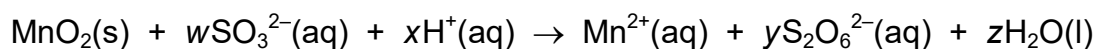
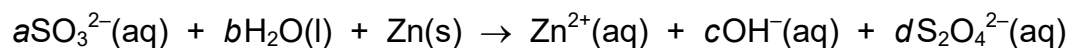


9 Sulfite ions, SO_3^{2-} , react separately with zinc and with manganese dioxide.

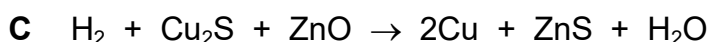
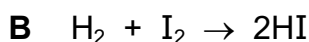
a , b , c , d , w , x , y and z are all whole numbers.



Which numbers are correct for a , b , w and x ?

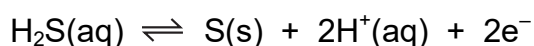
	a	b	w	x
A	1	2	2	4
B	2	2	2	4
C	1	2	4	2
D	2	2	4	2

10 Which equation shows hydrogen acting as an oxidising agent?



3 The reaction of hydrogen sulfide with sulfur dioxide gives sulfur as one of the products.

The two relevant redox equations are shown.



How many moles of hydrogen sulfide are needed to react with sulfur dioxide to produce 1 mol of sulfur?

A $\frac{1}{3}$ mol

B $\frac{2}{3}$ mol

C $\frac{3}{2}$ mol

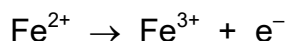
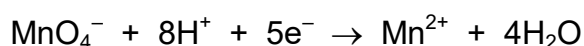
D 2 mol

11 In which substance is the average oxidation number of sulfur the highest?



11 Acidified potassium manganate(VII) reacts with iron(II) ethanedioate, FeC_2O_4 .

The reactions taking place are shown.



How many moles of iron(II) ethanedioate react with **one** mole of potassium manganate(VII)?

- A** 0.60 **B** 1.67 **C** 2.50 **D** 5.00

1 Manganese, Mn, and its compounds are widely used in many chemical reactions.

(a) Mn is usually found as a single isotope, manganese-55.

(i) Determine the number of protons, neutrons and electrons in an atom of manganese-55.

number of protons neutrons electrons [1]

(ii) Define isotopes.

..... [1]

(iii) A sample of manganese from the Moon is found to contain manganese-53 in addition to manganese-55.

State the two pieces of information needed to determine the relative atomic mass, A_r , of manganese in this sample.

1 [2]
2

(b) The shorthand electronic configuration of manganese is $[\text{Ar}] 3\text{d}^5 4\text{s}^2$.

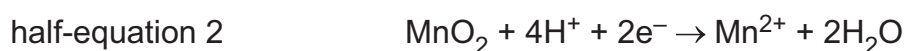
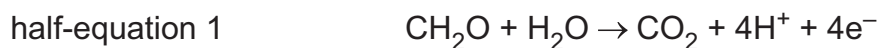
(i) Complete the full electronic configuration of manganese.

..... $3\text{d}^5 4\text{s}^2$ [1]

(ii) Deduce the total number of unpaired electrons in an atom of manganese.

..... [1]

- (c) Manganese(IV) oxide reacts with methanal, CH_2O , in acidic conditions to produce carbon dioxide. The movement of electrons to or from relevant species is shown in the following half-equations.



- (i) Identify the species that is reduced in half-equation 2. Explain your answer.

.....
..... [1]

- (ii) The oxidation state of carbon in methanal is 0.

Calculate the oxidation state of carbon in carbon dioxide.

..... [1]

- (iii) Construct the ionic equation for the reaction of manganese(IV) oxide with methanal in acidic conditions.

..... [2]

[Total: 10]

- 1** Iron is an element that is essential in the human diet. Some people need to take iron supplement tablets to ensure an adequate intake of iron.

You will investigate the mass of iron in an iron supplement tablet by titrating a solution with potassium manganate(VII).



FB 1 is an aqueous solution of iron supplement tablets made by dissolving 14 tablets in 1.00 dm^3 of solution. The iron in each tablet is iron(II) sulfate, $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$.

FB 2 is $0.0100 \text{ mol dm}^{-3}$ acidified aqueous potassium manganate(VII), KMnO_4 .

FB 3 is dilute sulfuric acid, H_2SO_4 .

(a) Method

- Fill a burette with **FB 2**.
- Pipette 25.0 cm^3 of **FB 1** into a conical flask.
- Use the 25 cm^3 measuring cylinder to add 10.0 cm^3 of **FB 3** to the conical flask.
- Perform a rough titration and record your burette readings in the space below.

The rough titre is cm^3 .

- Carry out as many accurate titrations as you think necessary to obtain consistent results.
- Make sure any recorded results show the precision of your practical work.
- Record, in a suitable form in the space below, all your burette readings and the volume of **FB 2** added in each accurate titration.

Rinse the burette with distilled water and leave to drain while you continue Question 1.

Results

I	
II	
III	
IV	
V	
VI	
VII	

[7] -

- (b)** From your accurate titration results, calculate a suitable mean value to use in your calculations. Show clearly how you obtain the mean value.

25.0 cm³ of **FB 1** required cm³ of **FB 2**. [1]

(c) Calculations

- (i)** Give your answers to **(c)(ii)**, **(c)(iii)** and **(c)(iv)** to an appropriate number of significant figures. [1]

- (ii)** Calculate the amount, in mol, of manganate(VII) ions in the volume of **FB 2** in **(b)**.

amount of MnO_4^- = mol [1]

- (iii)** Use your answer to **(c)(ii)** and the equations at the start of the question to calculate the concentration, in mol dm⁻³, of iron(II) ions in **FB 1**.

concentration of Fe^{2+} = mol dm⁻³ [1]

- (iv)** Use your answer to **(c)(iii)** to calculate the concentration, in g dm⁻³, of iron(II) ions in **FB 1**.

concentration of Fe^{2+} = g dm⁻³ [1]

- (v)** The manufacturer of the iron supplement tablets used to make **FB 1** claims that each tablet contains a minimum of 150 mg of Fe^{2+} .

Use your answer to **(c)(iv)** and the information given about **FB 1** to determine whether this claim is correct. Show your working.

[1]

- (d)** A student used all the **FB 3** and suggests that dilute hydrochloric acid would be a suitable replacement.
Suggest whether the student is correct or not. Explain your answer.

.....
.....
..... [1]