Revision Unit 3-4 – worksheet- equilibrium, organic, experimental technique and galvanic ells

1. The balanced chemical equation for the formation of ammonia is given below.

$$3H_2(g) + N_2(g) \rightleftharpoons 2NH_3(g) \quad \Delta H = ?$$

   a. Write the expression for the reaction quotient and give the units that this quotient is expressed.

   b. Give the balanced thermochemical equation for the formation of ammonia given that the formation of 0.170 grams of ammonia released 960 J of energy

   c. A student performed two experiments whereby a known amount of ammonia was injected into a 10 litre sealed vessel at 30^{o}C and allowed to reach equilibrium. At which point the concentrations of NH_3, N_2 and H_2 were measured.
   Experiment 1 – 17.0 grams of ammonia injected into the vessel
   Experiment 2 – 1.70 grams of ammonia injected into the vessel
      i. Give the reaction quotient for the reaction taking place in the sealed container.

      ii. In experiment one when equilibrium was reached the following relationship was observed. $[N_2] = [NH_3]$. Select from the three alternatives below how this relationship changes in experiment 2 and provide an explanation to justify your selection.

      $[N_2] < [NH_3]$, $[N_2] = [NH_3]$, $[N_2] > [NH_3]$

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d. Select from the three alternatives below in describing the **rate** of reaction in experiment 1 (E1) compared to experiment 2 (E2). Provide an explanation to justify your selection.

E1 > E2, E1 < E2, E1 = E2

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e. Under what condition/s will the value of the reaction quotient change.

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f. In another experiment, at a different temperature, 34.0 grams of ammonia was injected into a 10 L, sealed vessel and allowed to reach equilibrium. Once equilibrium was reached the gas mixture was analysed and found to contain 17.00 grams of ammonia. Calculate the value of equilibrium constant at this temperature with the appropriate units. Give the answer to the right number of significant figures.

2. Two galvanic cells are shown below wired together.

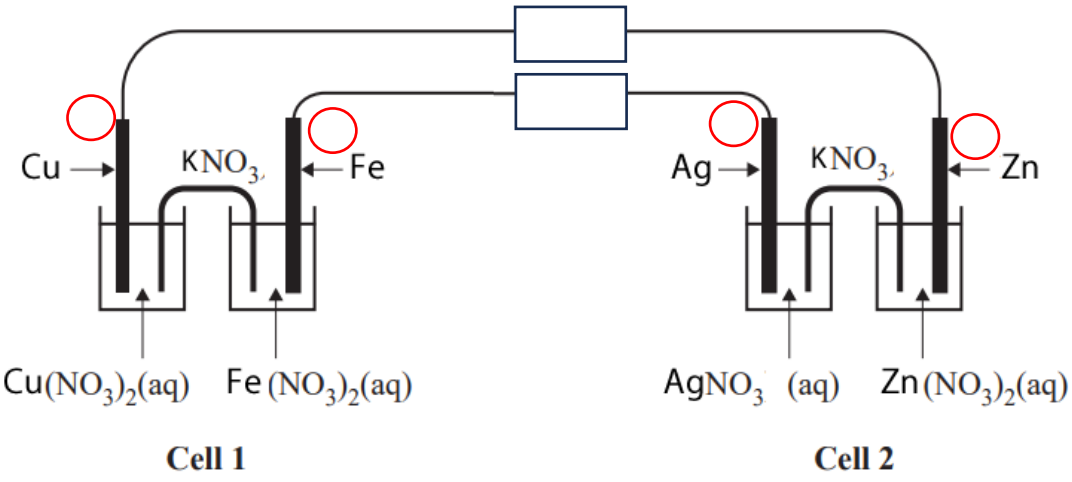

Diagram 1

a. Using the information given in diagram 1 answer the following true/false questions.

i. When the circuit is complete, a spontaneous reaction takes place in cell 1. True / False Justify your answer.

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ii. Chemical energy is converted into electrical energy in cell 2. True / False Justify your answer.

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iii. Cell 1 acts as an electrolytic cell as it is being charged. True / False Justify your answer.

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iv. Cell 2 is not able to charge cell 1. True / False Justify your answer.

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b. Draw the direction of electron flow by placing an arrow in the box provided in diagram 1.

c. Give the polarity of each electrode in the red circles provided in diagram 1.

d. Towards which electrode do the cations in the salt bridge move to in:

Cell 1 _____

Cell 2 _____

e. Give the half equations occurring in each cell.
Cell 1 anode _____ Cathode _____

Cell 2 anode _____ Cathode _____

f. This particular setup is allowed to run for 10.00 minutes producing a current of 1.45 A. After which the mass of each electrode was measured.

i. Which electrode gained the most mass? _____

ii. Calculate the mass, in grams, gained by this electrode.

iii. Describe how the colour in the half cell containing the copper electrode in cell 1 changes as the setup is allowed to operate over the 10 minute period. Give a detailed explanation using appropriate chemical equations.

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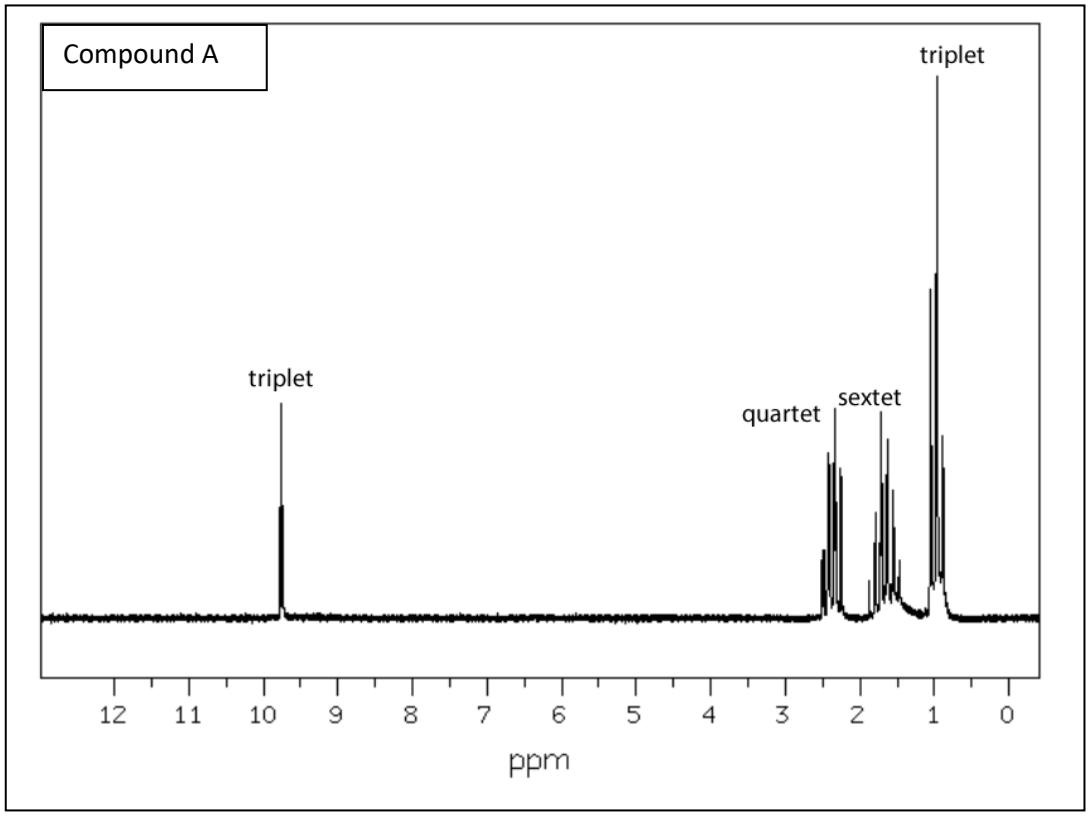
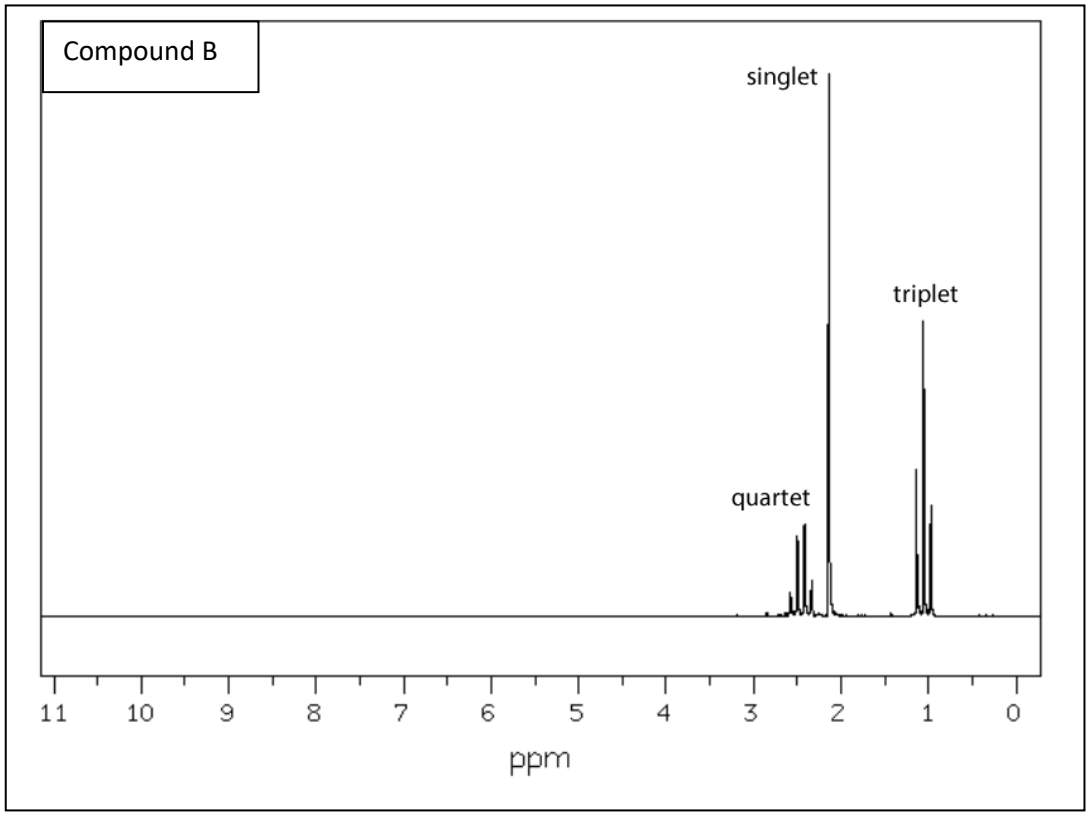
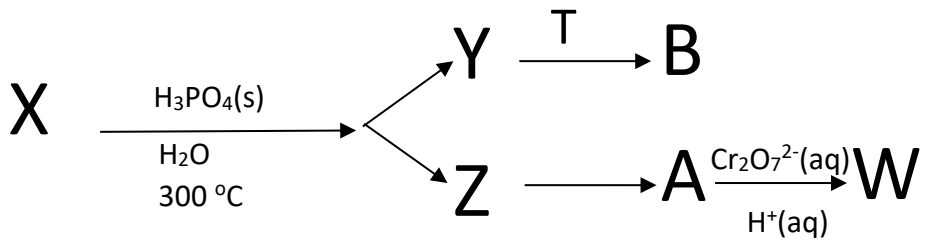
3. Consider the organic pathway and the spectra of compounds A and B shown below.







a. A pure, 0.880 gram sample of the straight chain organic compound W was dissolved in 20.0 mL of water. This solution was then titrated against a standard 0.330 M NaOH, using phenolphthalein as an indicator, to obtain an average titre of 30.30 mL.

   i. Calculate the mol of NaOH in the average titre.

   ii. Calculate the molar mass of compound W

   iii. Identify compound W.

b. Identify the following reactants/reagents. Identify the type of reaction that formed compounds Y and Z.

   X _____

   Y _____ _____

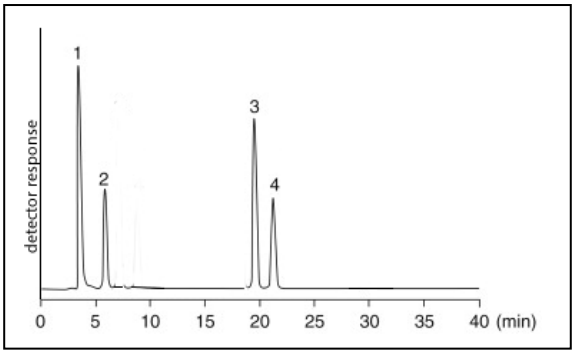
   Z _____ _____

   T _____

c. Draw the structural formulae of compounds A and B in the space below. Justify your answer with the use of the ^{1}HNMR spectra of A and B.

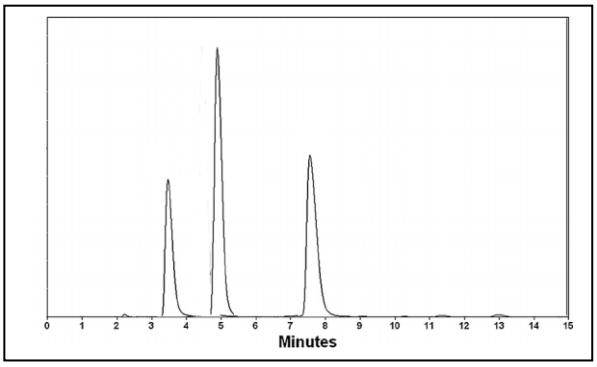
A	B

d. Reversed-phase chromatography was used to separate a mixture of compounds A, X, Z and W. The chromatogram is shown below.



i. Give the appropriate peak number to each compound. Justify your choice.

ii. Another mixture was analysed under exactly the same conditions and using the same column as the mixture in i. above. The chromatogram shown below was achieved. Does this new mixture contain any of the four compounds A, X, Z or W. Explain your reasoning



iii. Outline a procedure by which the concentration of the molecule identified in ii. above can be accurately obtained.

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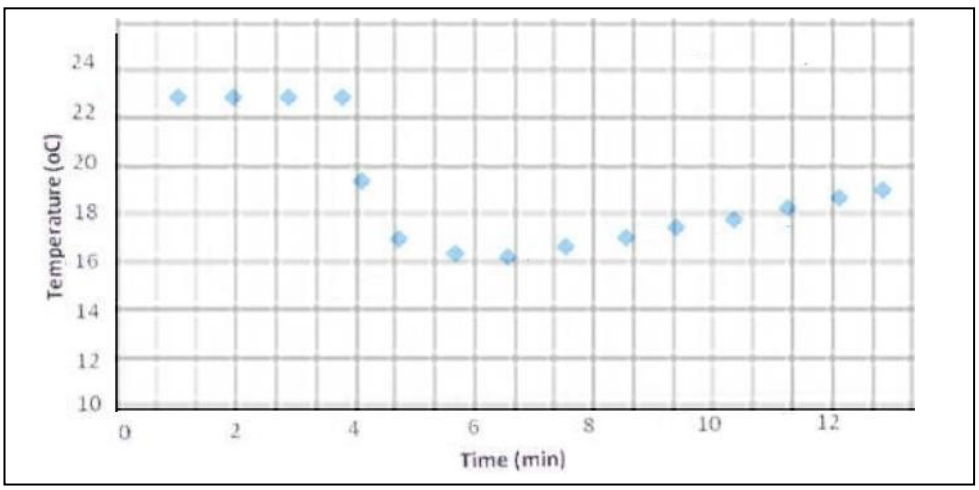
4. A solution calorimeter was calibrated by passing a current of 1.50 A at 6.00 volts for a period of 2.00 minutes. The temperature of the water rose by 1.29 ^{o}C.
   a. Calculate the calibration factor of the calorimeter in appropriate units.

   b. A mass of 21.44 grams of ammonium nitrate (NH_4NO_3) was dissolved in the calorimeter. The temperature was recorded over a period of 12.0 minutes and recorded in the temperature vs time graph shown below.



   i. Calculate the ΔH for the following reaction.
   $NH_4NO_3(s) \rightarrow NH_4^+(aq) + NO_3^-(aq)$ ΔH =

ii. Another student used exactly the same calorimeter, with the same volume of water, as the previous experiment, to measure the ΔH of the reaction $NH_4NO_3(s) \rightarrow NH_4^+(aq) + NO_3^-(aq)$. The student measured the temperature of the water directly using a digital thermometer, before and after dissolving 30.00 grams of ammonium nitrate.
Would you expect the magnitude of the ΔH to be equal, greater or less than that calculated in question i. above.? Explain your choice.

iii. In another experiment the student calibrated a similar calorimeter using 50.00 mL of water and then conducted the experiment by dissolving 15.99 grams of ammonium nitrate in 100 mL of distilled water in the exact same calorimeter as was calibrated. Are the results obtained valid? Justify your answer.

5. A student was asked to devise an experimental procedure to calculate Faraday's constant from first principles. The experimental setup is shown on the right in diagram 2.
The student decided to use a Hoffman voltameter to produce a measurable volume of hydrogen gas at SLC.
Below is the step-by-step procedure as written by the student.
Step 1 – Setup the Hoffman voltameter as shown in diagram 2 using a 3M H_2SO_4 solution. Local tap water was used to make the acid solution.
Step 2 – Set the power source to produce a constant current of 1.322 A at 3.00 volts.
Step 3 – Take a reading of the water level in the calibrated tube. Record the result
Step 4 – Turn on the switch for 1.00 minute.
Step 5 – Turn the switch off and record the final water level.
Step 6 – Repeat steps 3 – 5, 4 more times.

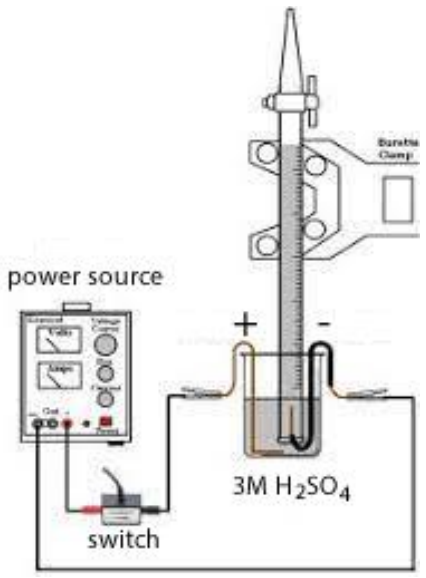


Diagram 2

Results are shown below for two students, in two different cities in Australia, working with the same procedure.

Trial	Volume of H_2(mL)	Volume of H_2(mL)
	Student-1	Student-2
1	11.00	8.00
2	9.00	7.98
3	13.99	8.01
4	6.99	8.00
5	10.00	7.99

Below is the working out of student 1 attempt at using the data to solve for Faraday's constant.

a. *Student-1 averaged the results obtained from the 5 trials to calculate Faraday's constant.*
   i. *Using student-1's averaged results calculate Faraday's constant.*

   ii. *Are the results from student-1's trials more accurate than student-2's results. Justify your answer showing all your calculations in the space below.*

iii. What type of error leads to student-1's data? Justify your answer.

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iv. What type of error leads to student-2' s data? Justify your answer.

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v. Compare each students results by placing a tick in the appropriate box in the table below.

Student	*More Accurate*	*More precise*	*Repeatable*
1			
2			

vi. Are the results valid? Justify your answer.

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vii. Offer one improvement to the procedure and suggest why your improvement will lead to better outcomes.

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