Real AP Past Papers with Multiple-Choice Questions

1. 2.54 g of beryllium chloride are completely dissolved into 50.00 mL of water inside a beaker.

(a) Draw a particulate representation of all species in the beaker after the solute has dissolved. Your diagram should include at least one beryllium ion, one chloride ion, and four water molecules. Make sure the atoms and ions are correctly sized and oriented relative to each other.

(b) What is the concentration of beryllium and chloride ions in the beaker?

A solution of 0.850 *M* lead nitrate is then titrated into the beaker, causing a precipitate of lead (II) chloride to form.

(c) Identify the net ionic reaction occurring in the beaker.

(d) What volume of lead nitrate must be added to the beaker to cause the maximum precipitate formation?

(e) What is the theoretical yield of precipitate?

(f) Students performing this experiment suggested the following techniques to separate the precipitate from the water. Their teacher rejected each idea. Explain why the teacher may have done so, and name the inherent errors of

(i) boiling off the water

(ii) decanting (pouring off) the water

Show Answer

2. Hydrogen peroxide, H_2O_2, is a common disinfectant. Pure hydrogen peroxide is a very strong oxidizer, and as such, it is diluted with water to low percentages before being bottled and sold. One method to determine the exact concentration of H_2O_2 in a bottle of hydrogen peroxide is to titrate a sample with a solution of acidified potassium permanganate. This causes the following redox reactions to occur:

Reduction: $8H^+ + MnO_4^- + 5e^- \rightarrow Mn^{2+} + 4H_2O(l)$

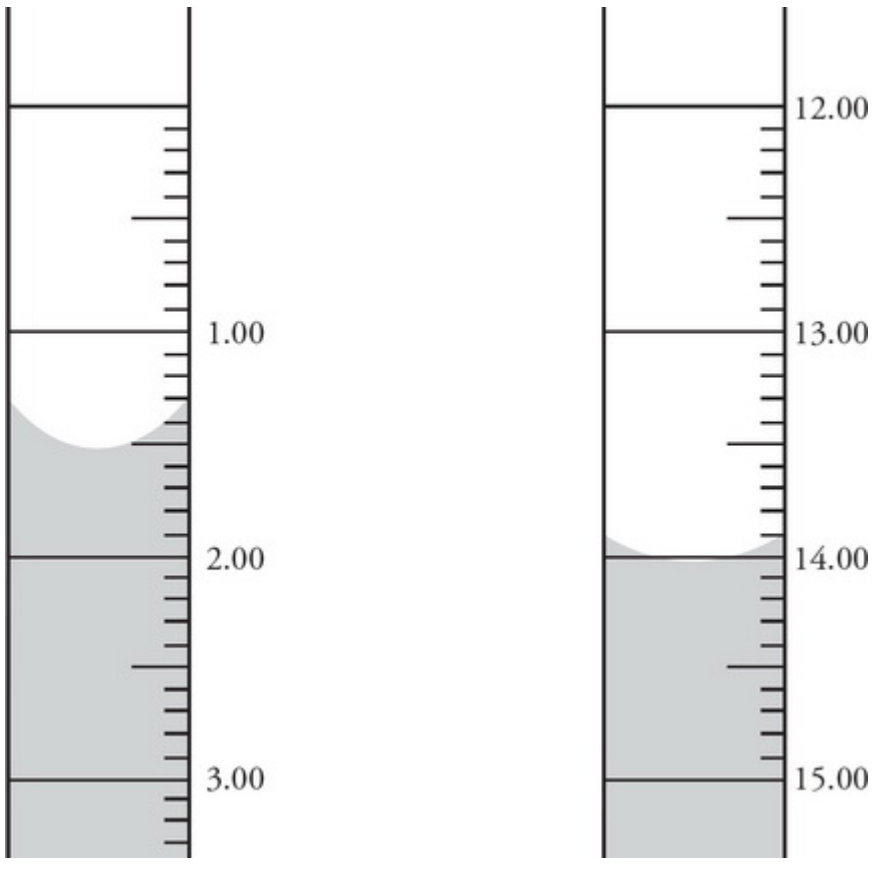
Oxidation: $H_2O_2(aq) \rightarrow 2H^+ + O_2(g) + 2e$

During a titration, a student measures out 5.0 mL of hydrogen peroxide solution into a graduated cylinder, and he pours it into a flask, diluting it to 50.0 mL with water. The student then titrates 0.150 *M* potassium permanganate solution into the flask with constant stirring.

(a) Write out the full, balanced redox reaction that is taking place during the titration.

(b) List two observations that the student will see as the titration progresses that are indicative of chemical reactions.

Diagrams of the permanganate in the buret at the start and end of the titration are as follows:



(c) (i) What volume of $KMnO_4$ was titrated?

(ii) What is the concentration of hydrogen peroxide in the original sample?

(d) How would the precision of the student's results have changed if the hydrogen peroxide sample were measured out in a 50 mL beaker instead of a graduated cylinder?

(i) Not filling the buret tip with solution prior to the titration

(ii) Not rinsing down the sides of the flask during titration

Show Answer

3. The **<u>unbalanced</u>** reaction between potassium permanganate and acidified iron (II) sulfate is a redox reaction that proceeds as follows:

$$H^+(aq) + Fe^{2+}(aq) + MnO_4^-(aq) \rightarrow Mn^{2+}(aq) + Fe^{3+}(aq) + H_2O(l)$$

(a) Provide the equations for both half-reactions that occur below:

(i) Oxidation half-reaction

(ii) Reduction half-reaction

(b) What is the balanced net ionic equation?

A solution of 0.150 *M* potassium permanganate is placed in a buret before being titrated into a flask containing 50.00 mL of iron (II) sulfate solution of unknown concentration. The following data describes the colors of the various ions in solution:

Ion	Color in solution
H^+	Colorless
Fe^{2+}	Pale Green
MnO_4^-	Dark Purple
Mn^{2+}	Colorless
Fe^{3+}	Yellow
K^+	Colorless
SO_4^{2-}	Colorless

(c) Describe the color of the solution in the flask at the following points:

(i) Before titration begins

(ii) During titration prior to the endpoint

(iii) At the endpoint of the titration

(d) (i) If 15.55 mL of permanganate are added to reach the endpoint, what is the initial concentration of the iron (II) sulfate?

(ii) The actual concentration of the $FeSO_4$ is 0.250 *M*. Calculate the percent error.

(e) Could the following errors have led to the experimental result deviating in the direction that it did? You must justify your answers quantitatively.

(i) 55.0 mL of $FeSO_4$ was added to the flask prior to titration instead of 50.0 mL.

(ii) The concentration of the potassium permanganate was actually 0.160 *M* instead of 0.150 *M*.