Phosphate by molybdate assay

Student worksheet

Principle

Phosphate(V) ions react with ammonium molybdate to produce a coloured complex. The reaction is carried out in an acidic solution containing excess ascorbic acid (vitamin C) to prevent the complex from slowly oxidising.

You can use this reaction for the quantitative analysis of low concentrations of PO_4^{3-} ions in solution. You can also use simple colour matching although the results will be less precise.

Equipment and materials

- Burette
- 100 cm^3 conical flask x 7 (or use one, thoroughly washing it between samples)
- 10 cm^3 pipette
- 5 cm^3 pipette
- 1 cm^3 pipette
- Small spatula
- Bunsen burner, tripod and gauze
- Colorimeter and suitable filter (orange/red) - a solution of the complex displays maximum absorption at 650 nm
- 100 cm^3 volumetric flask x 7 (or use one, thoroughly washing it between samples)
- Ammonium molybdate solution (7 cm^3)
- Ascorbic acid (vitamin C) (7 small spatula measures)
- Potassium dihydrogenphosphate(V) solution containing 0.1 g dm^{-3} phosphorus as phosphate(V) (100 ppm) (52.5 cm^3)
- Solution of unknown phosphorus concentration (5 cm^3)

Method

Care: Wear eye protection. Ammonium molybdate solution is an irritant.

1. Fill a burette with the standard potassium dihydrogenphosphate(V) solution containing 0.1 g dm^{-3} phosphorus as phosphate(V) (100 ppm).
2. Label six 100 cm^3 volumetric flasks A-F (or use one, thoroughly washing it between samples).

   Add the volumes of phosphate solution shown in the table, making the solution up to the mark with deionised water:

Volumetric flask	**A**	**B**	**C**	**D**	**E**	**F**
Volume of standard phosphate solution / cm^3	15.0	12.5	10.0	7.5	5.0	2.5
ppm phosphorus	15.0	12.5	10.0	7.5	5.0	2.5

3. Using pipettes, add 5 cm^3 of the 15 ppm phosphorus solution, 10 cm^3 of deionised water and 1 cm^3 of ammonium molybdate solution into a 100 cm^3 conical flask.
4. Add a small spatula measure of ascorbic acid crystals to the flask.
5. Slowly bring the mixture to the boil (a deep blue/green colour should develop) and then allow it to cool.
6. Measure the absorbance of the solution.

7. Repeat the procedure for the solutions containing 12.5, 10.0, 7.5, 5.0, 2.5 ppm phosphorus and for the solution in which the concentration of phosphorus is unknown.
8. Plot a graph of absorbance (*y* axis) against phosphorus concentration (in ppm) (*x* axis) for the remaining five samples.
9. Use the graph to find the concentration of phosphate(V) as ppm phosphorus in the unknown.