Model answer lesson 5 chapter 2

Question	Answer	Question	Answer
1	D	13	C (Steps ↓)
2	B (Steps ↓)	14	D (Steps ↓)
3	B (Steps ↓)	15	D (Steps ↓)
4	A (Steps ↓)	16	B (Steps ↓)
5	D (Steps ↓)	17	A (Steps ↓)
6	C (Steps ↓)	18	A (Steps ↓)
7	A (Steps ↓)	19	A (Steps ↓)
8	C (Steps ↓)	20	A (Steps ↓)
9	A (Steps ↓)	21	D (Steps ↓)
10	A (Steps ↓)	22	A (Steps ↓)
11	C (Steps ↓)	23	D (Steps ↓)
12	B (Steps ↓)		

Steps:

2) $NaOH + HCl \rightarrow NaCl + H_2O$

Acid (HCl)	Base (NaOH)
Ma = 0.1 M	No. of moles = x
Va = 1500×10^{-3} L	nb = 1
na = 1	

$$\frac{Ma\,Va}{na} = \frac{no.of\ moles}{nb}$$

$$\frac{0.1 \times 1500 \times 10^{-3}}{1} = \frac{no.of\ moles}{1}$$

No. of moles of NaOH = 0.15 moles

3) $2H_3PO_4 + 3Ca(OH)_2 \rightarrow Ca_3(PO_4)_2 + 6H_2O$

Acid (H_3PO_4)	Base ($Ca(OH)_2$)
Ma = x	Mb = 0.4 M
Va = 80×10^{-3} L	Vb = 60×10^{-3} L
na = 2	nb = 3

$$\frac{Ma\,Va}{na} = \frac{Mb\,Vb}{nb}$$

$$\frac{Ma \times 80 \times 10^{-3}}{2} = \frac{0.4 \times 60 \times 10^{-3}}{3}$$

Ma = 0.2M

4) 1 mole NaOH → molar mass (23+16+1) = 40g

X moles → 8g

X = 0.2 moles of NaOH

Acid (H_2SO_4)	Base (NaOH)
Ma = 0.5 M	Mb = 1 M
Va = x L	Vb = 30 × 10^{-3} L
na = 1	nb = 2

Concentration = $\frac{no.of\ moles}{volume\ of\ solution\ (L)} = \frac{0.2}{200 \times 10^{-3}}$ = 1M

$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$

$\frac{Ma\ Va}{na} = \frac{Mb\ Vb}{nb}$

$\frac{\mathbf{0.5}\ \times Va}{1} = \frac{1 \times 30 \times 10^{-3}}{2}$

Va = 0.03L

5) $H_2SO_4 + 2NaHCO_3 \rightarrow Na_2SO_4 + 2H_2CO_3$

Acid (H_2SO_4)	Base ($NaHCO_3$)
Ma = 0.1 M	No. of moles = x
Va = 7.15 × 10^{-3} L	nb = 2
na = 1	

$\frac{Ma\ Va}{na} = \frac{no.of\ moles}{nb}$

$\frac{0.1 \times\ 7.15\ \times 10^{-3}}{1} = \frac{no.of\ moles}{2}$

No. of moles of $NaHCO_3$ = 0.00143 moles

1 mole $NaHCO_3$ → molar mass = 84g

0.00143 moles → xg

X = 0.12012g

Mass % of $NaHCO_3$ = $\frac{mass\ of\ \mathrm{NaHCO3}}{total\ mass}$ × 100

Mass % of $NaHCO_3$ = $\frac{0.12012}{1}$ × 100 = 12.012%

6) $H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$

Acid (H_2SO_4)	Base (NaOH)
Ma = 0.1 M	Mb = x
Va = 25 × 10^{-3} L	Vb = 15 × 10^{-3} L
na = 1	nb = 2

$\frac{Ma\ Va}{na} = \frac{Mb\ Vb}{nb}$

$$\frac{0.1 \times 25 \times 10^{-3}}{1} = \frac{Mb \times 15 \times 10^{-3}}{2}$$

Mb = 0.33M

Concentration = $\frac{no.of\ moles}{volume\ of\ solution\ (L)}$

0.33 = $\frac{x}{450 \times 10^{-3}}$, x = 0.1485 moles of NaOH

1 mole NaOH → molar mass (23+16+1) = 40g

0.1485 moles → xg

X = 5.94g

7) KOH + HCl → KCl + H_2O

Acid (HCl)	Base (KOH)
Ma = 0.1 M	No. of moles = x
Va = 30 × 10^{-3} L	nb = 1
na = 1	

$$\frac{Ma\ Va}{na} = \frac{no.of\ moles}{nb}$$

$$\frac{0.1 \times 30 \times 10^{-3}}{1} = \frac{no.of\ moles}{1}$$

No. of moles of KOH = 0.003 moles

1 mole KOH → molar mass (39+16+1) = 56g

0.003 moles → xg

X = 0.168g

% of purity = $\frac{mass\ of\ \text{pure KOH}}{total\ mass\ of\ impure\ sample}$ × 100

% of purity = $\frac{0.168}{0.3}$ × 100 = 56%

8) NaOH + HCl → NaCl + H_2O

Acid (HCl)	Base (NaOH)
Ma = 0.1 M	No. of moles = x
Va = 10 × 10^{-3} L	nb = 1
na = 1	

$$\frac{Ma\ Va}{na} = \frac{no.of\ moles}{nb}$$

$$\frac{0.1 \times 10 \times 10^{-3}}{1} = \frac{no.of\ moles}{1}$$

No. of moles of NaOH = 0.001 moles

1 mole NaOH → molar mass (23+16+1) = 40g

0.001 moles → xg

X = 0.04g

Mass % of NaOH = $\frac{mass\ of\ \mathrm{NaOH}}{total\ mass}$ × 100

Mass % of NaOH = $\frac{0.04}{0.1}$ × 100 = 40%

9) $2HCl + Na_2CO_3 \rightarrow 2NaCl + H_2CO_3$

Acid (HCl)	Base (Na_2CO_3)
Ma = 0.05 M	No. of moles = x
Va = 20 × 10^{-3} L	nb = 1
na = 2	

$$\frac{Ma\ Va}{na} = \frac{no.of\ moles}{nb}$$

$$\frac{0.05 \times\ 20\ \times 10^{-3}}{2} = \frac{no.of\ moles}{1}$$

No. of moles of Na_2CO_3 = 0.0005 moles

1 mole Na_2CO_3 → molar mass (23×2) + 12 + (16×3) = 106g

0.0005 moles → xg

X = 0.053g

Mass of NaCl = Mass of mixture – mass of Na_2CO_3

Mass of NaCl = 0.4 - 0.053 = 0.347g

Mass % of NaCl = $\frac{mass\ of\ \mathrm{NaCl}}{total\ mass\ of\ mixture}$ × 100

Mass % of NaCl = $\frac{0.347}{0.4}$ × 100 = 86.75%

10) $2HCl + CaCO_3 \rightarrow CaCl_2 + H_2CO_3$

Acid (HCl)	Base ($CaCO_3$)
Ma = 0.8 M	No. of moles = x
Va = 15 × 10^{-3} L	nb = 1
na = 2	

$$\frac{Ma\ Va}{na} = \frac{no.of\ moles}{nb}$$

$$\frac{0.8 \times\ 15\ \times 10^{-3}}{2} = \frac{no.of\ moles}{1}$$

No. of moles of $CaCO_3$ = 0.006 moles

1 mole $CaCO_3$ → molar mass 40+12+(16×3) = 100g

0.006moles → xg

X = 0.6g

Mass % of $CaCO_3$ = $\frac{mass\ of\ \mathrm{CaCO3}}{total\ mass\ of\ mixture}$ × 100

Mass % of $CaCO_3$ = $\frac{0.6}{1.5}$ × 100 = 40%

11) $KCl + AgNO_3 \rightarrow AgCl + KNO_3$

*Molar mass of AgCl = 108 + 35.5 = 143.5g

AgCl → Cl

6.7g → xg

143.5g → 35.5g

X = 1.65 g of Cl

Mass % of Cl = $\frac{mass\ of\ \mathrm{Cl}}{total\ mass}$ × 100

Mass % of Cl = $\frac{1.65}{3.4}$ × 100 = 48.5%

12) $K_2SO_4 + BaCl_2 \rightarrow BaSO_4 + 2KCl$

*Molar mass of K_2SO_4 = (39×2) + 32 + (16×4) = 174g

*Molar mass of $BaSO_4$ = 137 + 32 + (16×4) = 233g

K_2SO_4 → $BaSO_4$

xg → 4.66g

174g → 233g

X = 3.48 g of K_2SO_4

Mass of impurities = Mass of impure sample – mass of K_2SO_4

Mass of impurities = 4 - 3.48 = 0.52g

% of impurities = $\frac{mass\ of\ \text{impurities}}{total\ mass\ of\ mixture}$ × 100

% of impurities = $\frac{0.52}{4}$ × 100 = 13%

13) $Na_2SO_4 + BaCl_2 \rightarrow BaSO_4 + 2NaCl$

*Molar mass of $BaCl_2$ = 137 + (35.5×2) = 208g

*Molar mass of $BaSO_4$ = 137 + 32 + (16×4) = 233g

$BaCl_2 \rightarrow BaSO_4$

xg → 2.734g

208g → 233g

X = 2.44 g of $BaCl_2$

% of $BaCl_2$ = $\frac{mass\ of\ \text{BaCl2}}{total\ mass}$ × 100

% of $BaCl_2$ = $\frac{2.44}{3.725}$ × 100 = 65.5%

14) $Pb(NO_3)_2 + BaCl_2 \rightarrow Ba(NO_3)_2 + PbCl_2$

*Molar mass of $PbCl_2$ = 207 + (35.5×2) = 278g

$PbCl_2 \rightarrow 2Cl$

1g → xg

278g → 2×35.5g

X = 0.255 g of Cl

Mass % of Cl = $\frac{mass\ of\ \text{Cl}}{total\ mass}$ × 100

Mass % of Cl = $\frac{0.255}{2}$ × 100 = 12.75%

15) *Molar mass of $BaCl_2$ = 137 + (35.5×2) = 208g

*Molar mass of H_2SO_4 = (1×2) + 32 + (16×4) = 98g

$BaCl_2 \rightarrow H_2SO_4$

0.5g → xg

208g → 98g

X = 0.235 g of H_2SO_4

1 mole H_2SO_4 → 98g

X moles → 0.235g

X = 0.00239 moles

Concentration = $\frac{no.of\ moles}{volume\ of\ solution\ (L)}$

1 = $\frac{0.00239}{x}$, x = 0.00239 L = 2.39 ml = 2.4 ml

16) $Fe_2O_3 + H_2 \xrightarrow{400\text{-}700^\circ C} 2FeO + H_2O$

*Molar mass of FeO = 55.8 + 16 = 71.8g

*Molar mass of Fe_2O_3 = (2×55.8) + (16×3) = 159.6g

$Fe_2O_3 \rightarrow 2FeO$

xg → 0.58g

159.6g → 2×71.8g

X = 0.64 g of Fe_2O_3

Mass % of Fe_2O_3 = $\frac{mass\ of\ \mathrm{Fe2O3}}{total\ mass}$ × 100

Mass % of $Fe_2O_3 = \frac{0.64}{0.7} \times 100 = 91.4\% = 92\%$

17) $Na_3PO_4 + 3AgNO_3 \rightarrow Ag_3PO_4 + 3NaNO_3$

Yellow ppt. soluble in ammonia solution → Ag_3PO_4

*Molar mass of $AgNO_3$ = 108 + 14+ (16×3) = 170g

*Molar mass of Ag_3PO_4 = (108×3) + 31 + (16×4) = 419g

$3AgNO_3 \rightarrow Ag_3PO_4$

xg → 2.25g

3×170g → 419g

X = 2.738 g of $AgNO_3$

18) $2Na_3PO_4 + 3BaCl_2 \rightarrow Ba_3(PO_4)_2 + 6NaCl$

White ppt. soluble in dil. HCl → $Ba_3(PO_4)_2$, therefore name of anion is phosphate

*Molar mass of $BaCl_2$ = 137 + (35.5×2) = 208g

*Molar mass of $Ba_3(PO_4)_2$ = (137×3) + ((31 + (16×4)×2) = 601g

$3BaCl_2 \rightarrow Ba_3(PO_4)_2$

xg → 1.21g

3×208g → 601g

X = 1.256 g of $BaCl_2$

19) $Fe_3O_4 + 4H_2SO_4 \xrightarrow[\text{Conc.}]{\blacktriangle} FeSO_4 + Fe_2(SO_4)_3 + 4H_2O$

$FeSO_4 + 2NaOH \rightarrow Fe(OH)_2 + Na_2SO_4$

$Fe_2(SO_4)_3 + 6NaOH \rightarrow 2Fe(OH)_3 + 3Na_2SO_4$

1 mole of Fe_3O_4 gives 1 mole of each of $FeSO_4$ and $Fe_2(SO_4)_3$

0.1 moles of Fe_3O_4 gives 0.1 moles of each of $FeSO_4$ and $Fe_2(SO_4)_3$

$FeSO_4 \rightarrow Fe(OH)_2$ (0.1 moles of $FeSO_4$ gives 0.1 moles of $Fe(OH)_2$)

1 mole $Fe(OH)_2 \rightarrow$ 90g

0.1 moles $\rightarrow$ xg

X = 9g

$Fe_2(SO_4)_3 \rightarrow 2Fe(OH)_3$ (0.1 moles of $Fe_2(SO_4)_3$ gives 0.2 moles of $Fe(OH)_3$)

1 mole $Fe(OH)_3 \rightarrow$ 107g

0.2 moles $\rightarrow$ xg

X = 21.4g

Total mass of precipitates = Mass of $Fe(OH)_2$ + Mass of $Fe(OH)_3$

Total mass of precipitates = 9 + 21.4 = 30.4g

20) $AgNO_3 + NaCl \rightarrow NaNO_3 + AgCl$

*Molar mass of AgCl = 108 + 35.5 = 143.5g

AgCl $\rightarrow$ Cl

3.52g $\rightarrow$ xg

143.5g $\rightarrow$ 35.5g

X = 0.87 g of Cl

Mass % of Cl = $\frac{mass\ of\ \mathrm{Cl}}{total\ mass} \times 100$

Mass % of Cl = $\frac{0.87}{4} \times 100 = 21.75\%$

21) $H_2SO_4 + 2NaNO_3 \rightarrow Na_2SO_4 + 2HNO_3$

1 mole H_2SO_4 → 98g

0.125 moles → xg

X = 12.25g

H_2SO_4 → $2HNO_3$

12.25g → xg

98g → 2×63g

X = 15.75 g of HNO_3

1 mole HNO_3 → 63g

x moles → 15.75g

X = 0.25 moles

$HNO_3 + NaOH \rightarrow NaNO_3 + H_2O$

Acid (HNO_3)	Base (NaOH)
No. of moles = 0.25	Mb = x
na = 1	Vb = 200 × 10^{-3} L
	nb = 1

$$\frac{no.of\ moles}{na} = \frac{Mb\ Vb}{nb}$$

$$\frac{0.25}{1} = \frac{Mb \times 200 \times 10^{-3}}{1}$$

Mb = 1.25M

22) $MnCl_x.4H_2O \rightarrow MnCl_x + 4H_2O$

Mass of water = Mass of hydrated sample – mass of anhydrous sample

Mass of water = 6.6 – 4.2 = 2.4g

$MnCl_x$ → $4H_2O$

4.2g → 2.4g

(55+35.5x)g → 4×18g

X = 2

$Mn_{25} \rightarrow Ar_{18}, 4s^2, 3d^5$

$Mn_{25}^{+2} \rightarrow Ar_{18}, 4s, 3d^5$

23) $2HCl + Na_2CO_3 \rightarrow 2NaCl + H_2CO_3$

Acid (HCl)	Base (Na_2CO_3)
Ma = 0.1 M	Mb = x
$Va = 25 \times 10^{-3}$ L	$Vb = 25 \times 10^{-3}$ L
na = 2	nb = 1

$$\frac{Ma\,Va}{na} = \frac{Mb\,Vb}{nb}$$

$$\frac{0.1 \times 25 \times 10^{-3}}{2} = \frac{Mb \times 25 \times 10^{-3}}{1}$$

Mb = 0.05M

Concentration = $\frac{no.of\ moles}{volume\ of\ solution\ (L)}$

$0.05 = \frac{x}{1}$, x = 0.05 moles of Na_2CO_3

*Molar mass of Na_2CO_3 = (23×2) + 12 + (16×3) = 106g

1 mole $Na_2CO_3 \rightarrow$ 106g

0.05 moles $\rightarrow$ xg

X = 5.3g

Mass of water = Mass of hydrated sample – mass of anhydrous sample

Mass of water = 14.3 – 5.3 = 9g

Mass % of water = $\frac{mass\ of\ \text{water}}{total\ mass\ of\ hydrated\ sample}$ × 100

Mass % of water = $\frac{9}{14.3}$ × 100 = 62.93%