Redox and Electrode Potential (MCQ)

1. Iodide ions, $I^-(aq)$, react with $MnO_4^-(aq)$. The unbalanced equation is shown below.

$I^-(aq) + MnO_4^-(aq) + H_2O(l) \rightarrow IO^-(aq) + MnO_2(s) + OH^-(aq)$

What is the ratio of $MnO_2(s)$ to $OH^-(aq)$ in the balanced equation?

A 1 : 3
B 1 : 2
C 1 : 1
D 3 : 2

Your answer ☐ **[1]**

2. Four redox systems relevant to hydrogen–oxygen fuel cells are shown below.

	$E^\ominus$ / V
$H_2O(l) + e^- \rightleftharpoons OH^-(aq) + \frac{1}{2}H_2(g)$	−0.83
$H^+(aq) + e^- \rightleftharpoons \frac{1}{2}H_2(g)$	0.00
$\frac{1}{2}O_2(g) + H_2O(l) + 2e^- \rightleftharpoons 2OH^-(aq)$	+0.40
$\frac{1}{2}O_2(g) + 2H^+(aq) + 2e^- \rightleftharpoons H_2O(l)$	+1.23

Which statement(s) is/are correct for an alkaline hydrogen–oxygen fuel cell?

1 The reaction at the positive electrode is: $\frac{1}{2}O_2(g) + 2H^+(aq) + 2e^- \rightarrow H_2O(l)$
2 The overall cell reaction is: $H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$.
3 The cell potential is 1.23 V.

A 1, 2 and 3
B Only 1 and 2
C Only 2 and 3
D Only 1

Your answer ☐ **[1]**

3. The redox equilibria for a hydrogen–oxygen fuel cell in alkaline solution are shown below.

$2H_2O(l) + 2e^- \rightleftharpoons H_2(g) + 2OH^-(aq)$ $\quad E^e = -0.83$ V
$^1/_2O_2(g) + H_2O(l) + 2e^- \rightleftharpoons 2OH^-(aq)$ $\quad E^2 = +0.40$ V

What is the equation for the overall cell reaction?

A $H_2(g) + 4OH^-(aq) \rightarrow 3H_2O(l) + {}^1/_2O_2(g)$
B $3H_2O(l) + {}^1/_2O_2 \rightarrow H_2(g) + 4OH^-(aq)$
C $H_2O(l) \rightarrow H_2(g) + {}^1/_2O_2(g)$
D $H_2(g) + {}^1/_2O_2(g) \rightarrow H_2O(l)$

Your answer ☐ **[1]**

4. Which enthalpy change(s) is/are endothermic?

1 The bond enthalpy of the C–H bond
2 The second electron affinity of oxygen
3 The standard enthalpy change of formation of magnesium

A 1, 2 and 3
B Only 1 and 2
C Only 2 and 3
D Only 1

Your answer ☐ **[1]**

5. A cell is constructed from the two redox systems below.

$Cu^{2+}(aq) + 2e^- \rightleftharpoons Cu(s)$ $\quad E^\ominus = +0.34$ V
$Ag^+(aq) + e^- \rightleftharpoons Ag(s)$ $\quad E^\ominus = +0.80$ V

Which statement(s) is/are correct for the cell?

1. The cell potential is 1.14 V.
2. The reaction at the copper electrode is $Cu(s) \rightarrow Cu^{2+}(aq) + 2e^-$.
3. The silver electrode increases in mass.

A 1, 2 and 3
B Only 1 and 2
C Only 2 and 3
D Only 1

Your answer ☐ **[1]**

6. Electrode potentials are given below.

$Al^{3+}(aq) + 3e^- \rightleftharpoons Al(s)$	−1.676 V
$Sn^{2+}(aq) + 2e^- \rightleftharpoons Sn(s)$	−0.137 V

A standard cell is constructed from $Al^{3+}(aq)|Al(s)$ and $Sn^{2+}(aq)|Sn(s)$ half cells.

Which statement is correct for the standard cell?

A Al is oxidised and the cell potential is 1.539 V.
B Sn is oxidised and the cell potential is 1.539 V.
C Al is oxidised and the cell potential is 1.813 V.
D Sn is oxidised and the cell potential is 1.813 V.

Your answer ☐

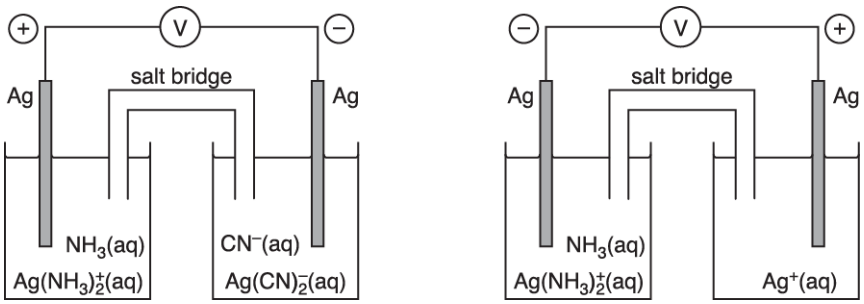
[1]

7. Three redox systems, **C**, **D** and **E** are shown in Table 6.1.

C	$Ag(NH_3)_2^+(aq) + e^- \rightleftharpoons Ag(s) + 2NH_3(aq)$
D	$Ag^+(aq) + e^- \rightleftharpoons Ag(s)$
E	$Ag(CN)_2^-(aq) + e^- \rightleftharpoons Ag(s) + 2CN^-(aq)$

Table 6.1

The two cells below were set up in an experiment to compare the standard electrode potentials of redox systems **C**, **D** and **E**. The signs on each electrode are shown.



List the three redox systems in order by adding the labels **C**, **D** and **E** to the table below.

$E^{\ominus}$	redox system
Most negative	
↑	
Least negative	

[1]

8. A standard cell is set up from $H^+(aq)|H_2(g)$ and $Ag^+(aq)|Ag(s)$ half cells.

The standard electrode potentials of the redox systems are shown below.

$H^+(aq) + e^- \rightleftharpoons \frac{1}{2}H_2(g)$ $\quad E^{\ominus} = +0.00$ V

$Ag^+(aq) + e^- \rightleftharpoons Ag(s)$ $\quad E^{\ominus} = +0.80$ V

What is the reaction at the negative electrode of the cell?

A. $H^+(aq) + e^- \rightarrow \frac{1}{2}H_2(g)$
B. $\frac{1}{2}H_2(g) \rightarrow H^+(aq) + e^-$
C. $Ag^+(aq) + e^- \rightarrow Ag(s)$
D. $Ag(s) \rightarrow Ag^+(aq) + e^-$

Your answer ☐

[1]

9. Which property is **not** correct for calcium?

A. It acts as an oxidising agent
B. It forms a basic oxide
C. It reacts with water to form hydrogen gas
D. Its hydroxide is more alkaline than magnesium hydroxide

Your answer ☐

[1]

10. An unbalanced equation for a redox reaction is shown below.

$Cu(s) + H^+(aq) + NO_3^-(aq) \rightarrow Cu^{2+}(aq) + NO_2(g) + H_2O(l)$

What is the balancing number for H^+ when the equation is balanced using the smallest whole numbers?

A. 2
B. 4
C. 6
D. 8

Your answer ☐

[1]

END OF QUESTION PAPER

Mark scheme – Redox and Electrode Potentials (MCQ)

Question			Answer/Indicative content	Marks	Guidance
1			**C**	1 (AO 2.6)	
			Total	**1**	
2			C	1 (AO2.1)	**Examiner's Comments** Only the higher attaining candidates opted for the correct answer of C. Many candidates thought statement 1 was correct, (giving option A as the answer), not realising that this equation refers to acidic conditions not alkaline conditions (as mentioned in the question). Others did not recognise that the cell potential was 1.23V (obtained by calculating the difference between +0.40 and –0.83), and so opted for option B.
			Total	**1**	
3			**D**	**1 (AO 2.5)**	**Examiner's Comments** Most candidates knew the correct equation.
			Total	**1**	
4			**B**	**1 (AO 1.1)**	**Examiner's Comments** D was the common distractor given as the answer by many candidates, suggesting confusion with the first electron affinity and second electron affinity of oxygen.
			Total	**1**	
5			**C**	1	
			Total	**1**	
6			**A**	1	
			Total	**1**	
7			E° / redox system Most negative – **E** **C** Least negative – **D** ✓	1	**ALL** 3 correct for 1 mark **Examiner's Comments** This part required candidates to apply their knowledge and understanding to three cells. Just over half the candidates were able to list the redox systems by *E* value. There was no clear pattern with incorrect responses.
			Total	**1**	

8			B	1	
			Total	**1**	
9			A	1	
			Total	**1**	
10			B	1	
			Total	**1**	