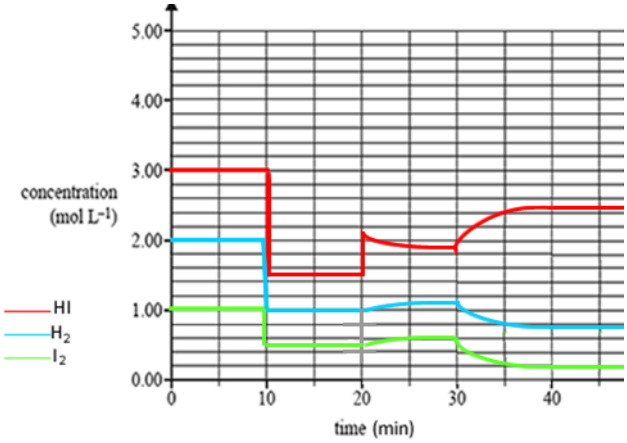
Revision task 5

1) Hydrogen iodide is formed in a 1.00 litre vessel according to the equation below.
$I_2(g) + I_2(g) \rightarrow 2HI(g)$ $\Delta H = +52$ kJ
The graph on the right shows the concentration of each reactant and product over time.



a) Give an expression for the equilibrium constant for this reaction.

$$\frac{[HI]^{2.}}{[I_2][H_2]}$$

b) Calculate the value of the equilibrium expression, at this temperature, between t = 0 and t = 10

9/2 =4.5

c) On the graph shown, indicate how the concentration of each species changes over time, in the 1 litre reaction vessel, when:

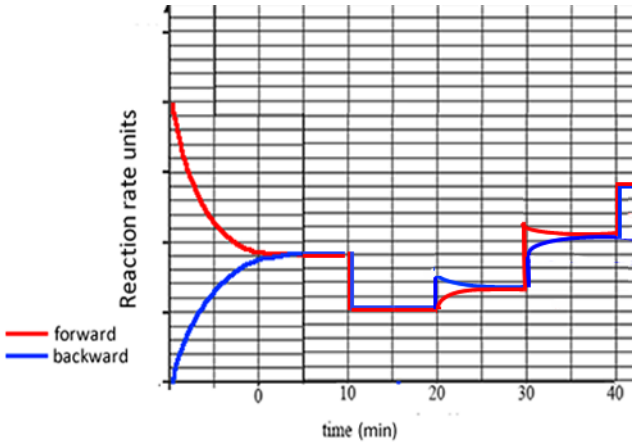
- the volume is doubled at t = 10. Indicate how the concentrations change without giving specific values for each species

- at t = 20 an amount of 0.60 mol of HI is added to the reaction vessel and the system returns to equilibrium before t =30. Clearly show the value of the concentration of each species at t = 30.

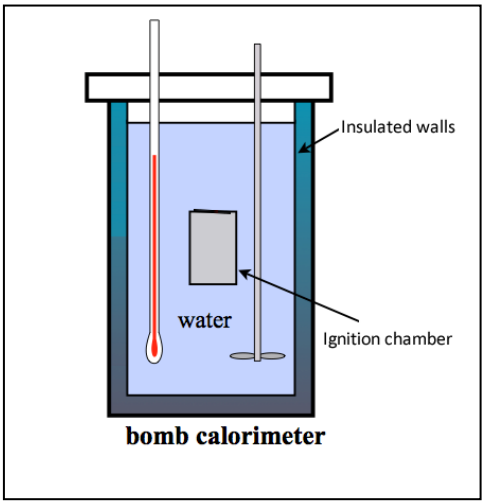
- at t = 30, the temperature is increased and equilibrium is once again reached before t = 40. Indicate how the concentrations change without giving specific values for each species.

- at t = 40 a catalyst is added. Indicate how the concentrations change without giving specific values for each species

d) Indicate how the rate of the backward and forward reactions change over time with each change stated in c) above.



2) A 25.00 gram sample of iodine is placed in a bomb calorimeter with 3.46 grams of hydrogen gas.
The reaction takes place according to the equation below $I_2(g) + H_2(g) \rightarrow 2HI(g)$ $\Delta H = +52.0$ kJ . The temperature of the 100.00 grams of water changes by 10.00 ^{o}C.



a) Calculate the amount, in mol, of the following species present in the ignition chamber when the water has reached its final temperature.

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Step 1 Find the amount of HI formed.
=> calculate the amount of energy produced
=> E = 4.18 X 100 X 10 = 4.18kJ
=> 2 / 52.0 = x / 4.18
=> x = 0.161 mol of HI
Step 2 Calculate the amount of I_2 and H_2 used
=> 0.161/2 = 0.0805

i. I_2
Step 1 calculate the initial mol of I_2
=> 25.00 / 253.8 = 9.48 X 10^{-2}
Step 2 calculate the amount of I_2 left
=> 0.0948 - 0.0805 = 0.0143

ii. H_2
Step 1 calculate the initial mol of H_2
=> 3.46 / 2 = 1.73
Step 2 calculate the amount of H_2 left
=> 1.73 - 0.0805 = 1.65

iii. HI

0.161

b) When calculating the answer to a) above, what is assumed?

All the energy given off by the reaction is absorbed by the water

c) Calculate the value of the equilibrium expression of the mixture in the ignition chamber.
$(0.161)^2$ / (1.65 X 0.0143) = 1.10
No need to calculate concentration as the units of volume cancel out.

3) A student conducted the experiment as pictured below. Three trials were conducted for each different metal and the results were averaged to get the voltage of each lemon cell.

Metal	Trial 1(V)	Trial 2(V)	Trial 3 (V)	Average (V)
Iron	1.00	1.30	1.15	1.15
Zinc	1.50	1.34	1.90	1.58
Magnesium	2.00	1.55	2.09	1.88

Conclusion- the reactivity of a metal is directly related to the voltage it produces in a galvanic cell.

a) State a plausible hypothesis being tested by the student.
The more reactive a metal is the greater the voltage produced by the galvanic cell.

b) Discuss, with reference to the results, as to whether the hypothesis is supported or not.

The results do support the hypothesis, in that the average voltage is higher for more reactive metals, when compared to copper, such as magnesium.

c) Identify :
i. the dependent variable - *Voltage*
ii the independent variable – *type of metal*
iii. four other variables that must be controlled.

Any other plausible variable
- size of lemon
- size and shape of electrodes
- depth at which the electrodes are inserted
- temperature of the room

- Write an evaluation of the student's experimental design. In your report:
  • identify and explain one strength of the experimental design
  Multiple trial of each metal were attempted.
  • suggest two improvements to the experimental design and justify your suggestions
- *Improvements may include:*
  - using proper half cells to regulate the concentration of the electrolytes as the electrolyte concentration cannot be always kept constant when using lemons.
- *- conduct more trials with each metal to achieve concordant results.*
  • comment on the validity of the conclusion based on the method used to obtain the results.
  It should be argued that no valid conclusion can be reached due to varying results obtained for each metal

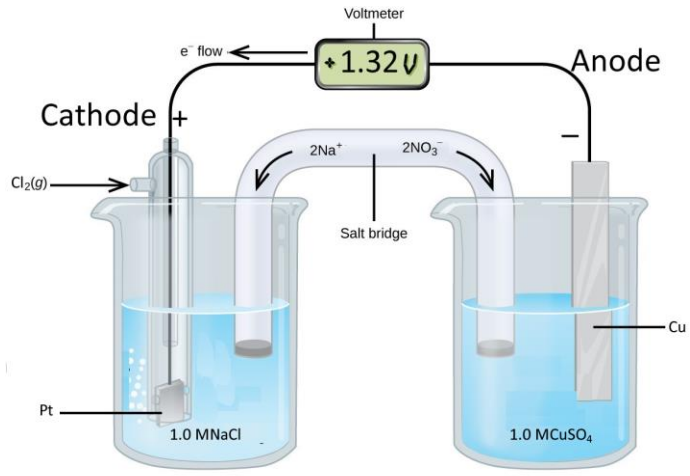
d) Suggest one other investigation that can be conducted that would extend the understanding of galvanic cells and add value to this investigation.
Investigate other reactive metals or other metals that are less reactive than copper. Any other plausible investigation that adds value to the investigation and extends the understanding of galvanic cells.

4) On the right is a list of items used to construct a galvanic cell in the laboratory at 25°C.

a) In the box below draw the galvanic cell clearly labelling the following.
- electrodes in each half-cell.
- salt bridge and its composition
- solutions in each half-cell
- direction of electron flow
- direction of negative ion flow
- polarity of each electrode
- the reactions occurring in each half-cell

- Copper wire and copper metal
- A supply of Cl_2 gas delivered at 1.00 atm pressure
- Platinum metal wire
- A 1.0M solution of a NaCl solution
- Filter paper
- A concentrated potassium nitrate solution
- Voltmeter
- Glassware (beakers, gas electrode)
- A 1.0M solution of a $CuSO_4$ solution

b) Is the information given in the E^o table of the data sheet sufficient to accurately predict the voltage registered by the voltmeter? Explain why.



$Cl_2(g) + 2e \rightarrow 2Cl^-(aq)$ $\quad$ $Cu(s) + \rightarrow Cu^{2+}(aq) + 2e$

Yes the voltage can be accurately predicted because both half cells are at standard conditions.

1 atm pressure 25°C and 1 M concentration.