Sample risk assessment record

# INVESTIGATION 24: Heat of combustion of alcohols

Assessment team: ______________________ Date: ______________ Year/group: *12*

Ref: *Heinemann Chemistry Practical Manual*

| Chemicals used | Conc. (mol/L) | Amount | User code | DG class/ haz | Procedure as per Appendix D? | What are the hazards? |
|---|---|---|---|---|---|---|
| ethanol | pure liquid | 50 mL | 7-12 | 3 | yes | Highly flammable |
| methanol | pure liquid | < 50 mL | 11-12 | 3/6.1 DHS | yes | Highly toxic vapour, when ingested causes permanent blindness, highly flammable |
| 1-propanol | pure liquid | < 50 mL | 7-12 | 3 | yes | Highly flammable, toxic if ingested or inhaled |

**Disposal of waste**

*Reuse all alcohols.*

## How are risks controlled?

- wear safety glasses
- use gloves
- wash hands after use
- other (specify): Replace cap on spirit burner to extinguish the flame, keep burners capped

## Assessment of risk:

Risk for this investigation is **not significant**, provided appropriate control measures are in place as indicated above.

Approved by: ______________________ Date: ______________

# Investigation 25

# Galvanic cells

## Rationale

Students are introduced to galvanic cells by constructing a simple Daniell cell and investigating the relationship between voltage and current when the volume of electrolyte is changed. In the second part, students measure the potential difference of a series of different half-cells, while keeping the $Cu/Cu^{2+}$ half-cell as a reference.

**Syllabus**

*Perform a first-hand investigation to identify the conditions under which a galvanic cell is produced.*
*Perform a first-hand investigation and gather first-hand information to measure the difference in potential of different combinations of metals in an electrolyte solution.*

## Background knowledge

Students have a knowledge of the terms oxidation and reduction, and of the activity series of metals. However, before introducing the galvanic cell, you should set up a displacement of metals demonstration or give it as a first-hand investigation (see worksheet on next page), as it is essential that students understand the relationship between the position of a metal in the activity series and the electron-attracting ability of its ions. (The more active metal displaces the less active metal from a solution of its ions.)

## Hints

- Prepare a set of metal displacement reactions, as per the worksheet, using only 3 mL of each 0.1 M solution and a partially immersed metal strip. Let it stand overnight for more definite results. Let students complete the worksheet before attempting the rest of the investigation.
- Tin(II) chloride could be used instead of nitrate, but it is less soluble.
- The Daniell cell could be also demonstrated using a galvanometer.

# Worksheet: Metal displacement reactions

| Test-tube | Solution | Metal | Observation |
|---|---|---|---|
| A | copper(II) sulfate | iron | |
| B | copper(II) sulfate | lead | |
| C | copper(II) sulfate | zinc | |
| D | iron(II) sulfate | copper | |
| E | iron(II) sulfate | lead | |
| F | iron (II) sulfate | zinc | |
| G | lead(II) nitrate | copper | |
| H | lead(II)nitrate | iron | |
| I | lead(II) nitrate | zinc | |
| J | zinc sulfate | copper | |
| K | zinc sulfate | iron | |
| L | zinc sulfate | lead | |

## Questions

**1** Which of the three metals gave:

**a** three reactions ______________________

**b** two reactions ______________________

**c** one reaction ______________________

**d** no reaction ______________________

**2** List the four metals in decreasing order of reactivity.

______________________

**3** Fill in the missing words.

In all the reactions observed, the ______________ active metal displaces the ______________ active metal from solution.

**4** Write a chemical equation for each observed reaction.

______________________

______________________

______________________

______________________

______________________

______________________

**5** Would you expect a replacement reaction to occur between:

**a** magnesium and copper(II) sulfate? ______________________

**b** tin and zinc sulfate? ______________________

## Procedure A: DANIELL CELL

### RESULTS

Voltage may differ slightly when the beaker is full and half-full. The current is slightly higher when the beaker is full.

### Discussion: PROCEDURE A

1 a from Zn to Cu
  b oxidation
  c reduction
  d $Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$
2 The salt bridge completes the circuit in the cell. The ions in the solution carry charges, so that positive ions (cations) travel towards the cathode and negative ions (anions) travel towards the anode via the salt bridge.
3 The voltage of a cell depends on the potential difference of the electrodes, not on the volume of electrolyte. The current depends upon the number of moles of electrons involved in the redox reaction. With a larger volume or more concentrated solution around the electrode, there are more ions to accept electrons and more electrons will be given out at the other electrode.
4 As the galvanic cell operates, ions are being used up and the concentration of electrolyte is decreasing, making fewer electrons available in the circuit.
5 The copper ion ($Cu^{2+}$) is the stronger competitor for electrons as copper is less reactive than zinc.

## Procedure B: HALF-CELL POTENTIAL

### RESULTS

All test half-cells are negative. Voltages vary from 0.15 V for tin, to nearly 2 V for magnesium. Different instruments will give different results.

### Discussion: PROCEDURE B

1 a reduction reaction of $Cu^{2+}$ ions to solid copper
  b oxidation
2 Tin may give a negative result if the measured voltage is lower then 0.34 V.
3 All predicted voltages are higher than measured. This is because school laboratory conditions vary from standard conditions. Other factors include dirty electrodes, poor connections, instrument errors, etc.
4 As the metals of two half-cells are further apart in the activity series, the galvanic cell shows a higher potential difference. A lower potential difference (lower voltage) is observed when metals are close in the activity series.

### FOLLOW-UP

1 a *around 0.2 V*
  b *0.47 V*
2 a *anode: $Zn/Zn^{2+}$; cathode: $Pb/Pb^{2+}$ as it is less active*
  b *oxidation in the zinc half-cell (zinc metal loses electrons); reduction in the lead half-cell ($Pb^{2+}$ ions reduced to lead solid)*
  c *0.63 V*
3 *Lead–acid car battery:*
  a *anode reaction: $Pb(s) + SO_4^{2-}(aq) \rightarrow PbSO_4(s) + 2e^-$*
  *cathode reaction: $PbO_2(s) + 4H^+(aq) + SO_4^{2-}(aq) + 2e^- \rightarrow PbSO_4(s) + 2H_2O(l)$*
  b *0.13 + 1.69 = 1.82 V*
  c *Advantages: rechargeable, long-lasting, cheap to produce*
  *Disadvantages: heavy, lead pollutes environment*
4 *Watches and calculators have button cells. One type of button cell is a zinc/silver battery.*
  a *Overall reaction for button cell: $Zn(s) + Ag_2O(s) \rightarrow ZnO(s) + 2Ag(s)$*
  *This reaction is not reversible, while the reaction in the car battery is.*
  b *The button cell is cost-effective, practical, small and portable. A car battery, while cheap to produce, is very heavy.*
  c *In our 'throw away' society, a button cell (which cannot be recharged) is more frequently disposed of than a car battery. Both galvanic cells have a major impact on technological advances in our society—their success has sparked further research into more advanced galvanic cells.*
  d *Car batteries are difficult to dispose of due to the toxic nature of lead and lead(II) oxide. A button cell is easier to dispose of as it is less toxic and much smaller.*