3}
5. a) $3.75x10^{-4}$ moles, b) $1.875x10^{-4}$ moles, c) 0.556 g dm^{-3}
6. a) $Ag^{+}(aq) + Cl–_{(aq)} \rightarrow AgCl_{(s)}$, b) $4.00x10^{-3}$ moles, c) $2.00·10^{-3}$ moles, d) 90.66%

7 a) $5.01x10^{-4}$ moles, b) $2.51x10^{-3}$ moles, c) 0.711 g, d) 0.268 g, $x = 6$

8 a) 9.46 mol dm^{-3}, b) 105.7 cm^3

9 a) $6\ Fe^{2+}(aq) + Cr_2O_7^{2-}(aq) + 14\ H^{+}(aq) \rightarrow 6\ Fe^{3+}(aq) + 2\ Cr^{3+}(aq) + 7\ H_2O_{(l)},$

b) $3.74x10^{-4}$ moles, c) $2.24·10^{-3}$ moles, d) 96.4%

10. 122 g mol^{-1}, possibly benzoic acid (C_6H_5COOH)

Page 33 Ex 1.5.2

1. a) 0.0050, b) 0.010, c) 0.005, d) 0.9 g, e) 90%
2. 82.6%. It was assumed that the impurities in the marble reacted with neither acid nor alkali. It was assumed that none of the evolved carbon dioxide remained in solution to react with the alkali.
3. a) 12.0 g mol^{-1} b) 24.0 g mol^{-1} c) 36.0 g mol^{-1}.

   Answer b) is most likely as this molar mass corresponds to magnesium, which is a divalent metal, rather than to carbon or chlorine.

Page 35 Ex 1.5.3

1. C
2. C
3. A
4. a) $4.376x10^5$, b) $2.3x10^{-7}$, c) $4.15x10^8$, d) $3.72x10^{-2}$, e) $4.768x10^2$, f) $3.26x10^0$
5. a) 820000, b) 0.00629, c) 271 380 000 000, d) 0.0000002, e) 42, f) 0.589

Page 36 Ex 1.16

1. B
2. D
3. B
4. B

5 a) 0.028, b) 28, c) $3.76·10^5$, d) 0.00175, e) $2x10^9$