

- 1 Rust contains iron(III) oxide.

Phosphoric acid, H_3PO_4 , can be used to remove rust from an iron object and prevent further rusting.

- (a) Write a chemical equation for the reaction between iron(III) oxide and phosphoric acid to form iron(III) phosphate and water.

..... [2]

- (b) Iron(III) phosphate is an insoluble salt.

Suggest how the formation of iron(III) phosphate prevents further rusting.

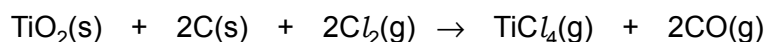
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..... [1]

[Total: 3]

- 2 Titanium is extracted from an ore called rutile. Rutile is an impure form of titanium(IV) oxide, TiO_2 .

Rutile is mixed with coke and heated in a furnace through which chlorine gas is passed. The product is gaseous titanium(IV) chloride, TiCl_4 .



The gaseous titanium(IV) chloride produced is condensed into the liquid state. The titanium(IV) chloride is then separated from liquid impurities.

- (a) Suggest the name of the process by which liquid titanium(IV) chloride could be separated from the liquid impurities.

..... [1]

- (b) Carbon monoxide, $\text{CO}(\text{g})$, is also produced in the reaction.

Why should carbon monoxide **not** be released into the atmosphere?

..... [1]

[Total: 2]

- 3 Iron does not rust when it is completely coated with zinc. When the zinc is scratched, the iron still does not rust.

- (a) Explain why the iron does **not** rust when it is completely coated with zinc.

..... [1]

(b) Explain why the iron still does **not** rust when the zinc is scratched.

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[3]

[Total: 4]

4 Air is a mixture. Nitrogen and oxygen are the two most common gases in air.

(a) What is meant by the term *mixture*?

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[1]

(b) State the percentage of oxygen, to the nearest whole number, in clean dry air.

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[1]

(c) Describe the steps in the industrial process which enables nitrogen and oxygen to be separated from clean dry air.

Use scientific terms in your answer.

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[3]

(d) Which physical property of nitrogen and oxygen allows them to be separated?

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[1]

[Total: 6]

5 The metal iron and the alloy steel are commonly used materials. A problem with them is that they rust.

(a) How does painting iron and steel prevent rusting?

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..... [1]

(b) Magnesium blocks can be attached to the bottom of steel boats.

Explain how the magnesium blocks prevent the whole of the bottom of the boat from rusting.

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..... [2]

(c) Replacing the magnesium blocks with copper blocks does not prevent rusting.

Explain why the copper blocks do **not** prevent rusting.

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..... [1]

[Total: 4]

6 Three common pollutants in the air are carbon monoxide, the oxides of nitrogen, NO and NO₂, and unburnt hydrocarbons. They are all emitted by motor vehicles.

(a) Describe how the oxides of nitrogen are formed.

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..... [2]

(b) Describe how a catalytic converter reduces the emission of these three pollutants.

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..... [4]

- (c) Other atmospheric pollutants are lead compounds from leaded petrol.
Explain why lead compounds are harmful.

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..... [1]

[Total: 7]