9 (a) State the electron configuration of a Ti(III) ion and that of a Ti(IV) ion. Explain, in terms of electron configurations and electron transitions, why Ti(III) compounds are usually coloured but Ti(IV) compounds are colourless.

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(5 marks)

(Extra space) .....

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Question 9 continues on the next page

9 (b) Transition metal ions and their complexes can often be identified from their colours. For each of the following, identify a complex ion responsible for the colour of the aqueous solution. Restrict your answers to complexes formed from the elements Cr, Fe, Co and Cu.

A deep blue solution formed in an excess of concentrated aqueous ammonia.

A green solution formed in an excess of aqueous sodium hydroxide.

A yellow–green solution formed in an excess of concentrated hydrochloric acid.

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(3 marks)

9 (c) An experiment is carried out to investigate the rate of the autocatalysed reaction between aqueous potassium manganate(VII) and ethanedioate ions in an excess of dilute sulfuric acid. When these reagents are mixed together, the colour of the reaction mixture gradually fades. The concentration of the manganate(VII) ions is recorded at different times using a spectrometer. The temperature of the reaction mixture is constant.

9 (c) (i) Give **two** reasons why the use of a spectrometer is the most appropriate method for measuring the concentration of the coloured ions in this experiment.

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(2 marks)

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9 (c) (ii) Sketch a curve to show how you would expect the concentration of manganate(VII) ions to change with time until the colour has faded because the concentration has reached a very low value. Explain the shape of the curve.

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(5 marks)

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END OF QUESTIONS