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VCE Chemistry ¾
Electroplating [2.4]
Test Solutions

20 Marks. 1 Minute Reading. 17 Minutes Writing.

Results:

Test Questions	_____ / 15
Extension Questions	_____ / 5

Section A: Test Questions (15 Marks)

Question 1 (4 marks)

Tick whether the following statements are **true** or **false**.

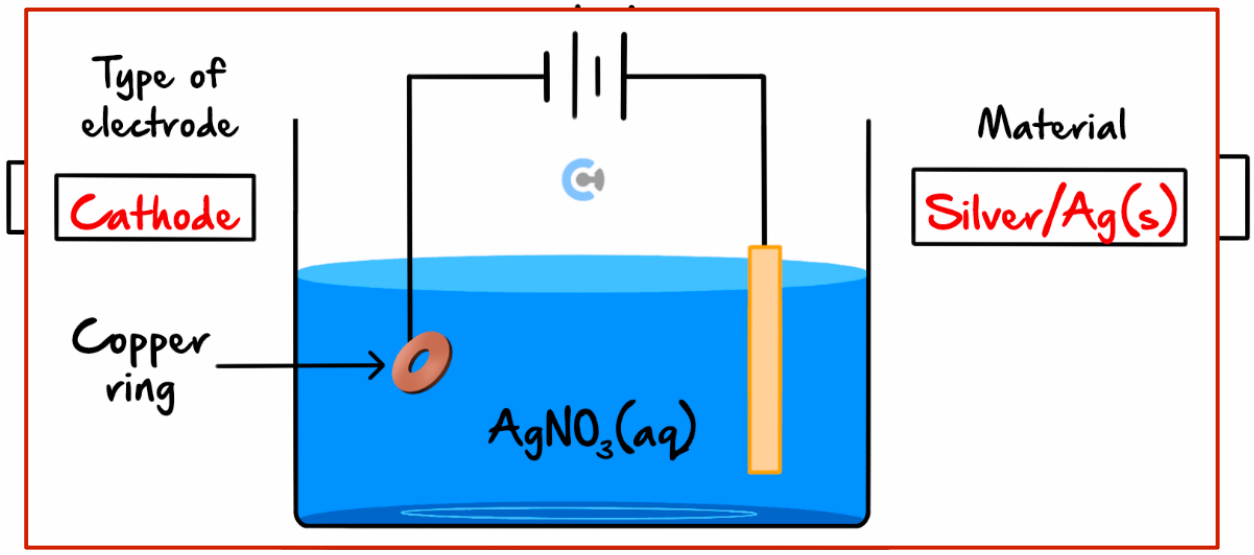
Statement	True	False
a. Electroplating can be used to protect metals by coating them in other metals, as well as for aesthetic purposes.	✓	
b. When multiple oxidants are present in an electrolytic cell, once the strongest oxidant is depleted, the cell stops operating as no more reactions can occur.		✓
c. High voltages are typically used to electroplate materials as this leads to a greater efficiency.		✓
d. Faraday's first law suggests that the more charge passed through a cell, the greater the chemical change observed, and this principle holds for both galvanic and electrolytic cells.	✓	
e. To deposit 65.4 g of zinc at the anode, 2 mol of electrons would be needed.		✓
f. When the same electric charge is passed through two separate electroplating cells, the cell which will have a greater mass change at the cathode will be the one whose electrolyte has ions with a greater molar mass.		✓
g. The power source used during electroplating is merely there to aid and speed up the reactions occurring, as they would occur even without an external supply of energy.		✓
h. Metal ions which are weaker in oxidant strength than water will typically not be able to reduce in an aqueous environment.	✓	

Space for Personal Notes

Question 2 (8 marks)

James is planning on proposing to his girlfriend but can't afford to buy a fancy ring. He does, however, have leftover strips of copper and silver from his time doing chemistry at school.

He realises he can set up the following cell, with the intention of coating a copper ring in silver.



a.

i. State whether the ring is acting as the anode or the cathode by writing 'anode' or 'cathode' in the box on the **left** in the diagram above. (1 mark)

ii. Label what **material** the electrode on the **right** should be made out of in the box above, and write half-equation occurring at this electrode. (2 marks)

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

b. Given that the solution of $AgNO_3$ has a concentration of 1.0 M initially, explain what will happen to its concentration during the operation of this cell. (1 mark)

Will remain as 1.0 M as Ag^+ is being consumed at cathode as quickly as it is being produced at anode, so overall no effect on $[Ag^+]$. Also, $[NO_3^-]$ is unaffected as it is a spectator ion.

c. Given that the volume of Silver needed to completely coat the ring is 5.12 cm^3 and the density of Silver is 10.49 g/cm^3. Calculate the time James needs to spend running this cell, in days, if he supplies a current of 50.0 mA. (4 marks)

$m(Ag) = d.V = 5.12\,cm^3 \cdot 10.49\,\frac{g}{cm^3}$

$= 53.7\,g$

$n(Ag) = \frac{m}{M} = \frac{53.7}{107.9} = 0.498\ mol$

$Ag^+ + e^- \rightarrow Ag$

$\therefore n(e^-) = n(Ag) = 0.498\ mol$

$\therefore Q = n(e^-) \times F = 0.498 \times 96500$

$= 4.80 \times 10^4\ C$

$t = \frac{Q}{I} = \frac{4.80 \times 10^4}{50.0 \times 10^{-3}} = 9.61 \times 10^5\ s$

$t = 11.1$ days (3 s.f.)

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Question 3 (3 marks)

Iron nails are often protected by being coated in zinc so as to prevent them from rusting.

a. Zinc is often referred to as the 'sacrificial coating'. Explain why this is the case. (1 mark)

Zn is a stronger reductant than Fe so it oxidises in preference when reacting with atmospheric oxygen and water. As such, it 'sacrifices' itself by reacting instead of the iron nail.

b. Your friend tells you that when a zinc-coated iron nail's surface is scratched, it begins to turn brown. Using your knowledge of chemistry, explain whether they are correct or not. (2 marks)

Once scratched, the inner iron is now exposed, and the zinc coating can no longer act as a physical barrier between the nail and atmospheric oxygen and water (1), so the iron nail will spontaneously react with them to form iron oxide (rust), giving the nail its brown appearance. The friend is correct (2).

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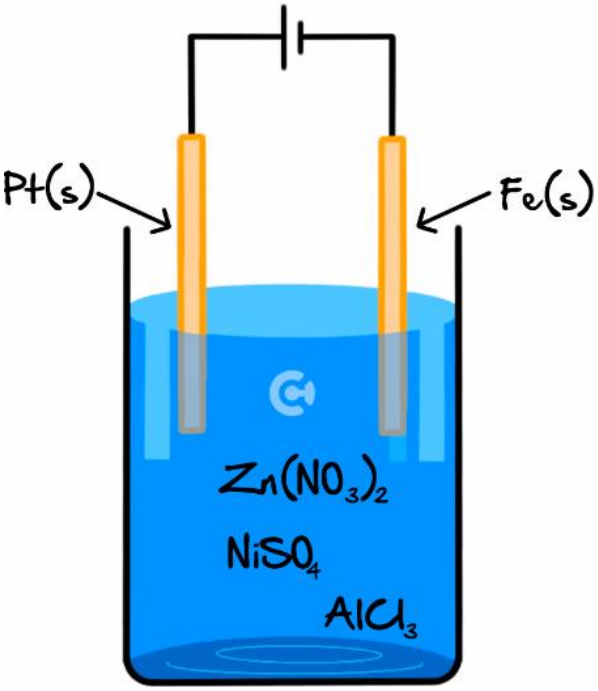
Section B: Extension Questions (5 Marks)

Question 4 (5 marks)

The following cell is being analysed by a group of Year 12 chemistry students.

They turn the power source on and observe a series of changes until the cell is eventually rendered inactive.



All the solutions in the electrolyte have a concentration of 0.20 *M*.

After some time since the cell is turned on, one of the ions is fully depleted.

a. State which ion this must be and predict the reactions that will take place at the iron electrode after this point in time up until the cell is unable to operate. (2 marks)

Ni^{2+} must be depleted first as it is the strongest oxidant.
After it is depleted, the Zn^{2+} will reduce as it is the next strongest oxidant present, and then water will simultaneously reduce until it is depleted (the Al^{3+} is unable to reduce.).

b. Once the cell is rendered in active, state the coatings on the iron electrode, from the outermost layer to the innermost layer. (1 mark)

$Zn(s), Ni(s)$

c.

i. Had more concentrated solutions been used, justify why this would have caused a greater mass change at the cathode. (1 mark)

More mol of ions are present, and thus more mol of electrons would be consumed. Since, $n(e^-)$ increases, so does Q from $Q = n(e^-) \times F$, and from Faraday's first law, if Q increases, so does mass change, as they are directly proportional (1).

ii. The students' teacher had urged them to not make use of highly concentrated solutions. Propose a reason for this recommendation. (1 mark)

Since, Cl^- is only a slightly weaker reductant than H_2O, at high concentrations it would oxidise in preference. This is unideal because then toxic $Cl_2(g)$ would be produced.

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