

## Answers to 90696 (3.3) NCEA 2004

Note: when marking the NCEA paper, award each question only the highest grade earned – ie award **M**, not **A** and **M**.



A = Correct equation

b i Anode is  $\text{H}_2$  electrode on left, cathode  $\text{O}_2$  electrode on right.

ii Oxidant is  $\text{O}_2$  and reductant is  $\text{H}_2$ .

A = Either all of answer (i) or (ii) correct

c  $E^\circ(\text{H}_2\text{O}/\text{H}_2, \text{OH}^-) = -0.83 \text{ V}$

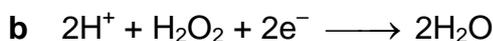
A = Correct value but wrong sign (ie + 0.83 V),

M = Correct answer with units



ii Fe

A = Both correct



A = Correctly balanced equation

c  $\text{H}_2\text{O}_2$  – because it is the oxidant in the redox couple with the most positive reduction potential and is therefore most easily reduced.

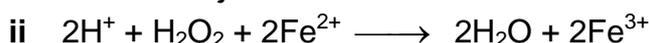
A =  $\text{H}_2\text{O}_2$  identified (may be included as part of a half-cell),

M =  $\text{H}_2\text{O}_2$  identified with appropriate justification. (Must be more than just 'highest  $E^\circ$  value')

d i  $E^\circ$  cell for this reaction is +1.01 V and since it is positive the reaction occurs.

A = +1.01 V with no justification *or* +2.55 V with justification,

M = +1.01 V with justification



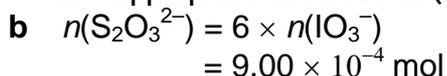
A = Correct equation

iii Colourless (or very pale green) solution will turn an orange colour (due to the formation of  $\text{Fe}^{3+}$ ).

A = Colour change correct

3 a The solution will go from colourless to yellow-brown (some black solid may form) – or from colourless to red/brown (recognising formula of  $\text{I}_3^-$  ion).

A = Appropriate observation. (Black solution not accepted)



M = Correct answer

c The iodine in  $\text{IO}_3^-$  has oxidation number +5 and the iodine in  $\text{I}_2$  has oxidation number 0. This decrease in oxidation number means the  $\text{IO}_3^-$  is reduced.

The  $\text{I}^-$  has oxidation number -1 and the increase to the value 0 in  $\text{I}_2$  means the iodide is oxidised.

A = Correct identification of oxidation number increase for  $\text{I}^-$  and  $\text{I}_2$  OR for  $\text{IO}_3^-$  to  $\text{I}_2$ ,

M = Full and correct discussion referring to all 3 oxidation numbers

4 a 0.46 V A = Correct answer.

- b**  $\text{Cu(s)} \mid \text{Cu}^{2+}(\text{aq}) \parallel \text{Ag}^{+}(\text{aq}) \mid \text{Ag(s)}$   
A = Correct answer. (States do not need to be included)
- c** Electrons flow through the external circuit from the Cu to the Ag electrode. Ions move through the salt bridge, cations move towards the  $\text{Ag}^{+}/\text{Ag}$  half-cell while anions move through the salt bridge towards the  $\text{Cu}^{2+}/\text{Cu}$  half-cell.  
A = Partial description of charge movement, eg movement of electrons through external circuit,  
M = Description of electron movement in external circuit and ion movement through salt bridge,  
E = Full description of electron and ion movement
- d** **i**  $2\text{Ag}^{+} + \text{Cu} \longrightarrow 2\text{Ag} + \text{Cu}^{2+}$   
A = Full description of electron and ion movement
- ii** In the  $\text{Cu}^{2+}/\text{Cu}$  half-cell the blue colour of the solution would become darker and the copper electrode would erode away. In the silver electrode half-cell more grey solid would be deposited on the electrode increasing its mass.  
A = Any two correct observations,  
M = Any two correct observations with an explanation of the chemistry involved,  
E = Full discussion including colours of species produced.  
Note: If equation is reversed, or colour described as green, but all else is as schedule, reduce grade by one level
- e**  $n(\text{Cu}) = 3.20 \text{ g} / 63.5 \text{ g mol}^{-1} = 0.0500 \text{ mol}$   
 $\text{Cu} + 2\text{Ag}^{+} \longrightarrow \text{Cu}^{2+} + 2\text{Ag}$   
 $n(\text{Ag}) 2 \times 0.0500 \text{ mol} = 0.100 \text{ mol}$   
 $m(\text{Ag}) = 0.100 \text{ mol} \times 108 \text{ g mol}^{-1} = 10.8 \text{ g}$   
Mass increases by 10.8 g.  
A = Appropriate calculation but uses 1:1 ratio for  $\text{Cu}:\text{Ag}^{+}$ .— must show working,  
M = Appropriate calculation with one minor error,  
E = Mass change correctly calculated
- f** The standard hydrogen electrode (SHE) has a standard reduction potential set at 0.00 V. This means that when it is connected to the  $\text{Cu}^{2+}/\text{Cu}$  half-cell the  $\text{Cu}^{2+}$  would now be reduced and this would be the positive electrode or cathode, while the SHE will be the negative electrode or anode. The overall cell voltage will be +0.34 V. The blue colour of the  $\text{Cu}^{2+}$  solution will fade and pink Cu metal will be deposited on the electrode. The acidity of the other electrode would increase as acid is produced.  
A = Recall of a single relevant concept such as the fact that the SHE has a reduction potential of 0.00 V, M = Single idea related to the operation of the cell, E = In-depth discussion of change in voltage and reverse direction of current

### Judgement Statement

#### Achievement

Total of **EIGHT** opportunities answered at Achievement (or higher)

$$8 \times A$$

#### Merit

Total of TEN opportunities answered with **FIVE** at Merit level and FIVE at Achievement level.

$$5 \times M + 5 \times A$$

#### Excellence

Total of TEN opportunities answered with **TWO** at Excellence level and THREE at Merit level and FIVE at Achievement level.

$$2 \times E + 3 \times M + 5 \times A$$