Part 1 Short answer

Q1 - Element 34 electron configuration

→ $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^4$

→ Selenium (Se)

→ S^{2-}

Q2 - Calculate protons, neutrons, and electrons

$^{65}Cu^{2+}$

Protons	Neutrons	Electrons
29	36	27

$65 - 29 = 36$ neutrons

Protons (29) $-2 = 27e^-$

Q3 - X_3Y_2, X is a metal cation, Y is a polyatomic anion

$Mg^{2+}\ PO_4^{3-}$

$Mg_3(PO_4)_2$

6^+ 6^-

Q4 - Moles of CO_2 given 7.35×10^{21} CO_2 molecules

$n = \frac{N}{N_A}$

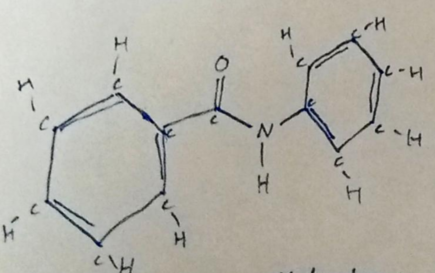
$\frac{7.35 \times 10^{21}}{6.02214 \times 10^{23}} \rightarrow 10^{-2}$

1.2205

$= 1.2205 \times 10^{-2}$

$= 1.23 \times 10^{-2}$

Q5 - Provide molecular & empirical formula



13 Carbon
1 oxygen
1 Nitrogen
11 Hydrogen

Molecular:
$C_{13}H_{11}NO$

Empirical
$C_{13}H_{11}NO$

Q6 - determine empirical formula from element percents

- 26.58% K
- 35.35% Cr
- 38.07% O

treated as grams

K g/mol = 39.0983 g/mol
Cr g/mol = 51.996 g/mol
O g/mol = 15.9994 g/mol

$\frac{26.58g\ K}{39.0983 g/mol} = 0.6798$ mol (lowest) $= 1$ K

$\frac{35.35g\ Cr}{51.996\ g/mol} = 0.6799$ mol; $\frac{0.6799}{0.6798} = 1$ Cr ×2

$\frac{38.07g\ O}{15.9994\ g/mol} = 2.379$ mol; $\frac{2.379}{0.6798} = 3.50$

→ $K_2Cr_2O_7$

Q7 - Bz with two isotopes

- Bz-115 g/mol = 114.9885 u, Abundance = 33.71%
- Bz-118 g/mol = 117.7998 u, Abundance = 66.29%

$(114.9885 \times 0.3371) + (117.7998 \times 0.6629)$

$= 116.85349755$ u

Q8 - Calculate CO_2 mass contained in a 1.00L cylinder with a pressure of 325.05 kPa at 25°C

grams

298.15K

$PV = \frac{g}{M}RT$

$n = \frac{PV}{RT}$

$CO_2 = 12.011 + 2(15.9994)$

$= 44.0098$ g/mol

$n = \frac{325.05kPa \times 1.00L}{8.31446 \times 298.15K}$

$n = 0.1311237341$ mol of CO_2

$= 5.770729$ grams

$= 5.77073$ grams

Q9 - pH of a OH^- concentration of 4.28×10^{-10} M

pOH = $-\log(OH^-)$

$= -\log(4.28 \times 10^{-10})$

$= 9.369$

pH + pOH = 14

pH = 14 − pOH → 14 − 9.369

$= 4.63144$ pH

pH of 4.631

Short answer

Q10 – H_2SO_4 concentration? – 20 mL
Against NaOH – 0.210 M
11.75 mL

$C_1V_1 = C_2V_2$

~~20 + 11.75 mL~~
~~= 31.75 mL~~ V_2

$C_1 = \frac{C_2 V_2}{V_1}$

$\frac{0.210M \times 0.01175L}{0.02L}$

= 0.123375 M of H_2SO_4

= 0.1 M of H_2SO_4

~~= 0.123 M of H_2SO_4~~

Extended Response

Q1. Stoichiometry

$Al(OH)_{3(s)}$ & $HCl_{(aq)}$ form $AlCl_3 + H_2O$

1a) Molar mass of $Al(OH)_3$

Al: 26.98154 + 3(15.9994) + 3(1.008)

~~= 78.00374 g/mol~~ → 78.004 g/mol

This one

1b) Mass of HCl

$c = \frac{n}{v}$

n = CV   0.160 M HCl × 0.08 L

= 0.0128 moles

HCl g/mol = 36.461 u
35.453
1.008

×

= 0.4667008 grams HCl

= 0.467 grams HCl

1c) Balance equation

$Al(OH)_{3\,(aq)} + 3HCl_{(aq)} \rightarrow AlCl_{3\,(aq)} + 3H_2O_{(l)}$

~~3H₂O~~

soluble in water

1d) Identify limiting reagent.

If with 0.450g $Al(OH)_3$ → $\frac{0.450g}{78.004 g/mol}$

= 0.005768

= 5.77×10^{-3} mol

with 0.467g HCl
(0.0128 mol)

÷ ~~ratio~~ coefficient (3)

= 0.004266… = 4.27×10^{-3}

HCl moles is less than $Al(OH)_3$, and therefore is the limiting reagent

HCl

1e) Theoretical yield (grams) of $AlCl_3$

~~4.27×10^{-3} mol~~

0.0128 mol HCl × $\frac{1 \text{ mol } AlCl_3}{3 \text{ mol } HCl}$ = ~~0.00~~ 4.27×10^{-3} mol $AlCl_3$

$AlCl_3$ M_r = 133.341 g/mol

26.9815 + 3(35.453)

×

= 0.5689 grams

theoretical yield = 0.569 grams $AlCl_3$

1f) Calculate # ions of Al^{3+} and Cl^- that will be found in the $AlCl_3$ solution formed

Both = 4.27×10^{-3} mol

1:3, 4 total

~~÷3 = 1.42×10^{-3}~~

÷4 = 1.07×10^{-3}

→ ×3 = 3.2025×10^{-3} mol Cl

→ ×2 = ~~3.7~~ 2.135×10^{-3} mol Al

× avogadro

$(3.2025 \times 10^{-3}) \times (6.022 \times 10^{23})$ = 1.928×10^{21} – Cl^- ions

$(2.135 \times 10^{-3}) \times (6.022 \times 10^{23})$ = 1.285×10^{21} – Al^{+3} ions

1g) If 489 mg of $AlCl_3$ is recovered, % yield?

theo.
0.569g = 569 mg

$\frac{489 \text{ mg}}{569 \text{ mg}}$ = 0.8594 %

= 85.9%

Q2. Thermodynamics

$2NO_{(g)} + O_{2(g)} \rightarrow 2NO_{2(g)}$

$\Delta S_r = -146.5$ J/mol/k → -0.14655
0.1465

$\Delta H_r = -114.1$ kJ/mol

2a) ΔG? At 25°C (298.15 K) spontaneous or not?

$\Delta G = \Delta H_r - (T \times \Delta S)$

A reaction is considered spontaneous when $\Delta G < 0$, and my result is well below that threshold

= -114.1 − (298.15 × -0.1465)

= -70.42 kJ/mol

~~= -157.7189~~ ~~= -157.8 kJ/mol~~

The reaction is spontaneous.

2b) Become/cease to be spontaneous? Temperature.

$-\frac{\Delta G - \Delta H}{\Delta S} = T$ $\frac{0 - -114.1}{-0.1465}$ + 273.15 =

~~505.618~~ K

~~505.618~~ K

778.84 K

Extended Response

Q2 continued

2c) Why is ΔS negative?
• 2 cases where entropy is positive

The total amount of particles is going down (3 particles to 2), meaning entropy has decreased.

positive entropy cases

1. A log combusting, releasing carbon as the more entropic CO_2

~~2. A lo~~

2. A container expanding, causing ~~more~~ movement opportunities for particles

2d) Find ΔH_r w/ Hess' law

$$2NO_{(g)} + O_{2(g)} \rightarrow N_2O_{4\,(g)}$$

$N_2O_4 \rightarrow 2NO_2$ $\Delta H = +57.93\ kJ/mol$

$\cdot 2NO_{2(g)} \rightarrow N_2O_{4\,(g)}$ $\Delta H = -57.93\ kJ\ mol^{-1}$

+

$2NO_{(g)} + O_{2(g)} \rightarrow 2NO_2$ $\Delta H = -114.1\ kJ$

$-56.17\ kJ$

$2NO_{(g)} + O_{2(g)} + \cancel{2NO_2} \rightarrow \cancel{2NO_2}\ N_2O_{4\,(g)}$

2e) Partial pressures

~~H~~ 2 parts NO : 3 parts O_2

$O_2 = 32\ g\ mol^{-}$

$NO = 30.005\ g/mol$

$\frac{141 kPa}{5} = 28.2 kPa$

$28.2_{kPa} \times 2 = 56.4\ kPa = 40\%\ NO$

$28.2_{kPa} \times 3 = 84.6\ kPa = 60\%\ O_2$

2f) Work

2.05L to 7.81L under atmos. pressure

work J/L $= 1.013 \times 10^5 Pa \times (7.81L - 2.05L)$

$= 583,632\ J/L$

$\div 1000$ (L)

~~= 583.6~~ = 584 joules (J)

Q3. Bonding & Intermolecular forces

Propan-2-ol (Isopropyl alcohol) − Iso.

$CH_3CHOHCH_3$ C_3H_8O $M_r = 60.0964\ g\ mol^{-}$

$3(12.011)\ 8(1.008) + 15.9994$

3a) Electron config for Carbon (6)

$$\underbrace{1s^2}_{core}\ \overbrace{2s^2\ \underbrace{2p^2}_{valence}}^{valence}$$

3b) Iso density = 0.786 g mL^{-1}. Calculate acetone moles in 300mL acetone

Acetone = C_3H_6O

$= 58.0804\ g\ mol^{-1}$

$0.786 \times 300\ mL$

$= 235.8$ grams

$\frac{235.8}{58.0804} = 4.0599$ mol

4.060 mol of acetone (??)

if Iso: 3.924 mol isopropyl

I think you made a mistake here

I assume Iso and acetone are the same density?

3c) Iso. combustion

Balance:

$\overset{C_3H_8O}{CH_3CHOHCH_{3\,(l)}} + O_{2(g)} \rightarrow CO_{2(g)} + H_2O_{(g)}$

CO_2 in moles from 30.0 mL iso?

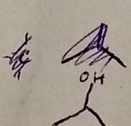
$C_3H_8O + 4.5\,O_2 \rightarrow 3CO_2 + 4H_2O$ ×2

Assuming infinite O_2 and Iso, not acetone

$$2C_3H_8O + 9O_2 \rightarrow 6CO_2 + 8H_2O$$

$3.924_{\,mol\ Iso} \times \frac{6\ CO_2}{2\ Iso} = 11.77\ mol\ CO_2$

3d) Predominant intermolecular forces on iso.?



Hydrogen bonding. The OH indicates hydrogen bonding. Dipolar forces are weaker and so it must be hydrogen.

• Dispersion
• Dipolar
• Hydrogen

} all 3, but Hydrogen is prevalent.

Q3. Continued

Extended Response

3e) Arrange C-C, C-O, and O-H on polarity (decreasing) high to low

O-H, C-H, C-O, C-C
1 2 3 4

3f) From 3c, calculate collected CO_2 pressure when in a 15.0L container.

Temp = 28.5°C $\overset{+273.15}{=}$ 301.65 K

$\frac{PV}{V} = nRT$

$P = \frac{nRT}{V}$ $= \frac{11.772 \times \cancel{8.314} \, 8.31446 \times 301.65K}{15.0L} = 1956.5835 \text{ kPa}$

15.0L → 3 sigs

3c CO_2 moles = 11.772 mol → 4 sig figs

~~1956.6 kPa~~

~~1957 kPa~~

~~1.956~~

1.96 × 10^3 kPa