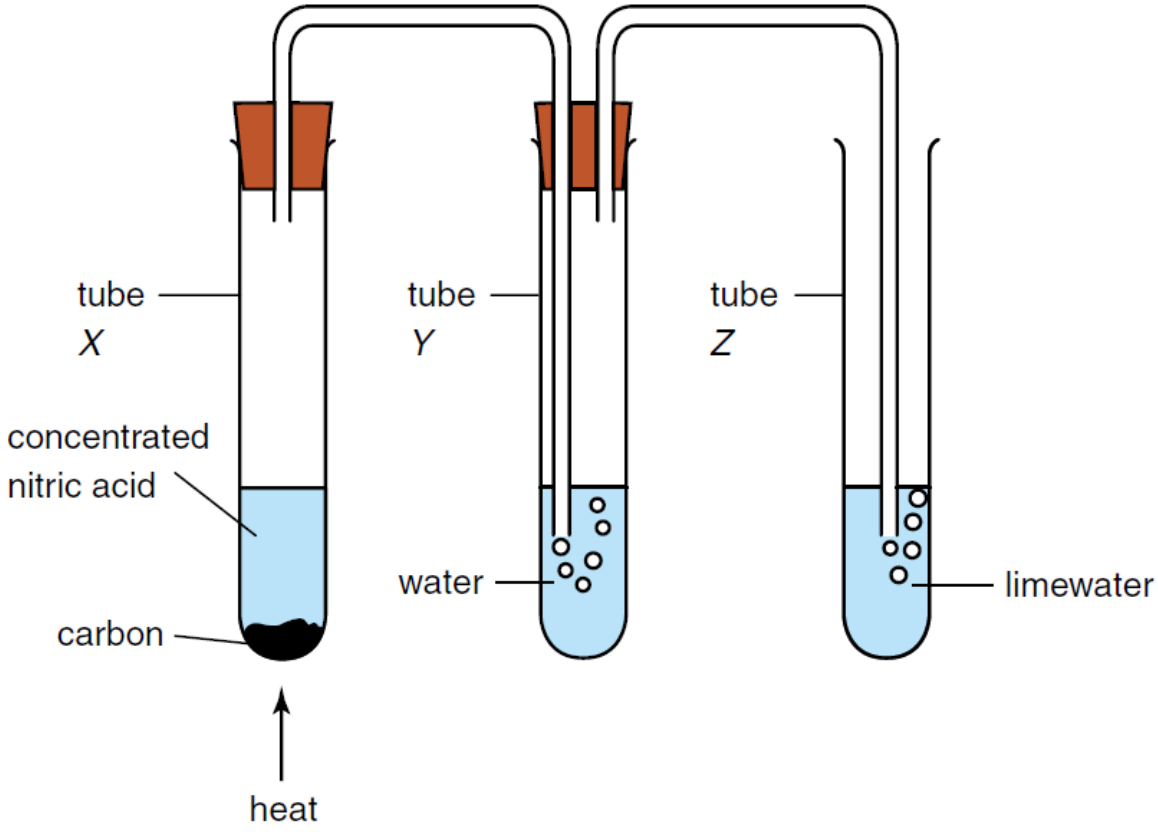
Quiz (Redox Reactions with Common Oxidizing Agent and Reducing Agent)

1. In an investigation of the properties of concentrated nitric acid, a student heated the acid with carbon in tube *X* as shown below:



(a) Concentrated nitric acid is commonly stored in brown bottles in the laboratory. Explain briefly, with the aid of an equation.

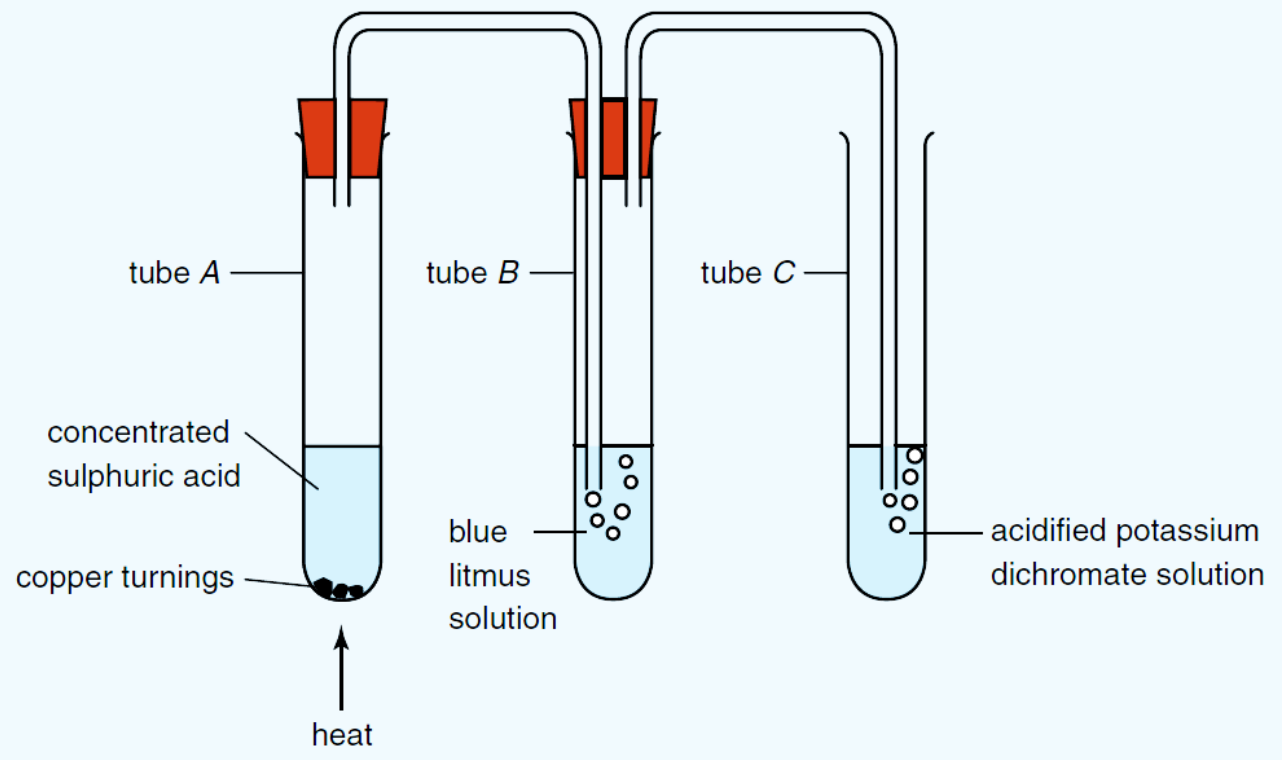
(b) During the experiment, brown fumes formed in tube *X*. What are the brown fumes formed?

(c) Write the chemical equation for the reaction that occurred in tube *X*.

(d) Would you expect the brown fumes to appear in tube *Y*? Explain your answer.

(e) State the observation in tube *Z*. Explain your answer and write an appropriate equation.

2. The following set-up was used to study the reaction of copper with concentrated sulphuric acid.



(a) During the experiment, the copper turnings turned black. What is the black substance?

(b) During the experiment, gas bubbles formed in tube *A*. What is the gas formed?

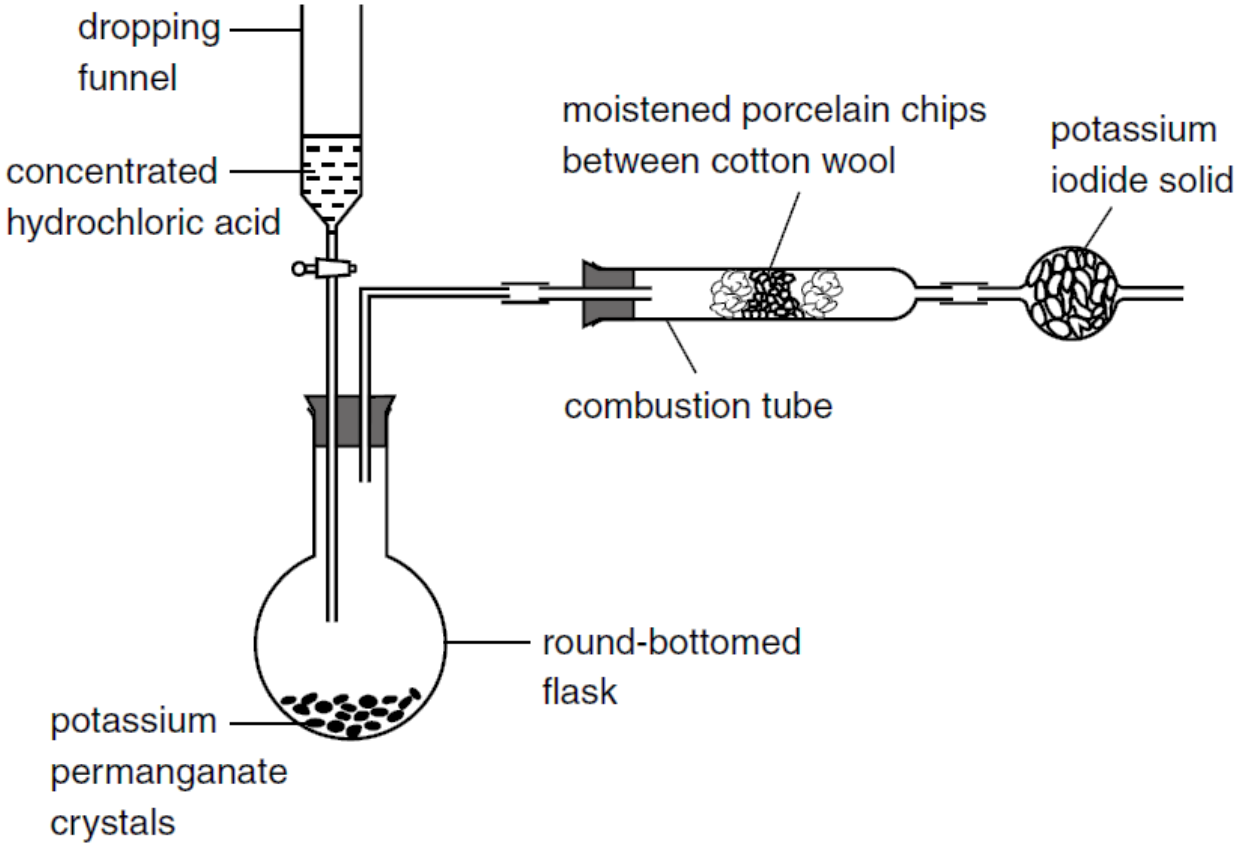
(c) Write the chemical equation for the reaction that occurred in tube *A*.

(d) Describe and explain the colour change of the solution in tube *A*.

(e) State and explain the observation in tube *B*.

(f) With the aid of a chemical equation, state and explain the observation in tube *C*.

3. The following experimental set-up is used to investigate a series of redox reactions in the laboratory.



(a) Describe the observation when concentrated hydrochloric acid is added to the potassium permanganate crystals in the round-bottomed flask.

(b) Write a balanced ionic equation to show the reaction taking place in (a) above.

(c) State which is the oxidizing agent and which is the reducing agent in this reaction. Justify your answer.

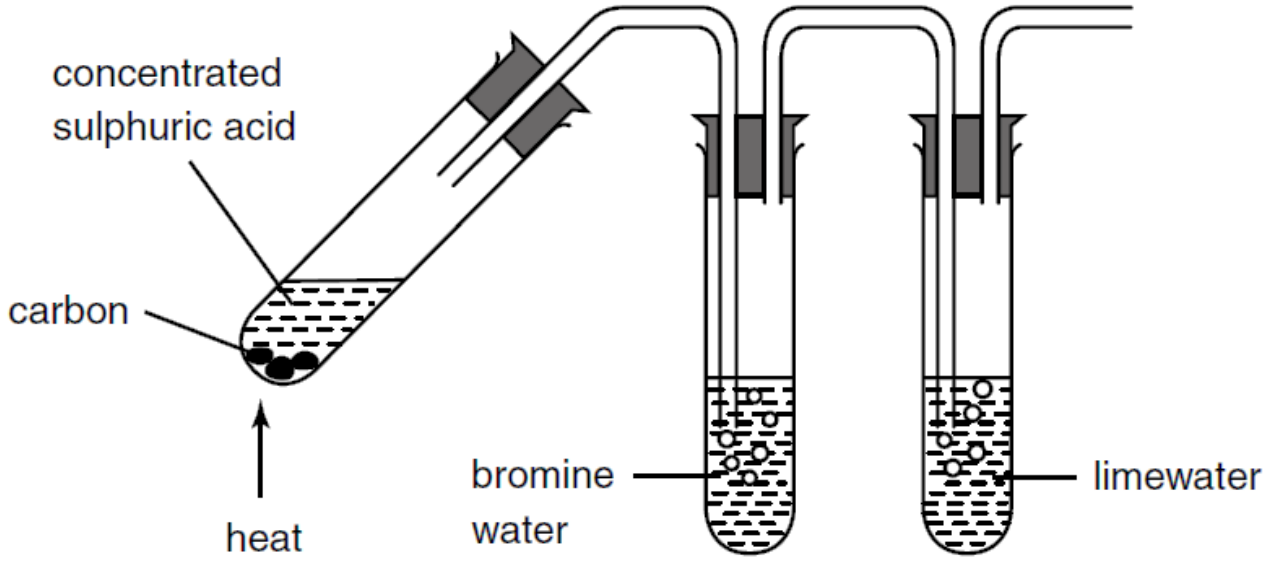
(d) Explain why the stopcock of the dropping funnel should be closed after the concentrated hydrochloric acid is used up.

(e) What is the purpose of putting moistened porcelain chips in the combustion tube?

(f) Describe the observation that can be made in the tube containing potassium iodide solid.

(g) Write a balanced ionic equation (no state symbols are needed) to show the reaction taking place in (f).

4. The following set-up shows the reaction between concentrated sulphuric acid and carbon.



(a) Write a chemical equation for the reaction between concentrated sulphuric acid and carbon.

(b) What property of concentrated sulphuric acid is responsible for the reaction between concentrated sulphuric acid and carbon?

(c) State the observable changes and write the chemical equations for the reactions involved in
(i) bromine water, and
(ii) limewater.

(d) If bromine water is replaced by acidified potassium dichromate solution, state the observable change and write the chemical equation for the reaction involved.

Suggested Answer

1. (a) This is because light speeds up the decomposition of concentrated nitric acid.

$4HNO_3(aq) \longrightarrow 4NO_2(g) + O_2(g) + 2H_2O(l)$

(b) Nitrogen dioxide

(c) $C(s) + 4HNO_3(aq) \longrightarrow CO_2(g) + 4NO_2(g) + 2H_2O(l)$

(d) No, the brown fumes would not appear in tube *Y*. This is because nitrogen dioxide will dissolve in water.

(e) The solution in tube *Z* turns milky. The $CO_2(g)$ produced reacts with limewater to form insoluble calcium carbonate.

$CO_2(g) + Ca(OH)_2(aq) \longrightarrow CaCO_3(s) + H_2O(l)$

2. (a) Copper(II) oxide

(b) Sulphur dioxide

(c) $Cu(s) + 2H_2SO_4(l) \longrightarrow CuSO_4(aq) + SO_2(g) + 2H_2O$

(d) The solution in tube A changes from colourless to blue because of the formation of blue copper(II) ions.

(e) The solution in tube B turns red because Sulphur dioxide dissolves in water to form an acidic solution.

(f) The acidified potassium dichromate solution changes from orange to green. Sulphur dioxide reduces orange dichromate ions to green chromium(III) ions.

$Cr_2O_7^{2-}(aq) + 3SO_2(g) + 2H^+(aq) \longrightarrow 2Cr^{3+}(aq) + 3SO_4^{2-}(aq) + H_2O(l)$

3. (a) Greenish yellow fumes form.

(b) $2MnO_4^-(aq) + 10Cl^-(aq) + 16H^+(aq) \longrightarrow 2Mn^{2+}(aq) + 5Cl_2(g) + 8H_2O(l)$

(c) Potassium permanganate is the oxidizing agent because the oxidation number of manganese decreases from +7 to +2.
Concentrated hydrochloric acid is the reducing agent because the oxidation number of chlorine increases from -1 to 0.

(d) To prevent the escape of chlorine gas through the dropping funnel.

(e) The water in the moistened broken porcelain chips can absorb unreacted hydrochloric acid vapour / hydrogen chloride gas, which is highly soluble in water.

(f) The white potassium iodide solid turns dark brown.

(g) $Cl_2 + 2I^- \longrightarrow 2Cl^- + I_2$

4. (a) $C(s) + 2H_2SO_4(l) \longrightarrow CO_2(g) + 2SO_2(g) + 2H_2O(l)$

(b) Oxidizing property

(c) (i) The bromine water is decolorized.
$SO_2(g) + Br_2(aq) + 2H_2O(l) \longrightarrow SO_4^{2-}(aq) + 2Br^-(aq) + 4H^+(aq)$

(ii) The limewater turns milky.
$CO_2(g) + Ca(OH)_2(aq) \longrightarrow CaCO_3(s) + H_2O(l)$

(d) The orange dichromate solution turns green.
$Cr_2O_7^{2-}(aq) + 3SO_2(g) + 2H^+(aq) \longrightarrow 2Cr^{3+}(aq) + 3SO_4^{2-}(aq) + H_2O(l)$