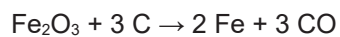**All questions are for separate science students only**

Q1.

This question is about displacement reactions.

Iron is extracted from iron oxide by a displacement reaction with carbon.

The equation for the reaction is:

$$Fe_2O_3 + 3\ C \rightarrow 2\ Fe + 3\ CO$$

(a) Which substance in the equation is reduced?

Give **one** reason for your answer.

Answer in terms of oxygen.

Substance reduced   _____

Reason   _____

_____

(2)

(b) Which expression shows how to calculate the mass of carbon needed to produce 1 mole of iron from iron oxide?

Relative atomic mass (A_r): C = 12

Tick (✓) **one** box. **(HT only)**

$\frac{1}{3} \times 12\ g$ ☐

$\frac{3}{2} \times 12\ g$ ☐

$1 \times 12\ g$ ☐

$3 \times 12\ g$ ☐

(1)

A student investigated displacement reactions of four different metals represented by **A**, **B**, **C** and **D**.

A, **B**, **C** and **D** are **not** the actual chemical symbols for the metals.
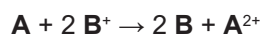
The student:

- added each metal to aqueous solutions of the metal nitrates
- observed whether a reaction took place.

The table below shows information about three of the reaction mixtures.

Reaction	Metal	Metal nitrate solution	Equation
1	**A**	**B**NO_3	**A** + 2**B**NO_3 → 2**B** + **A**$(NO_3)_2$
2	**C**	**A**$(NO_3)_2$	2**C** + 3**A**$(NO_3)_2$ → 3**A** + 2**C**$(NO_3)_3$
3	**C**	**D**$(NO_3)_2$	no reaction

(c)   The ionic equation for **Reaction 1** is:

$$\textbf{A} + 2\,\textbf{B}^+ \rightarrow 2\,\textbf{B} + \textbf{A}^{2+}$$

Why is this a redox reaction? **(HT only)**

Tick (✓) **one** box.

A gains electrons and **B**$^+$ loses electrons.	☐
A loses electrons and **B**$^+$ gains electrons.	☐
Both **A** and **B**$^+$ gain electrons.	☐
Both **A** and **B**$^+$ lose electrons.	☐

(1)

(d)   Which of the four metals has the greatest tendency to form positive ions?

Use the table above.

Tick (✓) **one** box.

A ☐   **B** ☐   **C** ☐   **D** ☐

(1)

(e) The nitrate ion has the formula NO_3^-

Which of the four metals could be aluminium?
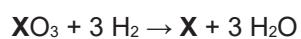
Explain your answer.

Use the table above.

Metal _____

Explanation _____

_____

_____

_____

(3)

(f) Metal **X** is extracted from an oxide of metal **X** by reaction with hydrogen.

The equation for the reaction is:

$$XO_3 + 3\,H_2 \rightarrow X + 3\,H_2O$$

The percentage atom economy for obtaining metal **X** by this method is 77.3%.

Calculate the relative atomic mass (Ar) of metal **X**. **(chemistry only)**

Relative atomic masses (A_r): H = 1   O = 16

_____

_____

_____

_____

_____

_____

_____

_____

Relative atomic mass (A_r) = _____

(4)

(Total 12 marks)