

5 Manganese is the element with atomic number 25 in the Periodic Table.  
 Calcium is the element with atomic number 20 in the Periodic Table.

(a) Complete Table 5.1 to show the number of protons, neutrons and electrons in the  $^{55}\text{Mn}$  atom and the  $^{42}\text{Ca}^{2+}$  ion.

Table 5.1

	$^{55}\text{Mn}$	$^{42}\text{Ca}^{2+}$
protons		
neutrons		
electrons		

[3]

(b) Manganese forms several oxides. The formulae of some of these oxides are shown.

- MnO**  
**Mn<sub>2</sub>O<sub>3</sub>**  
**Mn<sub>3</sub>O<sub>4</sub>**  
**MnO<sub>2</sub>**  
**Mn<sub>2</sub>O<sub>7</sub>**

(i) Suggest why manganese is expected to form coloured oxides.

..... [1]

(ii) State which other property of manganese is shown by the formation of several oxides.

..... [1]

(iii) State the formula of manganese(II) oxide.

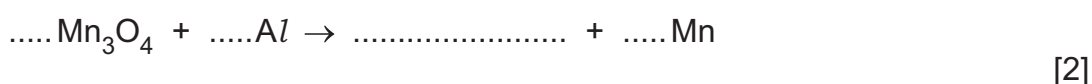
..... [1]

(c)  $\text{Mn}_3\text{O}_4$  is found in an ore of manganese. Manganese metal can be extracted from  $\text{Mn}_3\text{O}_4$  using aluminium as the reducing agent.

(i) Define the term reducing agent.

.....  
 ..... [2]

(ii) Complete the symbol equation by inserting the formula of the missing product and balancing the equation.



(d)  $\text{MnO}_2$  reacts with dilute hydrochloric acid as shown in the equation.



(i) Calculate the volume of chlorine gas formed, in  $\text{cm}^3$ , at r.t.p. when excess  $\text{MnO}_2$  reacts with  $50.0\text{cm}^3$  of  $0.200\text{mol/dm}^3$   $\text{HCl}$ .

Use the following steps.

- Calculate the number of moles of  $\text{HCl}$  used.

..... mol

- Determine the number of moles of  $\text{Cl}_2$  formed.

..... mol

- Calculate the volume of  $\text{Cl}_2$  formed.

.....  $\text{cm}^3$   
 [3]

(ii) Describe a test for chlorine gas.

test .....

observations ..... [1]

(iii) Explain, in terms of collision theory, why decreasing the temperature decreases the rate of this reaction.

.....  
 .....  
 .....  
 .....  
 ..... [3]