

Chemguide – questions

TRANSITION METALS: CHROMIUM

It is quite likely that you won't need to know all the chemistry below. Check your syllabus and past papers and concentrate on those questions that you need to be able to answer.

1. This question is mainly about the reactions of chromium(III) ions in solution.

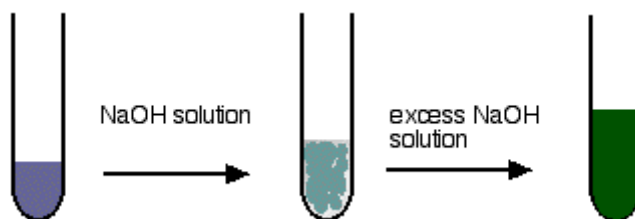
a) What sort of pH would you expect to find if you tested a solution containing chromium(III) sulphate?

b) Write an equation to show the cause of that pH.

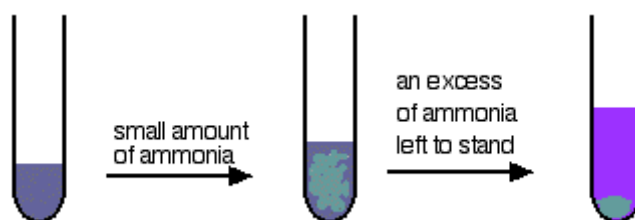
c) A solution of chromium(III) sulphate is a violet-blue-grey colour, but on heating it turns green. Explain what is happening.

d) The diagrams in this part of the question show the effect of adding various other solutions to a solution containing hexaaquachromium(III) ions. In each case, give the formula for the chromium-containing complex(es) in each tube.

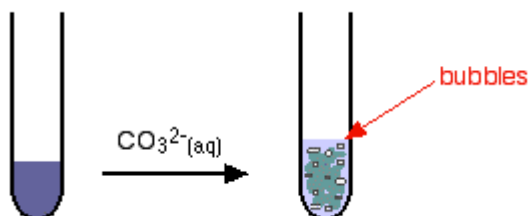
(i) addition of sodium hydroxide solution:



(ii) addition of ammonia solution:



(iii) addition of sodium carbonate solution:



e) Describe briefly how you would produce a sample of sodium chromate(VI) solution starting from a solution containing hexaaquachromium(III) ions.

Chemguide – questions

f) To convert the sodium chromate(VI) solution formed in part (e) into sodium dichromate(VI), you would first boil the solution, and then add an acid to it.

(i) Why is it necessary to boil the solution before adding the acid?

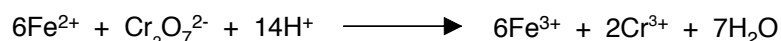
(ii) Adding the acid disturbs an equilibrium in the solution between chromate(VI) and dichromate(VI) ions. Write the equation showing that equilibrium.

(iii) Explain why adding an acid converts chromate(VI) ions into dichromate(VI) ions.

2. a) The dichromate(VI) ions in potassium dichromate(VI) are easily reduced to chromium(III) ions. Write the electron-half-equation for the reduction of dichromate(VI) ions to chromium(III) ions in acid solution. (You aren't necessarily expected to remember this – you should be able to work it out!)
- b) What colour change would you expect to see during such a reaction?
- c) One mixture which will reduce dichromate(VI) ions to chromium(III) ions is zinc and dilute sulphuric acid. Metallic zinc is oxidised to zinc ions. Write the electron-half-equation for this change.
- d) Combine your answers to parts (a) and (c) to give an ionic equation for the reaction.
- e) If air is kept out of this reaction, a further colour change happens. What is that change, and what chromium complex is present in the final solution?
3. a) If you oxidise a primary alcohol like ethanol using potassium dichromate(VI) and dilute sulphuric acid, it is possible to get one of two different products by varying the conditions of the reaction. What are the two possible products, and how do you vary the conditions in order to obtain them?
- b) In organic reactions involving oxidising agents, it is quite common to show them as equations involving [O] from the oxidising agent rather than to write the proper equation. Using this simplified form, write the equations to show the formation of the products you have mentioned in part (a).
4. Chrome alum is a double salt with the formula $\text{Cr}_2(\text{SO}_4)_3 \cdot \text{K}_2\text{SO}_4 \cdot 24\text{H}_2\text{O}$.
- a) What do you understand by the term *double salt*?
- b) You can make chrome alum by reducing potassium dichromate(VI) acidified with sulphuric acid using ethanol, because that produces the two parts of the salt in exactly the right proportions. The reaction has to be kept cold throughout. Why?

Chemguide – questions

5. a) Potassium dichromate(VI) is used in redox titrations because it is a primary standard. What do you understand by the term *primary standard*?
- b) Potassium manganate(VII) is another compound which can be used in redox titrations, and can be used, for example, to find the concentration of iron(II) ions in iron(II) sulphate. But it can't be used with iron(II) chloride, whereas potassium dichromate(VI) can be used for either. Explain why there is a difference.
- c) What is the disadvantage of using potassium dichromate(VI) in titrations compared to potassium manganate(VII)?
- d) The equation for the oxidation of Fe²⁺ ions by dichromate(VI) ions is



25 cm³ of a solution containing iron(II) ions was pipetted into a flask, and a quantity of dilute sulphuric acid was added together with a suitable indicator. The mixture required 23.1 cm³ of 0.0170M potassium dichromate(VI) solution to reach the end point.

Calculate the molar concentration of the iron(II) ions.

(I know this wasn't specifically dealt with on the Chemguide page, but by the time you get to this topic, you really should be able to do trivial calculations like this almost without thinking about it. If you can't, get it sorted!)

6. You can test for chromate(VI) ions in a solution by adding barium chloride solution or lead(II) nitrate solution. In each case, write down what you would see, and write the ionic equation for the reaction.