# 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.

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

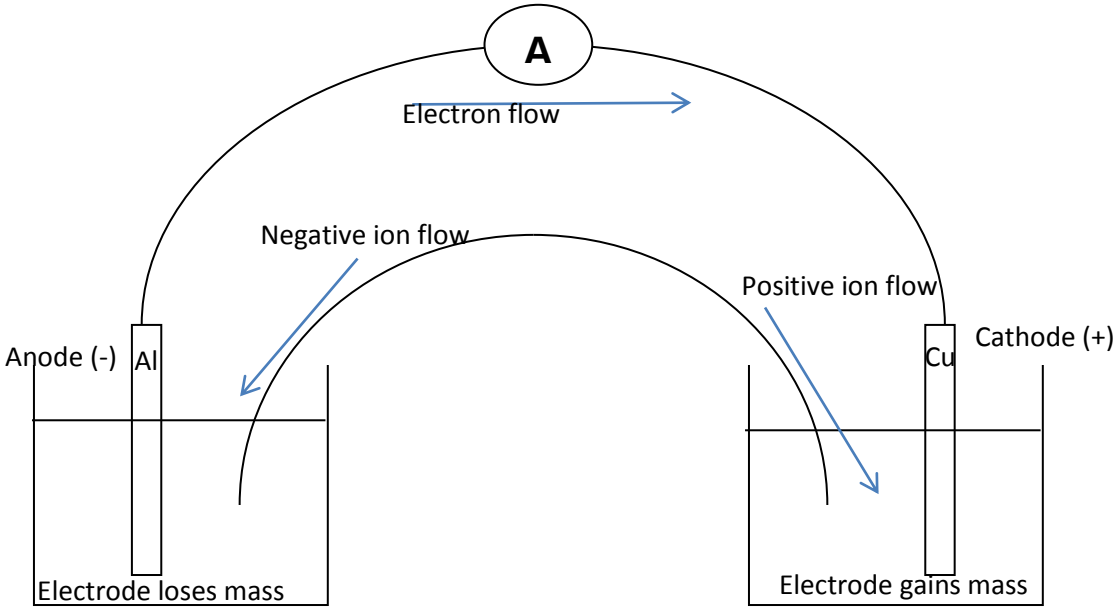
(c) The hydrogen sulfate ion, $HSO_4^-$, is **amphiprotic**. Give two balanced chemical equations that demonstrate the amphiprotic nature of this ion.

***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 2.00$gL^{-}$ 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***.