Task 4 Electrochemical Cell Part 1 Laboratory Activity **Name:** Solution

Task description: This session is for you to perform the activity and acquire data. The data and this experiment sheet will be used for **Part 2** of the assessment.

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Equipment required:

Beakers (four 100 mL)
Filter paper (four pieces)
Electrical leads (two)
Voltmeter
Strips of copper [Cu], zinc [Zn] and lead [Pb] (approximately 8 cm × 1 cm)
Copper(II) nitrate solution [$Cu(NO_3)_2$] 0.1 mol L^{-1} (30 mL)
Zinc nitrate solution [$Zn(NO_3)_2$] 0.1 mol L^{-1} (30 mL)
Lead(II) nitrate solution [$Pb(NO_3)_2$] 0.1 mol L^{-1} (30 mL)
Sodium sulfide solution [Na_2S] 2 mol L^{-1} (5 mL)
Saturated ammonium nitrate solution [NH_4NO_3] (25 mL)

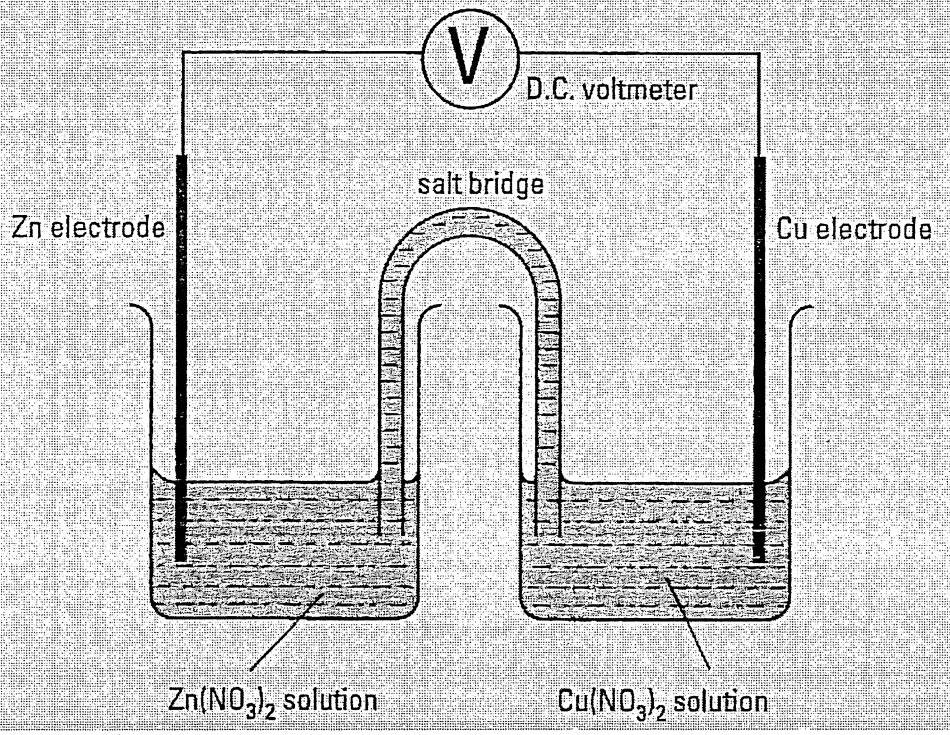
Procedure:

#1 In one 100 mL beaker place 30 mL of 0.1 mol L^{-1} $Cu(NO_3)_2$ solution and a freshly cleaned strip of copper. In another beaker place 30 mL of 0.1 mol L^{-1} $Zn(NO_3)_2$ solution and a freshly cleaned strip of zinc.

#2 Connect the copper electrode to the positive terminal of a voltmeter and the zinc electrode to the negative terminal. Is there any reading on the voltmeter?

#3 Soak a folded filter paper in saturated NH_4NO_3 solution and use the wet paper to bridge the solutions in the two beakers as shown in Figure 60.1. Make sure that the ends of the paper dip into the two solutions but are not touching the metal electrodes.

Fig. 60.1



#4 Measure and record the voltmeter reading.

#5 Repeat the procedure for reaction 2, using a clean piece of lead dipping into a 0.1 mol L^{-1} $Pb(NO_3)_2$ solution for the Pb/Pb^{2+} half-cell instead of the Zn/Zn^{2+} half-cell. Use a fresh salt bridge.

#6 Repeat the procedure for reaction 3, using Zn/Zn^{2+} and Pb/Pb^{2+} half-cells and a fresh salt bridge.

#7 Set up the $Zn/Zn^{2+}//Cu^{2+}/Cu$ cell again. To the $Cu(NO_3)_2$ solution add about 5 mL of 2 mol L^{-1} Na_2S. Note the voltmeter reading and the appearance of the solution.

Data acquired during activity (including observations):

(5 marks)

Table - ruled - (1)
title - (1)
Column titles - (1)
Observations (including voltages). - (1)
neatness - (1)

END OF PART 1

Task 4 Electrochemical Cell Part 2 Activity Analysis **Name:** Solutions

Task description: This session is for you to use the data acquired in **Part 1** answer the following questions:

TOTAL: / 27 Marks

Question 1:

For each cell you constructed draw a diagram similar to that shown in Figure 60.1.

a Write the half-equation for the reaction occurring in each half-cell. (½)

b Write an equation for the total reaction. (½)

c Label the anode and the cathode. (½)

d Mark the direction of electron flow through the wire. (½)

e Show the-direction of movement of positive and negative ions through the salt bridge. (½)

neatness (½)

Cell 1 (Cu/Cu^{2+} Zn/Zn^{2+}): **(3 marks)**

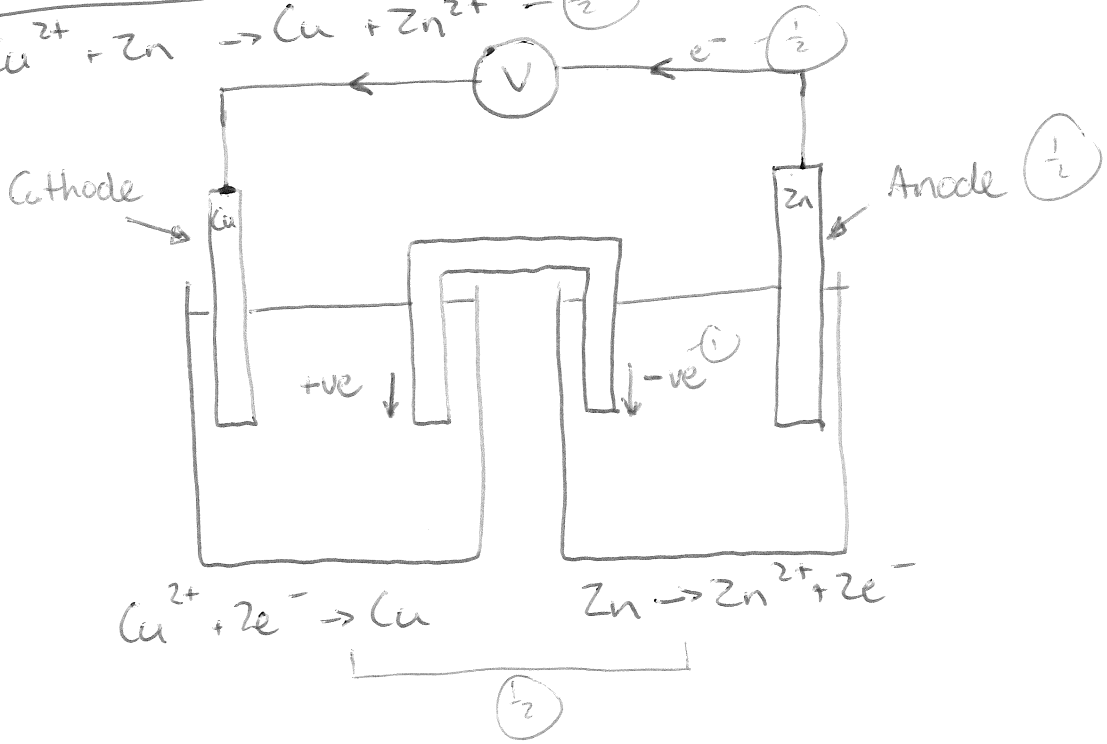
Eo

$Cu^{2+} + 2e^- \rightarrow Cu$ +0.34

~~$Zn^{2+} + 2e^- \rightarrow Zn$ -0.76 SWAP~~

$Zn \rightarrow Zn^{2+} + 2e^-$ +0.76

Total $Cu^{2+} + Zn \rightarrow Cu + Zn^{2+}$ (½)



$Cu^{2+} + 2e^- \rightarrow Cu$ $Zn \rightarrow Zn^{2+} + 2e^-$

(½)

Cell 2 (Cu/Cu^{2+} Pb/Pb^{2+}): **(3 marks)**

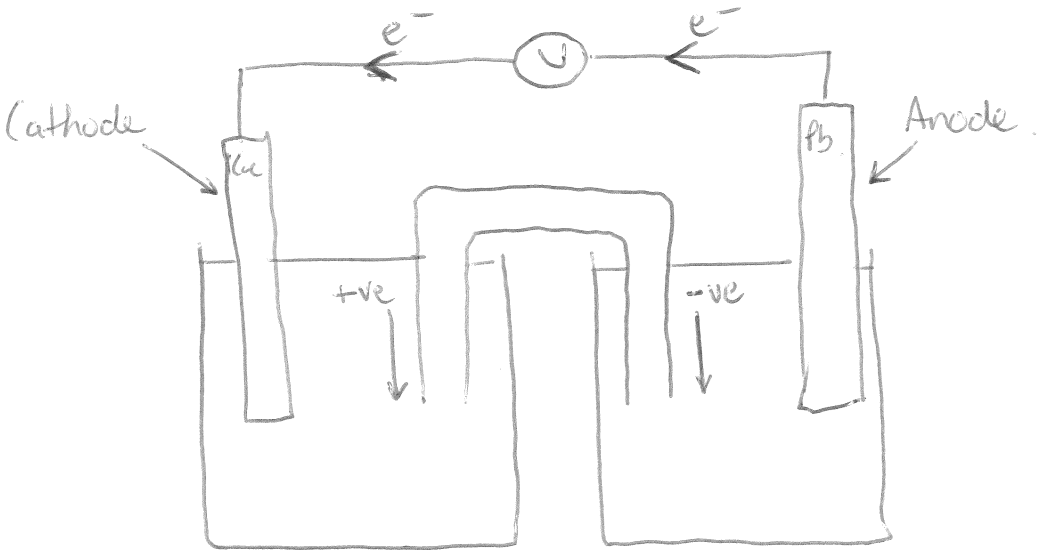
E^o

$Cu^{2+} + 2e^- \rightarrow Cu$ $+0.34\ V$

~~$Pb^{2+} + 2e \rightarrow Pb$ $-0.13\ V$~~ -SWAP

$Pb \rightarrow Pb^{2+} + 2e^-$ $+0.13\ V$

$Pb + Cu^{2+} \rightarrow Cu + Pb^{2+}$



$Cu^{2+} + 2e^- \rightarrow Cu$ $\quad$ $Pb \rightarrow Pb^{2+} + 2e^-$

Cell 3 (Zn/Zn^{2+} Pb/Pb^{2+}): **(3 marks)**

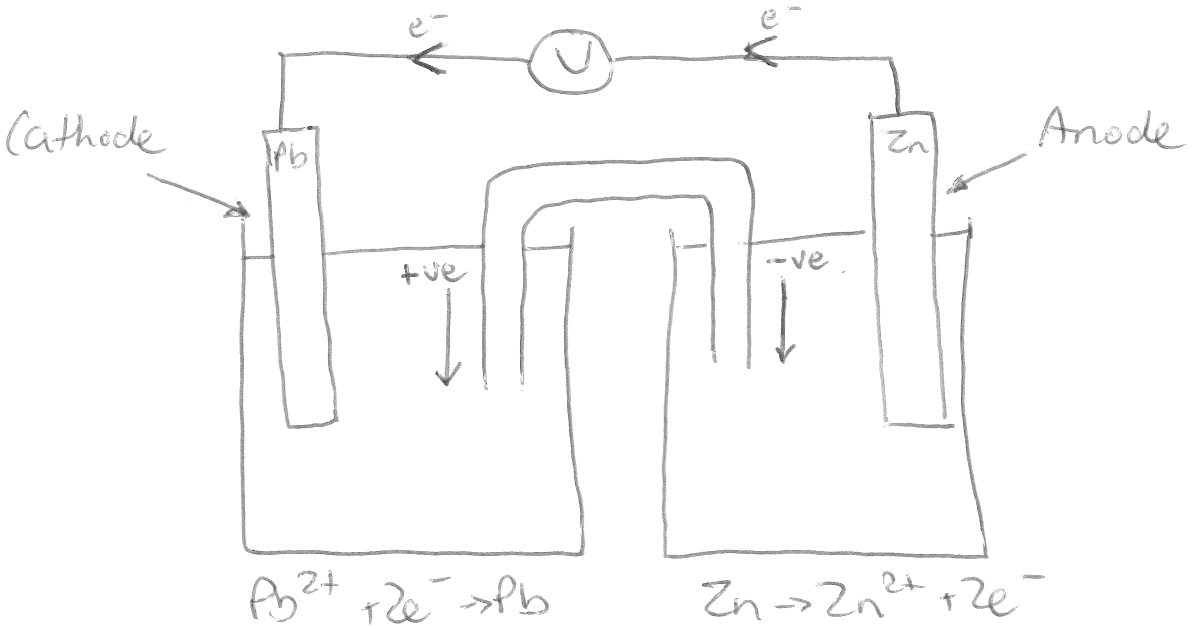
E^o

$Zn^{2+} + 2e^- \rightarrow Zn$ -0.76 V SWAP

$Pb^{2+} + 2e^- \rightarrow Pb$ -0.13 V

$Zn \rightarrow Zn^{2+} + 2e^-$ $+0.76$ V

$Pb^{2+} + Zn \rightarrow Pb + Zn^{2+}$



Question 2: How do the voltages from the experiment compare to the theoretical values derive using your data sheet? Account for the difference. **(3 marks)**

Practical results are probably lower - observation - (1)

Voltage lost due to electrical resistance of the wire and voltmeter. - (2)

Question 3: Account for your observations when Na_2S solution was added to the $Cu(NO_3)_2$ solution in the Zn/Zn^{2+} Cu/Cu^{2+} cell. **(2 marks)**

black solid + voltage.

Smaller or zero voltage due to the (1) sulfide ion precipitating out the copper ions and making insoluble CuS. Resulting is less Cu^{2+} to (1) create voltage hence going flat quicker.

Na^+ ions

Question 4: Use your data from the experiment to arrange the metals in decreasing oxidising strength. Show and explain how you determined your rank. **(2 marks)**

Comparing the voltage arrangement. A large (1) potential exists between a good oxidant and good reductant. Hence.....

values (1)

Question 5: What is the independent variable? **(1 mark)**

The metal electrodes and cation solutions.

Question 6: What is the dependent variable? **(1 mark)**

Voltage

Question 7: List three controlled variables. **(1 mark)**

3 different.

(1) only for 3.

Question 8: List two systemic errors associated with the activity **(2 marks)**

calibration of the voltmeter - (1)

When cleaning out the beaker - (1)
leaving H_2O which dilutes the solution.

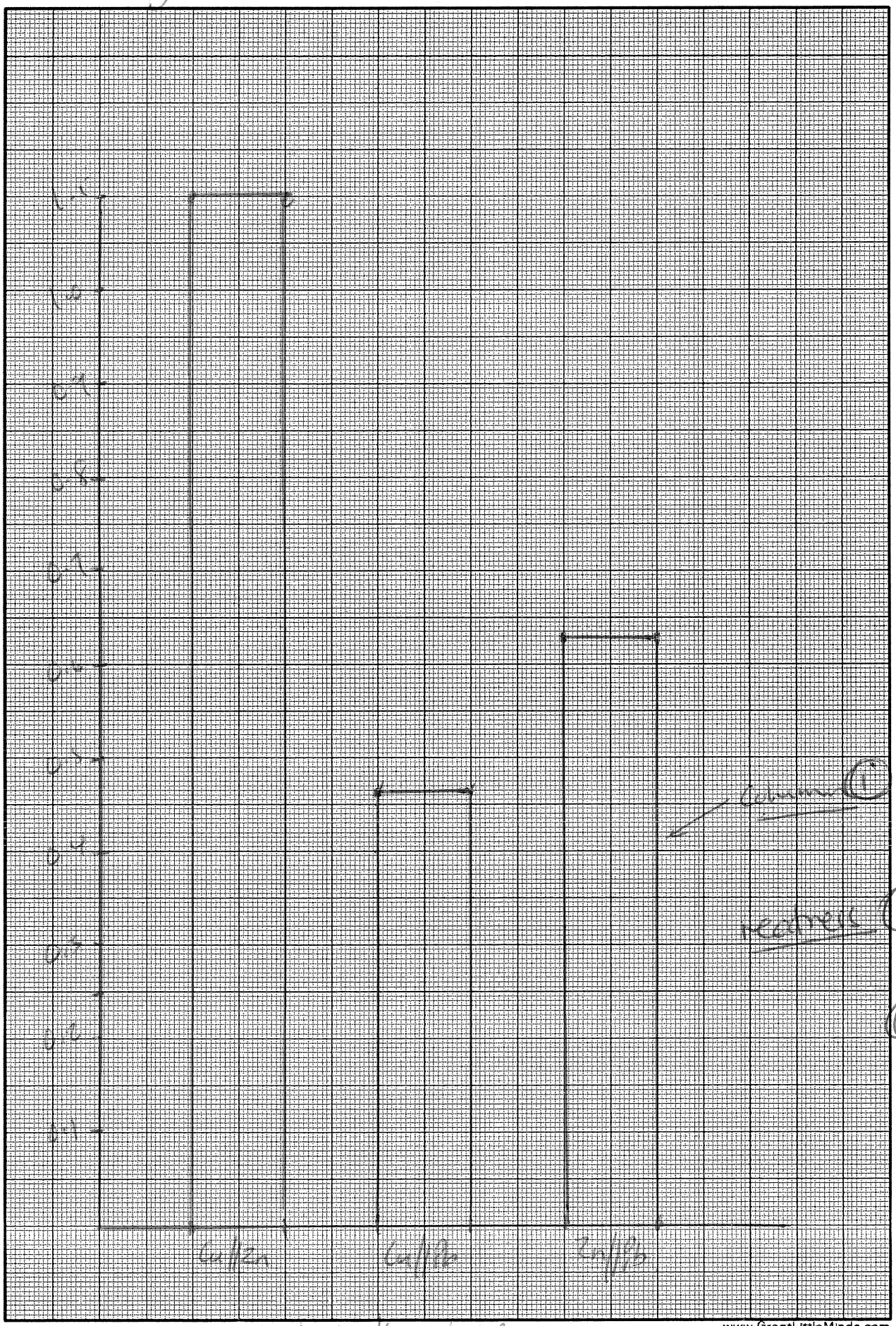
Question 9: Considering the data explain which type of graph you should use. **(2 marks)**

Column graph - (1)

Discrete data (1)

Question 10: Graph your data on the graph paper on the next page. If you have no data, use the theoretical voltages. **(4 marks)**

Voltages of Electrochemical Cells - (1) title.



Column (1)

readings (1)

(1) total.

(1) axis units

END OF PART 2