Exam Papers Practice

19.1 Electrochemical Cells

Mark Schemes

Course	DP IB Chemistry
Section	19. Redox Processes (HL only)
Topic	19.1 Electrochemical Cells
Difficulty	Medium

To be used by all students preparing for DP IB Chemistry HL
Students of other boards may also find this useful

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The correct answer is **D** because:

- To find the EMF use the formula

$$EMF = E_{reduction} - E_{oxidation}$$

- The Sn loses electrons so it will be the oxidation half equation and the Fe^{3+} the reduction half equation

$$EMF = +0.77 - (-0.14) = +0.91\,V$$

- Alternatively, you can use

$$EMF = E_{right} - E_{left}$$

- Left is oxidation in voltaic cells

A is incorrect as	you get this answer if you switched the oxidation and reduction half cells: EMF = -0.14 - (+0.77) = -0.91 V
B is incorrect as	you get this answer if you didn't pay attention to the negative sign in the Sn potential: EMF =+0.77 - (0.14) = +0.63 V
C is incorrect as	you get this answer if you attempted to multiply the Fe^{3+} half cell potential by two: EMF = (+0.77 x 2) - (-0.14) = +1.68 V Electrode potentials are not molar quantities so the coefficients in the equation are irrelevant to calculating the EMF

2

The correct answer is **D** because:

- The positive electrode is where reduction takes place in a voltaic cell
- Reduction takes place when a species gains electrons and decreases in oxidation state
- By deducing the oxidation state changes, you can tell all three statements involve reduction:

Cu^{2+} (aq) to Cu (s) Oxidation states: +2 to 0

Br_2 (g) to Br^- (aq) Oxidation states: 0 to -1

Co^{3+} (aq) to Co^{2+} (aq) Oxidation states: +3 to +2

A, **B** & **C** are incorrect as	all three reactions can take place at the positive electrode in a voltaic cell

3

The correct answer is **B** because:

- With inert or passive electrodes such as Pt, copper is produced at the cathode and oxygen at the anode
- The overall equation for the reaction is:

$$2CuSO_4\,(aq) + 2H_2O\,(l) \rightarrow 2Cu\,(s) + O_2\,(g) + 2H_2SO_4\,(aq)$$

- We can see the same quantity of electrical charge produces copper and oxygen in a 2:1 ratio

A & **C** are incorrect as	copper is below hydrogen in the activity series so it is preferentially discharged, therefore hydrogen will not be a product
D is incorrect as	the products are correct, but the stoichiometry is wrong for the overall reaction equation

4

The correct answer is **A** because:

- Zinc is less negative than magnesium, so it is a weaker reducing agent and cannot reduce magnesium ions to magnesium metal
- Chloride ions cannot be oxidised to chlorine by zinc powder because the negative electrode potential shows zinc is an effective reducing agent not oxidising agent

B is incorrect as	to produce chlorine gas, chloride ions would have to be oxidised which is not possible
C is incorrect as	to produce magnesium metal, magnesium ions would have to be reduced by zinc which is not possible
D is incorrect as	the zinc does not react, so cannot produce zinc chloride

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The correct answer is **C** because:

- The solutions have the same concentration but a different cation charge, so to solve the problem we have to work out the largest amount of charge passed for the smaller ion charge, i.e. Ag^+
- The largest amount of charge passed, Q = I x t, is option B, 1.0 x 750 = 750 C
- However, this will give half the number of moles of copper because of the 2:1 ratio of electrons to copper atoms:

$$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$$

- The next largest charge is C and D, which both come to 500 C

$$2.0 \times 250 = 500\ C$$

$$1.0 \times 500 = 500\ C$$

- However, more silver than copper will be formed because of the 1:1 ratio of electrons to silver atoms:

$$Ag^+(aq) + e^- \rightarrow Ag(s)$$

A is incorrect as	there is only 1.5 x 250 = 375 C of charge passed
B is incorrect as	there is a large charge passed, 750 C But, due to the 2:1 ratio of electrons to copper atoms, this will only produce the equivalent of 375 C 'worth' of copper atoms
D is incorrect as	there is 500 C of charge passed But, due to the 2:1 ratio of electrons to copper atoms, this will only produce the equivalent of 250 C 'worth' of copper atoms