

3. Answer the following questions relating to Fe and its ions, Fe^{2+} and Fe^{3+} .

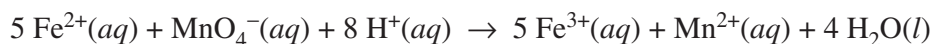
(a) Write the ground-state electron configuration of the Fe^{2+} ion.

Ion	Ionic Radius (pm)
Fe^{2+}	92
Fe^{3+}	79

(b) The radii of the ions are given in the table above. Using principles of atomic structure, explain why the radius of the Fe^{2+} ion is larger than the radius of the Fe^{3+} ion.

(c) Fe^{3+} ions interact more strongly with water molecules in aqueous solution than Fe^{2+} ions do. Give one reason for this stronger interaction, and justify your answer using Coulomb's law.

A student obtains a solution that contains an unknown concentration of $\text{Fe}^{2+}(\text{aq})$. To determine the concentration of $\text{Fe}^{2+}(\text{aq})$ in the solution, the student titrates a sample of the solution with $\text{MnO}_4^-(\text{aq})$, which converts $\text{Fe}^{2+}(\text{aq})$ to $\text{Fe}^{3+}(\text{aq})$, as represented by the following equation.



(d) Write the balanced equation for the half-reaction for the oxidation of $\text{Fe}^{2+}(\text{aq})$ to $\text{Fe}^{3+}(\text{aq})$.

(e) The student titrates a 10.0 mL sample of the $\text{Fe}^{2+}(\text{aq})$ solution. Calculate the value of $[\text{Fe}^{2+}]$ in the solution if it takes 17.48 mL of added 0.0350 M $\text{KMnO}_4(\text{aq})$ to reach the equivalence point of the titration.

To deliver the 10.0 mL sample of the $\text{Fe}^{2+}(\text{aq})$ solution in part (e), the student has the choice of using one of the pieces of glassware listed below.

- 25 mL buret
- 25 mL graduated cylinder
- 25 mL beaker
- 25 mL volumetric flask

(f) Explain why the 25 mL volumetric flask would be a poor choice to use for delivering the required volume of the $\text{Fe}^{2+}(\text{aq})$ solution.

In a separate experiment, the student is given a sample of powdered $\text{Fe}(\text{s})$ that contains an inert impurity. The student uses a procedure to oxidize the $\text{Fe}(\text{s})$ in the sample to $\text{Fe}_2\text{O}_3(\text{s})$. The student collects the following data during the experiment.

Mass of $\text{Fe}(\text{s})$ with inert impurity	6.724 g
Mass of $\text{Fe}_2\text{O}_3(\text{s})$ produced	7.531 g

(g) Calculate the number of moles of Fe in the $\text{Fe}_2\text{O}_3(\text{s})$ produced.

(h) Calculate the percent by mass of Fe in the original sample of powdered $\text{Fe}(\text{s})$ with the inert impurity.

(i) If the oxidation of the $\text{Fe}(\text{s})$ in the original sample was incomplete so that some of the 7.531 g of product was $\text{FeO}(\text{s})$ instead of $\text{Fe}_2\text{O}_3(\text{s})$, would the calculated mass percent of $\text{Fe}(\text{s})$ in the original sample be higher, lower, or the same as the actual mass percent of $\text{Fe}(\text{s})$? Justify your answer.