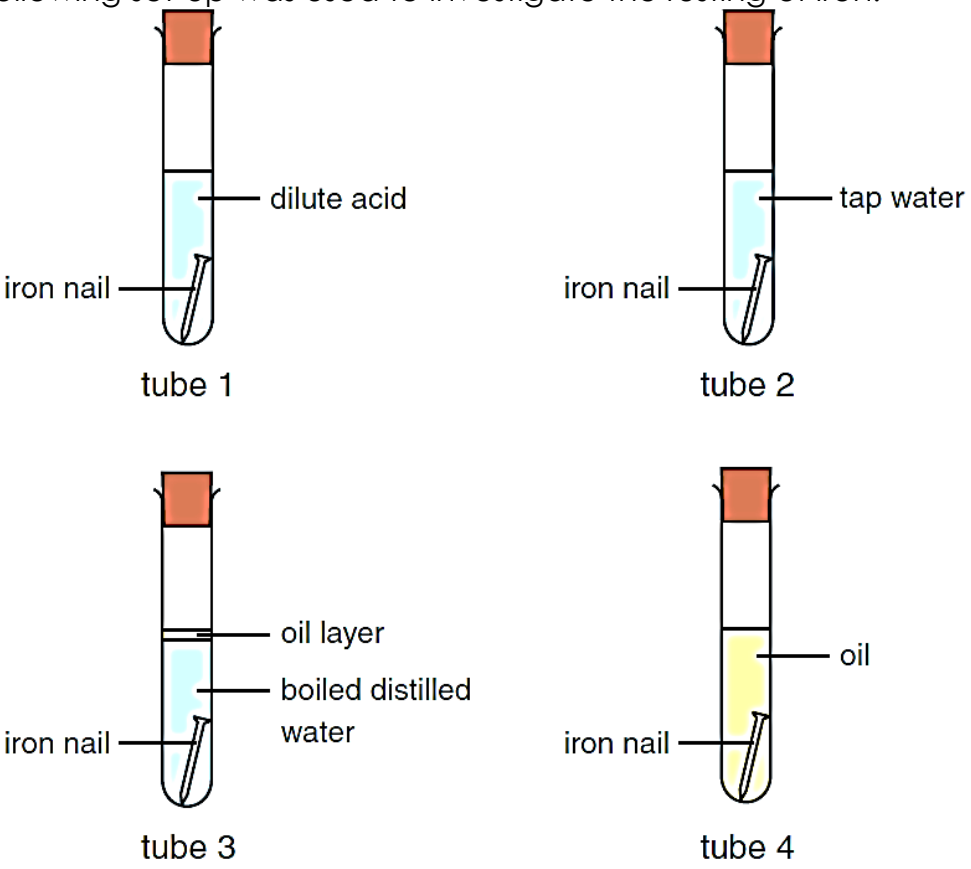
Quiz (Rusting and its Prevention)

1. The following set-up was used to investigate the rusting of iron.



After a few days, only the iron nails in tubes 1 and 2 rusted.

(a) (i) Name the positive and the negative ions produced during the initial stage of the rusting process.

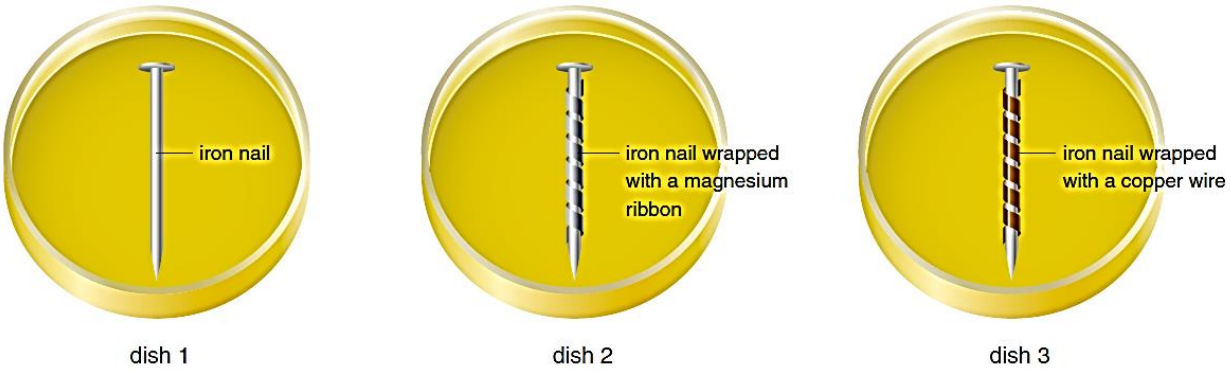
(ii) Write an overall equation for the rusting process.

(b) Explain why the iron nails in tubes 3 and 4 did not rust.

(c) What would happen if the iron nail in tube 2 were wrapped with a copper wire? Explain briefly.

2. Refer to the experiment below. There are three Petri dishes, each containing a gel with a rust indicator.

Dish 1 contains a single iron nail.
Dish 2 contains an iron nail partly wrapped with a magnesium ribbon.
Dish 3 contains an iron nail partly wrapped with a copper wire.



(a) Write down the expected observation(s) in each Petri dish.

(b) Explain the observed results in (a).

(c) From your answers to (a) and (b), suggest a method to protect iron from rusting.

3. The order of some metals in the metal reactivity series is shown below:
magnesium, aluminium, zinc, iron, tin, copper

(a) Which of the above metals can be used to protect iron from rusting by sacrificial protection?

(b) Name the method of protecting iron from rusting by coating a thin layer of zinc on the surface of iron.

(c) Explain how tin-plating can be used to protect iron from rusting.

(d) Explain why tin, rather than zinc, is used in making food cans.

4. There are many methods of rust prevention. Decide which method(s) you would use to protect each of the following iron-made objects from rusting:

(1) Lamppost	(2) Kitchen sink
(3) Letter box	(4) Shower
(5) Oil tanker	(6) Refrigerator
(7) Nail clipper	(8) Gate
(9) Lock	(10) Steel pier legs (immersed in sea water)
(11) Car exhaust pipe	(12) Food can
(13) Bus stop sign	(14) Cutlery (e.g. knife, fork, spoon)

(Hint: Each method of rust prevention has its own advantages and disadvantages.)

You should consider the following in making the choice:

- The special environment under which the iron-made object is used (For example: Is the temperature high?
  Are there acidic pollutants or soluble ionic compounds? Is the iron-made object often scratched during use? Is the iron-made object used as a food container?)
- Is the appearance important?
- Is the cost of rust prevention reasonable?

Suggested Answer

1. (a) (i) The positive ion: iron(II) ion;
the negative ion: hydroxide ion

(ii) $4Fe(s) + 3O_2(g) + 2nH_2O(l) \longrightarrow 2Fe_2O_3 \bullet nH_2O(s)$

(b) In tube 3, dissolved air in distilled water had been driven off by boiling. Besides, the oil layer on top prevented air from dissolving in water again. Because there was no air (oxygen), the iron nail in tube 3 did not rust.

In tube 4, iron nail was immersed in oil. Oil did not contain dissolved air. Because there were no air and water, the iron nail in tube 4 did not rust.

(c) Copper is less reactive than iron. If the iron nail were wrapped with a copper wire, iron would lose electrons more readily. As a result, rusting would occur faster.

2. (a) **Dish 1:** A blue colour appears around the head and tip of the iron nail. A pink colour appears around the body of the nail.
Dish 2: A pink colour appears around the head and tip of the iron nail.
Dish 3: A blue colour appears around the head and tip of the iron nail. The blue patches are larger than those observed in dish 1. A pink colour appears around the body of the nail.

(b) **Dish 1:** A blue colour appears, showing that the iron nail rusts.
The pink colour indicates that hydroxide ions form in the rusting process.
Dish 2: Blue colour does not appear while pink colour appears. This indicates that no rusting occurs. Only hydroxide ions form in the corrosion process of magnesium.
This is because magnesium, being more reactive, loses electrons more readily than iron.
This prevents iron from losing electrons. The iron nail therefore cannot form iron(II) ions and does not rust.
Dish 3: A blue colour appears, showing that the iron nail rusts. The pink colour indicates that hydroxide ions form in the rusting process.
The iron nail wrapped with a copper wire rusts more quickly than the iron nail alone.
This is because copper, being less reactive than iron, causes iron to lose electrons more readily. This speeds up the rusting of the iron nail.

(c) Connect iron to a more reactive metal (e.g. magnesium or zinc).

3. (a) Magnesium, aluminium and zinc

   (b) Galvanizing/sacrificial protection

   (c) The tin layer protects iron from rusting by preventing it from contacting air and water.

   (d) his is because tin ions are not poisonous, while zinc ions are poisonous.

4. (1) Painting, galvanizing
   (2) Chromium-plating
   (3) Painting
   (4) Chromium-plating
   (5) Painting, sacrificial protection
   (6) Enamelling
   (7) Use of stainless steel
   (8) Painting
   (9) Oiling/greasing
   (10) Cathodic protection
   (11) Chromium-plating
   (12) Tin-plating
   (13) Painting
   (14) Use of stainless steel