Solutions to the practice test Chemistry Unit 2

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SECTION A

Question	Answer	Question	Answer	Question	Answer
1	**C**	9	**D**	17	**D**
2	**B**	10	**A**	18	**B**
3	**D**	11	**C**	19	**A**
4	**A**	12	**D**	20	**A**
5	**A**	13	**B**	21	**A**
6	**D**	14	**C**	22	**B**
7	**D**	15	**D**	23	**C**
8	**A**	16	**B**	24	**A**
				25	**D**

1) A 4.304 g sample of a hydrocarbon gas occupied a volume of 0.158 L at 154.1 kPa and 27.0 °C.

Given that the substance was a gas at the above temperature and pressure, calculate the moles of hydrocarbon gas present in the 4.304 g sample.

PV=nRT

PV/(RT) = n
V = 0.158 L
P = 154.4 kPa
T = 27 +273 = 300 K
=> n = 154.1 X 0.158/(8.31 X 300)
=> 0.0098 = n

In $g.mol^{-1}$, calculate the molar mass of the hydrocarbon.

Mass = mol X Fm
Fm = mass/mol
=> Fm =4.304/ 0.0438
=> Fm = 98.3

What temperature, in Celsius, is required for 0.374 g of the above gas to occupy a volume of 2.26 L at a pressure of 1.5 atm?

PV =nRT
=> T = PV/nR
n = 0.374/98.3 =0.0038
P = 1.5 X 101.3 = 151.95
V = 2.26 L
=> T = 151.95 X 2.26 /(0.0038 X 8.31) =10875 K = 10,875 -273 = 10,602

Briefly explain the equation $P_1 V_1 = P_2 V_2$.

At constant temperature and mol of gas the p and V are inversely related. As P increases V decreases so the product of the two is constant.

Question 2

Octane(C_8H_{18}) is an ingredient of car fuel. It is mixed with oxygen and then burnt to produce carbon dioxide and water vapour.

(a) Write a balanced chemical equation for the combustion of octane.

$2C_8H_{18}(g) + 25O_2(g) \Rightarrow 18H_2O(g) + 16CO_2(g)$

(b) What mass of carbon dioxide is produced if 30.0 g of octane is mixed with 30.0 g of oxygen gas?

mol of O_2 = 30/32 = 0.94
mol of octane= 30/114 = 0.26

For 0.29 mol of octane we need mol of oxygen equivalent to (25/2) X 0.26 = 3.25.

But we only have 0.94 mol of oxygen so oxygen is the limiting reagent.

Hence mol of carbon dioxide produced is (16/25) X 0.94 = 0.61
Mass of carbon dioxide = 0.61 X 44 = 26.8

Question 3

(i) Balance the following half-equations and identify each as either an oxidation or a ***reduction reaction.***

$H_2O_2(aq) \rightarrow H_2O(l)$
Balance for oxygen by adding water to the left hand side
$H_2O_2(aq) \rightarrow 2\,H_2O(l)$
Balance for hydrogen by adding H^+ to the left hand side
$H_2O_2(aq) + 2H^+(aq) \rightarrow 2\,H_2O(l)$
Balance for charge by adding electrons to the left hand side
$H_2O_2(aq) + 2H^+(aq) + 2e \rightarrow 2\,H_2O(l)$ (reduction reaction, electrons are used)

(ii) ***$Cl_2(g) + 2e \rightarrow 2Cl^-(aq)$ (also a reduction reaction, electrons are used)***

(a) Assign oxidation numbers to the underlined element in each of the following molecules or ions.

(i) $\underline{\mathbf{Cr}}_2O_7^{-2}$ ***(+6)***

(ii) $C\underline{\mathbf{H}}_4$ ***(+1)***

(iii) $\underline{\mathbf{Mn}}O_7^-$ (+13)

(b) Consider the following redox reaction.

$$Cr_2O_7^{-2}(aq) + Cu(s) \rightarrow Cr^{3+}(aq) + Cu^{2+}(s) + H_2O(l)$$

Write balanced half-equations for

The reduction process

$Cr_2O_7^{-2}(aq) => Cr^{3+}(aq)$

$Cr_2O_7^{-2}(aq) => 2Cr^{3+}(aq)$

$Cr_2O_7^{-2}(aq) => 2Cr^{3+}(aq) + 7H_2O(l)$

$Cr_2O_7^{-2}(aq) + 14H^+ => 2Cr^{3+}(aq) + 7H_2O(l)$

$Cr_2O_7^{-2}(aq) + 14H^+ + 6e => 2Cr^{3+}(aq) + 7H_2O(l)$

The oxidation process

$Cu(s) => Cu^{2+} + 2e$

c) From these half-equations write the balanced overall equation,

$Cr_2O_7^{-2}(aq) + 14H^+ + 6e => 2Cr^{3+}(aq) + 7H_2O(l)$

$+ \quad (Cu(s) => Cu^{2+} + 2e) \times 3$

$= Cr_2O_7^{-2}(aq) + 14H^+ + Cu(s) => 2Cr^{3+}(aq) + 7H_2O(l) + Cu^{2+}(aq)$

d) determine which chemical species is the reductant. ***Cu(s)***

Question 4

A solution of aqueous calcium hydroxide ($Ca(OH)_2$)was made by dissolving 0.02 mol of the alkali in water. This resulted in a 370 mL solution.

(a) Write a balanced **ionic equation** to show that calcium hydroxide is a strong base.

$Ca(OH)_2(s) => Ca^{2+}(aq) + 2OH^-(aq)$

(b) Calculate the molar concentration, in $mol.L^{-1}$, of the solution?
concentration = mol/Vol(L) = 0.02/0.37 = 0.054 M

(c) Calculate the $[H_3O^+]$ in the sodium hydroxide solution in $mol.L^{-1}$.

If $[Ca(OH)_2] = 0.054$ the $[OH^-] = 0.108$
$[H_3O^+][OH^-] = 10^{-14}$
$[OH^-] = 0.108\ M = 10^{-0.97}$
$=> [H_3O^+] = 10^{-14}/10^{-0.97}$
$=> [H_3O^+] = 10^{-13.03}$

(d) Calculate the pH of the resultant solution. ***13***

Question 5

Complete (a) to (c) below using the Brønsted-Lowry theory of acids and bases.

(a) i) Phosphoric acid, H_3PO_4, is a **strong acid**. Write appropriate, balanced chemical equations to show complete and successive ionisation of this acid in water.

a) ***$H_3PO_4(aq) + H_2O(l) \Rightarrow H_3O^+(aq) + H_2PO_4^-(aq)$***

b) $H_2PO_4^-(aq) + H_2O(l) \Rightarrow H_3O^+(aq) + HPO_4^{-2}(aq)$

c) $HPO_4^{-2}(aq) + H_2O(l) \Rightarrow H_3O^+(aq) + PO_4^{-3}(aq)$

ii) Indicate which reaction, from the ones above, is least likely to proceed to the right and give an explanation?

Reaction c) because HPO_4^{-2} is a very weak acid and will not react to any great extent with the water.

(b) In water, the carbonate ion, CO_3^{2-}, is a **weak base**. Write an appropriate, balanced chemical equation for the behaviour of this base in aqueous solution.

$CO_3^{2-}(aq) + H_2O(l) \Rightarrow HCO_3^-(aq) + OH^-(aq)$

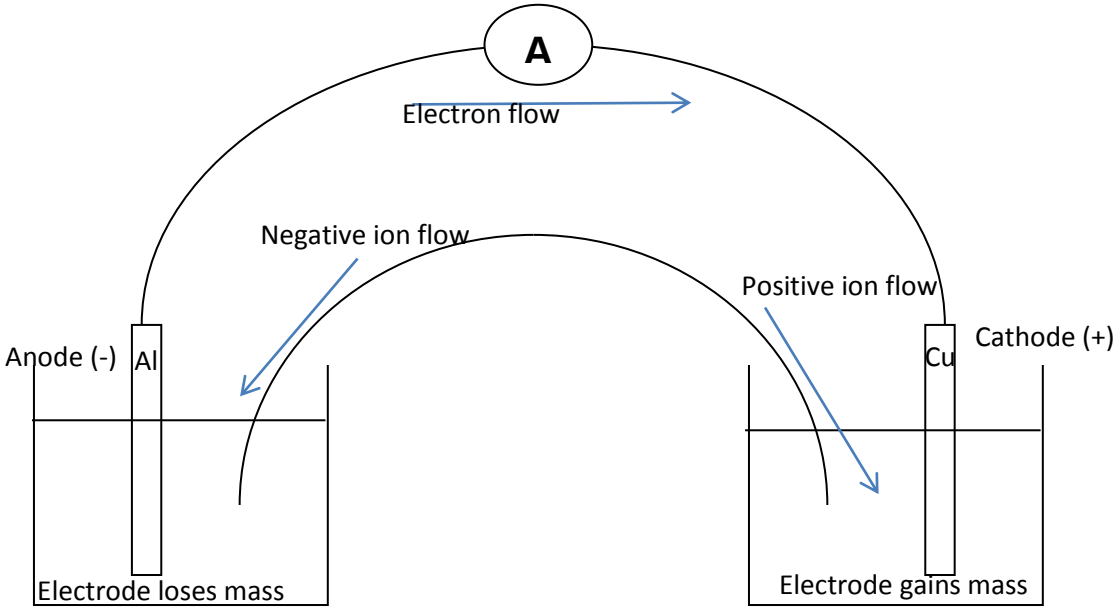
(c) The hydrogen sulfate ion, HSO_4^-, is **amphiprotic**. Give two balanced chemical equations that demonstrate the amphiprotic nature of this ion.

a) As an acid
$HSO_4^-(aq) + + H_2O(l) \Rightarrow SO_4^{-2}(aq) + H_3O^+(aq)$

b) As a base
$HSO_4^-(aq) + H_2O(l) \Rightarrow H_2SO_4(aq) + OH^-(aq)$

Question 6

a) On the below diagram of an electrochemical cell clearly indicate the
- anode and its polarity
- cathode and its polarity
- direction of electron flow
- direction of negative ion flow
- direction of positive ion flow
- the electrode gaining mass
- the electrode losing mass



Oxidation

$Al(s) \Rightarrow Al^{3+}_{(aq)} + 3e$

Reduction

$Cu^{2+}(aq) + 2e \Rightarrow Cu(s)$

Overall

$2Al(s) + 3Cu^{2+}(aq) \Rightarrow 2Al^{3+}_{(aq)} + 3Cu(s)$

Question 7

A student mixed 20.0 mL of 0.010 M sodium carbonate (Na_2CO_3), with 60.0 mL of 0.010 M hydrochloric acid, HCl. The mixture was allowed to react completely.

(a) Write a balanced equation for the reaction between calcium hydroxide and hydrochloric acid.

Na2CO3(aq) + 2HCl (aq) => CO2(g) + H2O(l) + 2NaCl(aq)

(b) Calculate the number of moles of Na_2CO_3 in the 20.0 mL sample.

Mol =Concentration X vol (L) = 0.02 X 0.01 = 0.0002

(c) Calculate the number of moles of HCl in the 60 mL sample.

Mol =Concentration X vol (L) = 0.06 X 0.01 = 0.0006

(d) At the completion of the reaction, which reactant is in excess and by how much in grams?

HCl by 0.0002 mol => 0.0002 X 36.5 = 0.0073 grams

Question 8

A pure sample of a gas has a density of 2.00gL^{-} at 25.0 °C and 1.05 atm pressure.

a) Calculate its molar mas in g/mol

PV =nRT
=> PV = (m/M)RT
=> PM = (m/V)RT
=> PM = d RT
=> M =dRT/P
=> M = 2.00X 8.31 X 298 /106.4 = 46.5

b) A student is told that it is a dioxide. Which is the most likely gas?
NO_2 with a molar mass of 46 it is the closest.