IB Higher Level Redox Test

1. Which of the following does **not** contain hydrogen in oxidation state +1?

A. H_2O B. H_2O_2 C. NaOH D. NaH

2. Ethanol can be oxidized to ethanoic acid.

$$CH_3CH_2OH + H_2O \rightarrow CH_3COOH + H^+$$

When this half-equation is balanced using the smallest possible whole numbers

A. the coefficient of H^+ is 2
B. $1e^-$ must be added to the left hand side
C. $4e^-$ must be added to the right hand side
D. $1e^-$ must be added to the right hand side

3. What happens at the positive electrode in a voltaic cell and in an electrolytic cell?

	Voltaic cell	**Electrolytic cell**
A.	reduction	reduction
B.	oxidation	oxidation
C.	oxidation	reduction
D.	reduction	oxidation

4. Some standard electrode potentials are shown below.

$U^{3+}(aq) + 3e^- \rightleftharpoons U(s)$ $E^\ominus = -1.79$ V
$Cr^{3+}(aq) + 3e^- \rightleftharpoons Cr(s)$ $E^\ominus = -0.74$ V

Which species is the strongest reducing agent?

A. Cr(aq) B. U(s) C. $U^{3+}(aq)$ D. $Cr^{3+}(aq)$

5. In the electrolysis of aqueous sodium sulfate 0.24 dm^3 of oxygen gas was produced. What is the **total** volume of gas produced?

A. 0.24 dm^3 B. 0.36 dm^3 C. 0.48 dm^3 D. 0.72 dm^3

6. Two half equations and standard electrode potentials are shown below.

$Ni^{2+}(aq) + 2e^- \rightleftharpoons Ni(s)$ $E^\ominus = -0.26$ V
$Fe^{3+}(aq) + e^- \rightleftharpoons Fe^{2+}(aq)$ $E^\ominus = +0.77$V

The standard cell potential and cell notation are

A.	0.51 V	$Ni^{2+}(aq)\|Ni(s)\|\|Fe^{3+}(aq)\|Fe^{2+}(aq)$
B.	1.03 V	$Ni(s)\|Ni^{2+}(aq)\ \|\|Fe^{3+}(aq)\|Fe^{2+}(aq)\|Pt(s)$
C.	1.80 V	$Ni(s)\|Ni^{2+}(aq)\ \|\|Fe^{3+}(aq),Fe^{2+}(aq)\|Pt(s)$
D.	1.03 V	$Ni(s)\|Ni^{2+}(aq)\ \|\|Fe^{3+}(aq),Fe^{2+}(aq)\|Pt(s)$

7. The Winkler method was used to measure the concentration of dissolved oxygen in a sample of water. Manganese(II) sulfate, sulfuric acid and potassium iodide were added to 50.0 cm^3 of the water. The iodine that was formed was titrated against a sodium thiosulfate solution with a concentration of 2.00×10^{-3} mol dm^{-3}. It was found that 10.00 cm^3 of sodium thiosulfate was required for the titration.

The equations for the reactions are:

$2Mn(OH)_2(s) + O_2(aq) \rightarrow 2MnO(OH)_2(s)$

$MnO(OH)_2(s) + 4H^+(aq) \rightarrow Mn^{4+}(aq) + 3H_2O(l)$

$Mn^{4+}(aq) + 2I^-(aq) \rightarrow Mn^{2+}(aq) + I_2(aq)$

$I_2(aq) + 2S_2O_3^{2-}(aq) \rightarrow S_4O_6^{2-}(aq) + 2I^-(aq)$

The concentration of dissolved oxygen in ppm is given by

A. $\frac{10.00 \times 32.00 \times 2.00}{4 \times 50.0}$

B. $\frac{10.00 \times 32.00 \times 2.00}{50.0}$

C. $\frac{10.00 \times 32.00 \times 2.00 \times 10^6}{1000 \times 4 \times 50.0}$

D. $\frac{10.00 \times 2.00}{32.00 \times 4 \times 50.0}$

8. Which compound contains nitrogen atoms with different oxidation states?

A NH_4NO_3 B N_2O_4 C $C_6H_4(NO_2)_2$ D Mg_3N_2

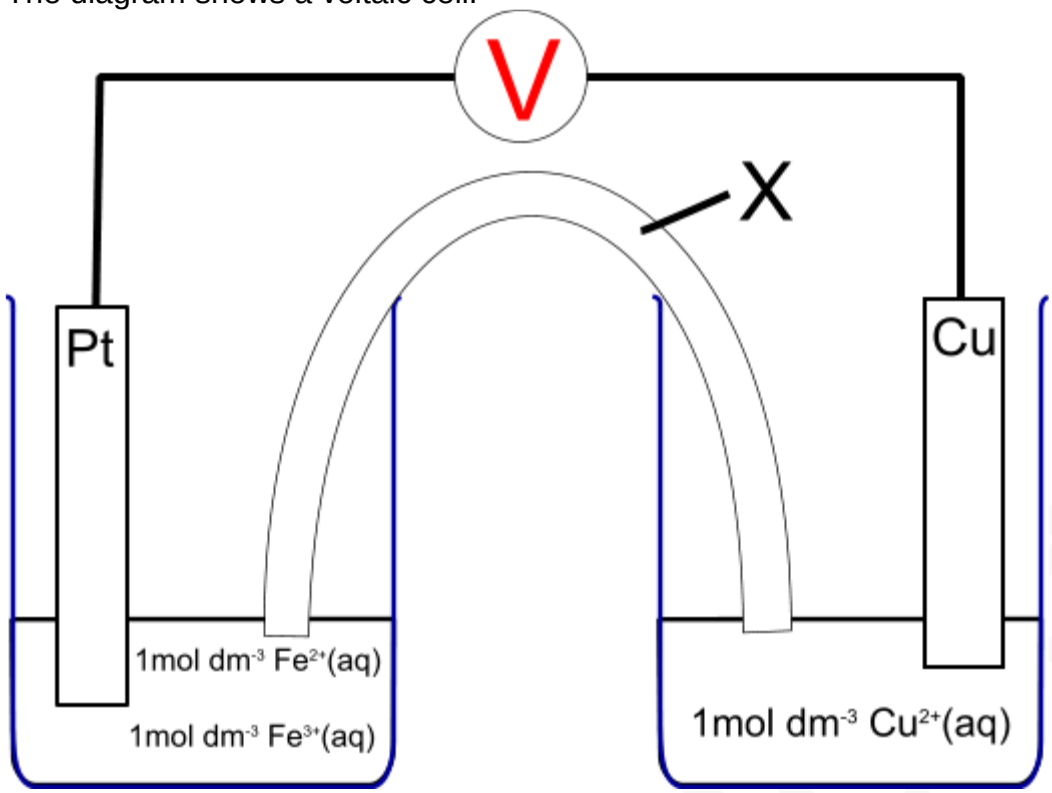
9. Which of the following is **not** a redox reaction?

A. $Zn(NO_3)_{2(aq)} + Mg_{(s)} \rightarrow Mg(NO_3)_{2(aq)} + Zn_{(s)}$
B. $U_{(s)} + 6ClF_{(l)} \rightarrow UF_{6(l)} + 3Cl_{2(g)}$
C. $2NO_{2(g)} \rightleftharpoons N_2O_{4(g)}$
D. $2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)}$

10. Which of the following is ***not*** an observation that could be made when 1 mol dm^{-3} copper(II) sulfate solution is electrolyzed using platinum electrodes.

A The cathode becomes coated with a pink-brown metal
B bubbles of gas are given off at the anode
C the pH increases
D the blue colour of the electrolyte fades

11. The diagram shows a voltaic cell.



(a) State the name of the component labelled X and explain what its purpose is. [2]

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(b) Calculate the cell potential. [1]

(c) On the diagram above, indicate the direction of electron flow in the external circuit and of negative ions through X. [2]

(d) Write an overall redox equation for the reaction occurring in the above cell when current flows. [2]

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(e) State the cell diagram notation for this cell. [1]

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12. Consider the following half equations and standard electrode potentials

$Ni^{2+}(aq) + 2e^- \rightleftharpoons Ni(s)$	$E^\ominus = -0.26$ V
$Cl_2(g) + 2e^- \rightleftharpoons 2Cl^-(aq)$	$E^\ominus = +1.36$ V
$Fe^{3+}(aq) + e^- \rightleftharpoons Fe^{2+}(aq)$	$E^\ominus = +0.77$ V
$Br_2(l) + 2e^- \rightleftharpoons 2Br^-(aq)$	$E^\ominus = +1.09$ V

(a) Use these equations to identify, giving a reason, the strongest reducing agent. [2]

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(b) Discuss whether nickel metal will react with chlorine gas to form nickel(II) chloride [2]

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13. Chlorate(V) ions react with sulfate(IV) ions to form chloride ions and sulfate(VI) ions in aqueous solution.

(a) Write a balanced redox equation for this reaction. [2]

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(b) State which is the oxidizing agent in this reaction. [1]

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14. The equation below represents a redox reaction

$2KMnO_4 + 5Na_2C_2O_4 + 8H_2SO_4 \rightarrow 2MnSO_4 + 10CO_2 + K_2SO_4 + Na_2SO_4 + 8H_2O$

(a) State the oxidation state of carbon in $Na_2C_2O_4$? …… [1]

(b) 27.60 cm^3 of 0.0200 mol dm^{-3} $KMnO_4(aq)$ reacts with 25.00 cm^3 of $Na_2C_2O_4(aq)$. Calculate the concentration of the $Na_2C_2O_4(aq)$. [2]

15. The redox equation for the reaction between dichromate(VI) and bromide ions is:

$Cr_2O_7^{2-}(aq) + 14H^+ + 6Br^-(aq) \rightarrow 2Cr^{3+}(aq) + 7H_2O(l) + 3Br_2(l)$

Calculate

(a) the standard cell potential [1]

(b) the value of $\Delta G^\ominus$ for this reaction [2]