Name: _____

ALL of your answers and working should be written into this answer booklet.
This test consists of 15 multiple-choice questions, and 4 written questions.

Multiple-Choice

Record your answer by placing a cross (x) through the appropriate letter. If you change your mind then completely block out the error and cross your new answer.

eg (a) (b) (c) (x)

1. (a) (b) (c) (x)
2. (a) (b) (x) (d)
3. (a) (b) (x) (d)
4. (a) (b) (x) (d)
5. (a) (x) (c) (d)

6. (x) (b) (c) (d)
7. (a) (b) (x) (d)
8. (a) (x) (c) (d)
9. (a) (x) (c) (d)
10. (x) (b) (c) (d)

11. (a) (b) (x) (d)
12. (a) (b) (c) (x)
13. (a) (b) (x) (d)
14. (a) (b) (c) (x)
15. (a) (b) (x) (d)

Section 2 – Written Section. –25 marks

Answer all questions in the spaces provided.

1. Give balanced ionic equations for any reactions, which occur in the following experiments.

   Describe observations such as colour change, precipitate formation, and gas evolution etc resulting from the chemical reaction.

   (a) A piece of zinc metal is placed in a concentrated solution of copper (II) sulfate.

   Equation/s:

   $$Zn_{(s)} + Cu^{2+}_{(aq)} \rightarrow Zn^{2+}_{(aq)} + Cu_{(s)}$$

   Observations:
   A pink solid forms on the metal strip which dissolves into a blue solution that loses its colour.

   (2 marks)

   (b) Acidified potassium permanganate solution is added to iron (II) ammonium sulfate solution.

   Equation/s:

   $$MnO_4^-{}_{(aq)} + 5Fe^{2+}_{(aq)} + 8H^+_{(aq)} \rightarrow Mn^{2+}_{(aq)} + 5Fe^{3+}_{(aq)} + 4H_2O_{(l)}$$

   Observations:
   A pale green solution gradually becomes browner and then purple.

   (2 marks)

(c) Acidified potassium dichromate oxidising sulfur dioxide.

Equation/s:

$$3SO_{2(aq)} + Cr_2O_7^{2-}{}_{(aq)} + 2H^+{}_{(aq)} \rightarrow 3SO_4^{2-}{}_{(aq)} + 2Cr^{3+}{}_{(aq)} + H_2O_{(l)}$$

Observations:
An orange solution is added to a colourless, pungent solution producing an odourless, green solution.

(2 marks)

(d) A wine sample is treated with potassium hydroxide to free any sulfur dioxide that has combined with other components in the wine. Then after sufficient time it is acidified with sulfuric acid. To determine the sulfur dioxide content of the wine it is titrated with standard iodine solution, using starch as an indicator. (Give the equation and observations only for the titration.)

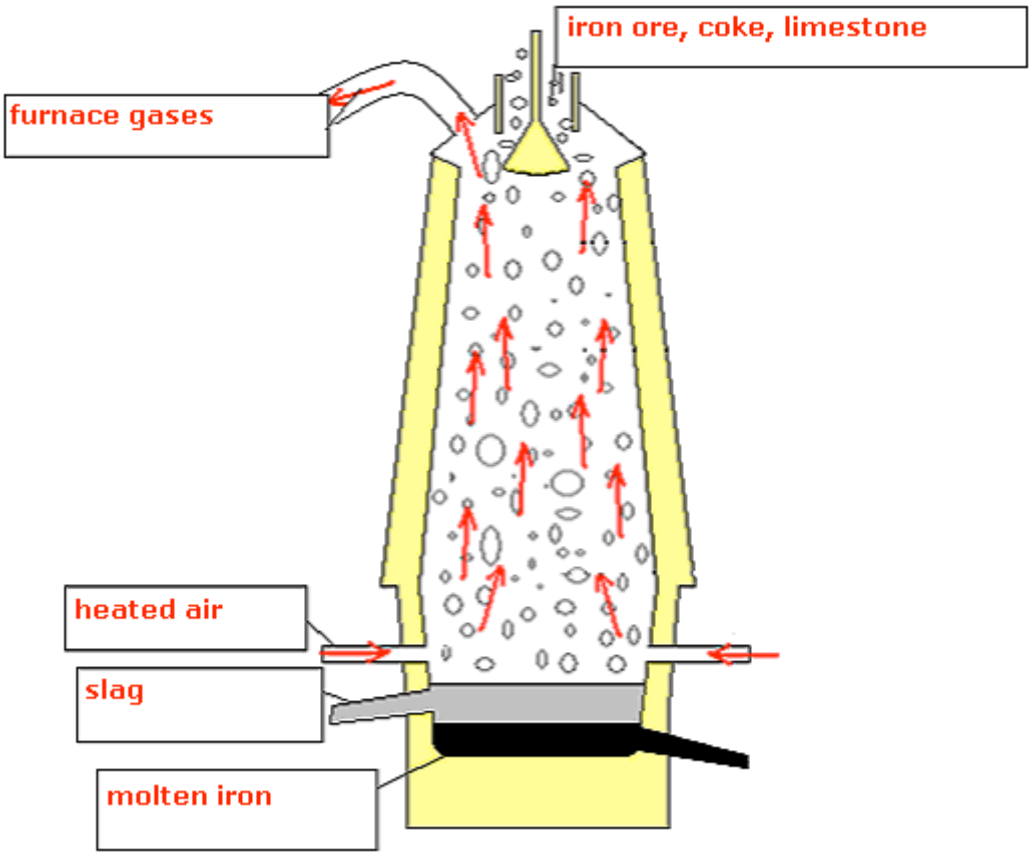
Equation/s:

$$SO_{2(aq)} + I_{2(aq)} + 2H_2O_{(l)} \rightarrow 4H^+{}_{(aq)} + SO_4^{2-}{}_{(aq)} + 2I^-{}_{(aq)}$$

Observations:
At the end point of the titration the colourless solution turns blue/black.

(2 marks)

2. (a) Label the diagram of the blast furnace.



(b) Describe, with the aid of chemical equations, the various stages in the extraction of iron from iron ore in the blast furnace.

Carbon and carbon dioxide produce the primary reducing agent carbon monoxide.

$$C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$$

$$C_{(s)} + CO_{2(g)} \rightarrow 2CO_{(g)}$$

Carbon monoxide reduces iron in iron oxide.

$$Fe_2O_{3(s)} + 3CO_{(g)} \rightarrow 2Fe_{(s)} + 3CO_{2(g)}$$

Limestone produces calcium oxide which is used to remove slag.

$$CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$$

$$CaO_{(s)} + SiO_{2(s)} \rightarrow CaSiO_{3(l)}$$

(3 marks)

3 A 2.050g sample of haematite (mainly Fe_2O_3) was dissolved in sulfuric acid and diluted to 250.0mL. A 25.0mL sample of the diluted solution was treated with just enough zinc to reduce the iron (III) ions to iron (II) ions. The 25.00mL sample was then titrated with $0.0212 mol L^{-1}$ potassium permanganate solution. A volume of 23.40mL of $KMnO_4$ solution was needed to the end point.

(a) Using appropriate half equations, write a balanced equation for the oxidation of the Fe^{2+} ions by the permanganate solution.

$$5 (Fe^{2+}_{(aq)} \rightarrow Fe^{3+}_{(aq)} + e^-)$$

$$MnO_4^-{}_{(aq)} + 8H^+_{(aq)} + 5e^- \rightarrow Mn^{2+}_{(aq)} + 4H_2O_{(l)}$$

$$5\ Fe^{2+}_{(aq)} + MnO_4^-{}_{(aq)} + 8H^+_{(aq)} \rightarrow 5\ Fe^{3+}_{(aq)} + Mn^{2+}_{(aq)} + 4H_2O_{(l)}$$

(b) Calculate the number of moles of potassium permanganate used in each titration.

$n(MnO_4^-) = c(MnO_4^-) \times v(MnO_4^-) = .0212 \times .0234 = 4.96 \times 10^{-4}$ mole

(c) Calculate the number of moles of Fe^{2+} in the 25.00mL sample.

For every 1 MnO_4^- ion there will be 5 Fe^{2+} ions (from the equation)
Ie $5 \times 4.96 \times 10^{-4} = 2.48 \times 10^{-3}$ mole

(d) Calculate the number of moles of iron in the 250.0mL solution.

There will be 10 times this number of moles in the original 250mL sample
ie 2.48×10^{-2} mole

(e) Calculate the mass of Fe_2O_3 in the 2.050g sample of haematite, and then what percentage of the haematite is Fe_2O_3.

$n(Fe_2O_3) = 0.5 \times n(Fe) = 0.5 \times 2.48 \times 10^{-2} = 1.24 \times 10^{-2}$
$M(Fe_2O_3) = (2 \times 55.85) + (3 \times 16.0) = 159.7g$
$M(Fe_2O_3) = n \times M = 1.24 \times 10^{-2} \times 159.7 = 1.98g$
% of Fe_2O_3 in the original sample is $(1.98/2.05) \times 100 = 96.6\%$

(5 marks)