Revision task 4

1) A 3.42 grams sample of a famous brand of brick cleaner was accurately weighed into a 250 mL volumetric flask and made to the mark with distilled water.
A 25.00 mL aliquot was the taken from the volumetric flask and placed into a 100 mL conical flask with two drops of an appropriate indicator. This was then titrated against a 0.115 M Na_2CO_3 and an average titre of 15.32 mL was obtained.

a) Write a balanced chemical equation of the reaction taking balance in the conical flask.

b) Calculate the amount of HCl in the conical flask.

c) Calculate the amount of HCl in the volumetric flask and hence the 3.42 grams sample of brick cleaner.

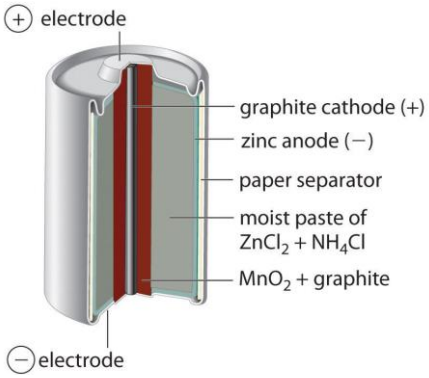
d) Calculate the concentration, in % w/w of HCl in the brick cleaner.

e) Calculate the concentration of the HCl in the brick cleaner in mol/Litre if the density of the brick cleaner is 1.24 g/mL.

2) Pictured below is a Leclanché cell. The overall reaction taking place in this cell is

$2MnO_2(s) + 2NH_4Cl(aq) + Zn(s) \rightarrow Mn_2O_3(s) + Zn(NH_3)_2Cl_2(s) + H_2O(l)$

a) Which species is oxidised and which is reduced?



b) Write the equation to the half-reaction taking place at the anode.

c) Write the reaction occurring at the cathode

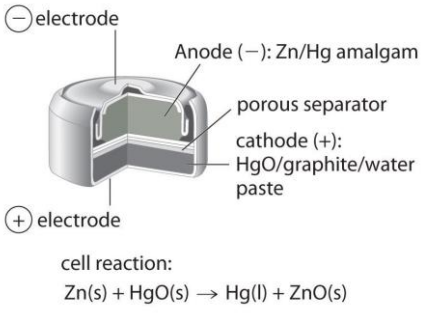
d) If the battery produces 1.50 volts find the E^o value for the half-reaction that takes place at the cathode, at standard conditions

e) Describe what happens to the pH of the surroundings at the cathode during discharge. Explain why.

f) An **alkaline battery** is essentially a Leclanché cell adapted to operate under ***alkaline***, or basic, conditions. It produces a more constant voltage output as it discharges than a Leclanché cell.
The overall reaction that occurs in an alkaline battery is
$Zn(s) + 2MnO_2(s) \rightarrow ZnO(s) + Mn_2O_3(s)$
a) Give the equation to the half-reaction that occurs at the negative terminal of the battery.

g) Give the equation to the half-reaction that occurs at the positive terminal of the battery.

h) Consider the alkaline button cell pictured on the right.
i. Give the equation to the half-reaction occurring at the anode
ii. Give the equation to the half-reaction occurring at the cathode.
iii. Give one disadvantage when disposing of this cell.

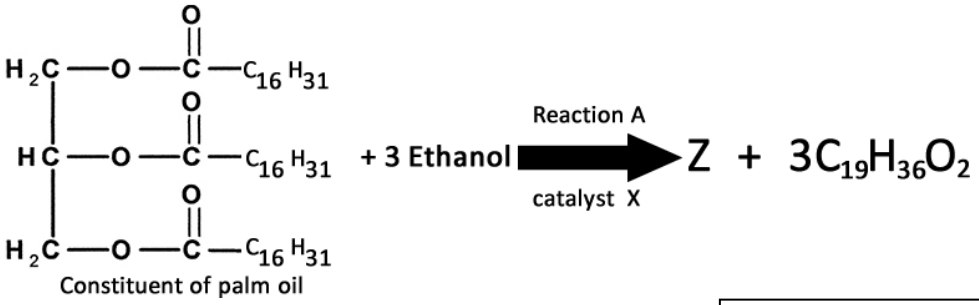


3) A sustainable community is set up in a remote part of inland Australia. Corn crops are grown to derive glucose which is then fermented to produce ethanol.

a) Give the name of the process and a balanced equation for the synthesis of glucose by the plant.

b) Give the name and a balanced equation for the production of ethanol via microbial action.

c) Palm oil is also grown by the community and used in the formation of biodiesel as shown by the reaction pathway below.



Substance Z

i) Name a suitable substance for catalyst X

ii) What type of reaction is reaction A?

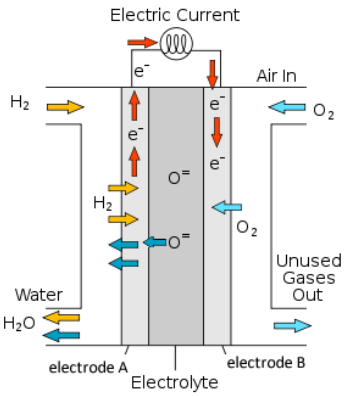
iii) Draw the structural formula of substance Z in the box provided on the right.

iv) $C_{19}H_{36}O_2$ is then used in a process called steam reformation to produce hydrogen gas according to the equation below.

$C_{19}H_{36}O_2(g) + 17H_2O(g) \rightarrow 19CO(g) + 35H_2(g)$

This hydrogen is used to feed a **solid oxide fuel cell** shown on the right.

- Label the anode and cathode of the fuel cell.
- Write the equation to the half-reaction (states not required) occurring at the:
  - Anode
  - Cathode



- At SLC 20.00 g per minute of $C_{19}H_{36}O_2$ is used every minute to form hydrogen gas.
    - Calculate the volume of hydrogen that is produced every minute.

    - If all the hydrogen formed is used to fuel the cell, calculate the current in Amps delivered by the battery, assuming it is 100% efficient. A current of *x* Amps means that *x* Coulombs of charge flows per second.

- Is hydrogen gas, obtained through steam reformation of biodiesel, a renewable fuel? Explain your answer.

d) The chemical engineers in the community were discussing the use of ethanol in the direct production of electrical power. Two options were proposed.

i. Use ethanol to run a piston, electric generator.

ii. Use ethanol in a fuel cell .

Discuss, with reference to efficiency, cost, and production of Green House gasses, the merits of each option.

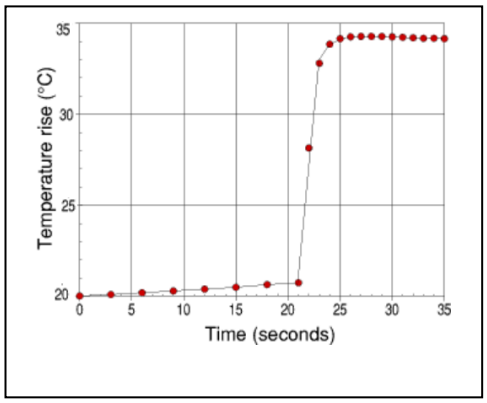
e) Write the balanced chemical equation for the:

- combustion of liquid ethanol in oxygen gas

- half-reaction occurring at the anode of the ethanol fuel cell

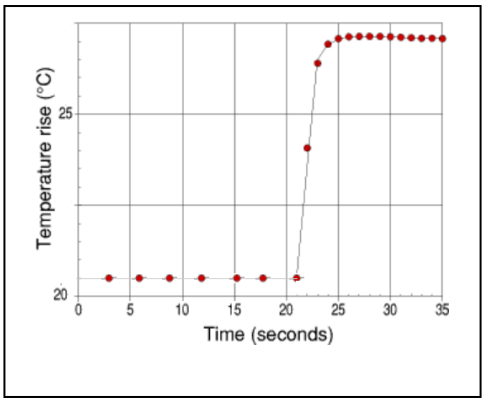
f) Calculate the electric current, in Amps, produced by an ethanol fuel cell that burns 20.0 grams of ethanol per minute and operates at 60.0% efficiency.

4) A bomb calorimeter, containing 50.0 mL of water at 20.6 ^{o}C was calibrated by passing a current of 6.11 A at 2.76 V for 2.50 minutes through the heating coil. The temperature was recorded periodically and the data recorded on a temperature vs time graph shown on the right.



a) Calculate the calibration(C_f) factor for the calorimeter.

b) 0.0280 grams of liquid butane was placed in the bomb calorimeter with excess oxygen and ignited. The temperature was recorded and shown on the graph on the right.



i. Write a balanced chemical equation for the combustion of butane.

ii. Calculate the molar heat of combustion for butane

iii. Give the **ΔH** for the equation in i. above.

c) Compare the molar heat of combustion of butane as calculated with the theoretical value. Explain any discrepancy.