SCH 3UE Unit 1 – Quantitative Chemistry
Unit Review Problems – Answer Key

1. a)

Process Eqn. $KI_{(aq)} + SnCl_{2(aq)} \text{ -----> } SnI_{2(s)} + KCl_{(aq)}$

Balanced Eqn. $2\ KI_{(aq)} + SnCl_{2(aq)} \text{ -----> } SnI_{2(s)} + 2\ KCl_{(aq)}$

g --> mol

$1.40\ mol \bullet L^{-1}$ in 10.0mL
$= 1.40\ mol \bullet L^{-1} \bullet\ 0.01$
$= 0.014\ mol$

$\frac{2.280g}{189.60\ g/mol}$
$=0.01203\ mol$

i) Therefore, $SnCl_2$ is the reagent in excess.

Mass of XS consumed in rxn:

LR	:	$SnCl_2$
2	:	1
0.014 mol		x

Let x be #mol consumed
$x = (0.014\ mol)/2 = 0.007\ mol$ consumed
$mass = mol \bullet M_R$
$mass = 0.007\ mol \bullet 189.60\ g/mol$
$mass = 1.3272\ g\ SnCl_2$ consumed

Mass remaining: $m_{rem} = 2.280\ g - 1.3272\ g$
$= 0.9528\ g\ SnCl_2$ (XS) remain

ii) Therefore, 0.9528g of excess $SnCl_2$ remain.

To determine mass of pcpt. Product SnI_2 formed:

mol : mol
LR : product
KI : SnI_2

2	:	1
0.014 mol		x

Let x be #mol SnI_2 pcpt. Formed
$x = (0.014\ mol)/2 = 0.007\ mol\ SnI_2$ formed

Mass of product: $m_p = 0.007\ mol \bullet M_R$
$m_p = 0.007\ mol \bullet 372.51\ g/mol$
$= 2.608\ g\ SnI_2$ precipitate formed

iii) Therefore, the maximum mass of SnI_2 formed is 2.608g

To determine LR/XS:

mol	:	mol
KI	:	$SnCl_2$
0.014	:	0.01203
2		1
0.007	:	0.01203

0.01203mol, $SnCl_2$, is XS

b)

Process Eqn.: $X\ Sn + Y\ I \text{ -----> } Sn_XI_Y$

Sn mass consumed: 4.100g – 3.385g
=0.715g Sn consumed to react equally with iodine

Process Eqn.:	X Sn	+	Y I	----->	Sn_XI_Y
Mass values:	0.715g		3.105g		
g --> mol:	118.71g/mol		126.90g/mol		
mol values:	=0.006023mol		=0.02447mol		

mol : mol ratio: Since refluxed until equal proportions, no LR or XS.

	mol	:	mol
	Sn	:	I
	0.006023mol	:	0.02447mol
/ by smallest #mol:	0.006023mol		0.006023mol
	~ 1	:	4

Process Eqn.:	X Sn	+	Y I	----->	Sn_XI_Y
	1 Sn	+	4 I	----->	SnI_4

Therefore the formula of the compound formed is SnI_4, Tin (IV) iodide.

2.

Elements:	C	H	N	O
% composition	40.45%	7.86%	15.73%	35.96%
100% = 100g	40.45g	7.86g	15.73g	35.96g
g --> mol	12.011g/mol	1.0079g/mol	14.007g/mol	15.999g/mol
	= 3.3677 mol	= 7.7984 mol	= 1.1230 mol	= 2.2476 mol
/ by smallest #mol	1.1230	1.1230	1.1230	1.1230
	= 3 mol	= 7 mol	= 1 mol	= 2 mol

Empirical Formula: 3C + 7H + 1N + 2O
$= C_3H_7NO_2$

Molecular Formula: #mol = mass / M_R
= 89.0g / (89.01g/mol)
= 1
∴ $= 1(C_3H_7NO_2) = C_3H_7NO_2$

Therefore the compound is likely Alanine, $C_3H_7NO_2$.

3.

Produced $BaSO_4$ / by M_R: $\frac{0.3550g}{233.43g/mol} = 1.521 \cdot 10^{-3}$ mol

produced SO_4: $n_{SO4} = 1.521 \cdot 10^{-3}$ mol

a) Therefore $1.521 \cdot 10^{-3}$ mol $BaSO_4$ were precipitated

b) $mass_T = XM_{R1} + YM_{R2}$

c) #mol SO_4 $n = X + Y$

$n_{SO4} = X + Y$

$Y = n_{SO4} - X$ ... (1)

$m_{mix} = XM_{R1} + YM_{R2}$ ... (2)

Sub (1) in (2): $= XM_{R1} + (n_{SO4} - X)M_{R2}$

$= XM_{R1} + n_{SO4}M_{R2} - XM_{R2}$

$m_{mix} - n_{SO4}M_{R2} = XM_{R1} - XM_{R2}$

$m_{mix} - n_{SO4}M_{R2} = X(M_{R1} - M_{R2})$

$X = \frac{m_{mix} - n_{SO4}M_{R2}}{M_{R1} - M_{R2}}$

$= \frac{(0.3973g) - (1.521 \cdot 10^{-3}mol)(287.5g/mol)}{(246.5g/mol) - (287.5g/mol)}$

$= \frac{-0.03999g}{-41.0g/mol}$

Num. value X: $= 9.75 \cdot 10^{-4}$ mol

Num. value Y (1): $Y = n_{SO4} - X$

$= 5.46 \cdot 10^{-4}$ mol

d) Therefore the numerical value of X is $9.75 \cdot 10^{-4}$ mol.

% $MgSO_4 \cdot 7H_2O$: $m_{ms} = XM_{R1}$

$= 0.240g$

$\%m = m_{ms}$ / total mass

$= [(0.240g) / (0.3973g)] \cdot 100\%$

$= 60.4\ \%$

e) Therefore $MgSO_4 \cdot 7H_2O$ represents 60.4% of total mass.

4. a)

Process Eqn.: $2C_XH_Y + (2X + 0.5Y)O_2$ -----> $(2X)CO_2 + YH_2O$

Balanced Eqn.: $C_XH_Y + (X + 0.25Y)O_2$ -----> $XCO_2 + 0.5YH_2O$

#mol CO_2 (n_{CO2}): $n_{CO2} = m_{CO2} / M_{RCO2}$

$= 1.56g / (44.095g/mol)$

$= 0.0354$ mol

i) Therefore, 0.0354 mol of CO_2 were produced.

#mol H_2O (n_{H2O}): $n_{H2O} = m_{H2O} / M_{RH2O}$

$= 0.638g / (18.015g/mol)$

$= 0.0354$ mol

ii) Therefore, 0.0354 mol of H_2O were produced.

Empirical Formula $m_C : m_{CO2}$ $m_H : m_{H2O}$

X : X Y : 0.5Y

1 : 1, :. $n_{CO2} = n_C = 0.0354$ mol 2 : 1, :. $n_H = 2(0.0354\text{mol}) = 0.708$mol

	C	:	H
	0.0354mol	:	0.708mol
/ by smallest #mol	0.0354mol		0.0354mol
	1	:	2

:. 1C2H = CH_2

iii) Therefore, the empirical formula of the compound is CH_2.

b)

Convert to L: $V_{HC} = 448\text{cm}^3$

$= 448\text{cm}^3 \bullet \text{L}(1000\text{cm}^{-3}) = 0.448\text{L}...(V_1)$

:. 1.00 mol of gas is contained in 22.4L at 0°C, 101.3 k Pa:

Mols hydrocarbon $n_{HC} = V \bullet (n/V_1)$

$= 0.448\text{L} \bullet (1.00\text{mol}/22.4\text{L}) = 0.0200$ mol

Molecular mass: $n_{HC} = m_{HC} / M_{RHC}$

$M_{RHC} = (1.12\text{g}) / (0.0200\text{mol})$

$= 56.0$ g/mol

Mol. Formula $\frac{M_{RHC}}{M_{REF}} = \frac{(56.0\text{g/mol})}{(14.0\text{g/mol})}$

$= 4$

:. $4(CH_2) = C_4H_8$

c) Therefore the molecular formula of the compound is C_4H_8, butene.