AP® Chemistry (Operational)
2004 Sample Student Responses

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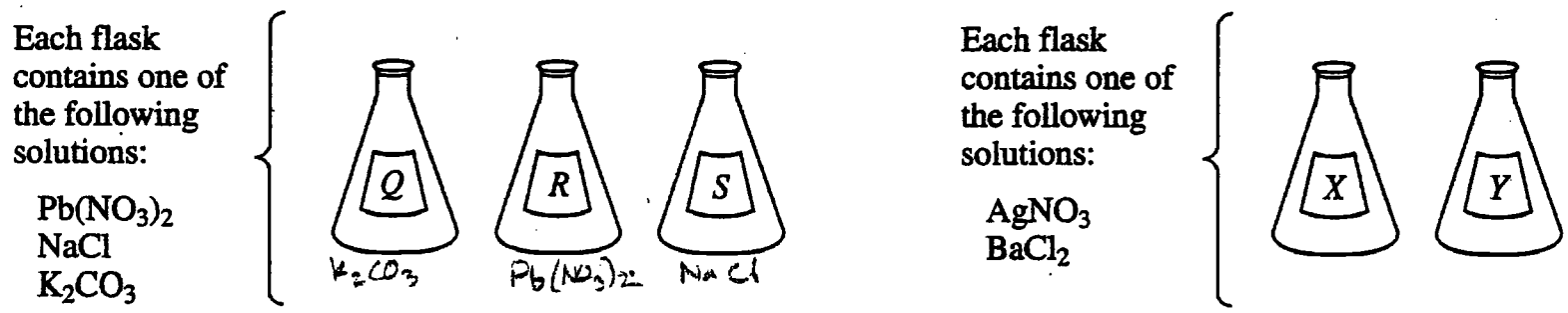
Your responses to the rest of the questions in this part of the examination will be graded on the basis of the accuracy and relevance of the information cited. Explanations should be clear and well organized. Examples and equations may be included in your responses where appropriate. Specific answers are preferable to broad, diffuse responses.

Answer BOTH Question 5 below AND Question 6 printed on page 22. Both of these questions will be graded. The Section II score weighting for these questions is 30 percent (15 percent each).

5. In a laboratory class, a student is given three flasks that are labeled Q, R, and S. Each flask contains one of the following solutions: 1.0 M $Pb(NO_3)_2$, 1.0 M NaCl, or 1.0 M K_2CO_3. The student is also given two flasks that are labeled X and Y. One of these flasks contains 1.0 M $AgNO_3$, and the other contains 1.0 M $BaCl_2$. This information is summarized in the diagram below.



(a) When the student combined a sample of solution Q with a sample of solution X, a precipitate formed. A precipitate also formed when samples of solutions Q and Y were combined.

(i) Identify solution Q.

(ii) Write the chemical formulas for each of the two precipitates.

(b) When solution Q is mixed with solution R, a precipitate forms. However, no precipitate forms when solution Q is mixed with solution S.

(i) Identify solution R and solution S.

(ii) Write the chemical formula of the precipitate that forms when solution Q is mixed with solution R.

(c) The identity of solution X and solution Y are to be determined using only the following solutions: 1.0 M $Pb(NO_3)_2$, 1.0 M NaCl, and 1.0 M K_2CO_3.

(i) Describe a procedure to identify solution X and solution Y.

(ii) Describe the observations that would allow you to distinguish between solution X and solution Y.

(iii) Explain how the observations would enable you to distinguish between solution X and solution Y.

a) (i) Solution Q is K_2CO_3

(ii) Ag_2CO_3
$BaCO_3$

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ADDITIONAL PAGE FOR ANSWERING QUESTION 5.

b) (i) Solution R is $Pb(NO_3)_2$
Solution S is NaCl

(ii) $PbCO_3$

c) (i) Mix solution S (NaCl) with aliquots of both Solution X and solution Y in separately labeled beakers.

(ii) One of these reactions will form a precipitate, the other will not

(iii) The precipitate formed will be $AgCl(s)$, From the reaction of solutions S and $AgNO_3$. Thus, the beaker with the precipitate is $AgNO_3$ and the other one is $BaCl_2$

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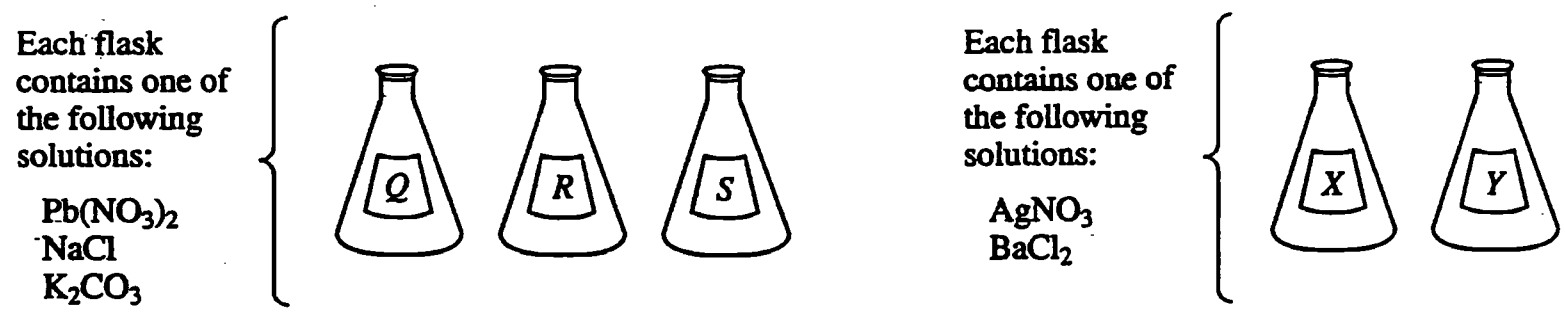

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a)(i) solution Q is NaCl

(ii) $NaCl + AgNO_3 \rightarrow NaNO_3 + AgCl(s)$

$Cl^- + Ag^+ \rightarrow AgCl(s)$

$Cl^- + Ba^{+2} \rightarrow BaCl_2(s)$

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ADDITIONAL PAGE FOR ANSWERING QUESTION 5.

b)(i) R = $Pb(NO_3)_2$ S = K_2CO_3

(ii) $Cl^- + Pb^{+2} \rightarrow PbCl_2(s)$

c)(i) The $Pb(NO_3)_2$ could be combined with X and then Y. If no precipitate forms in one of the solutions that one is the $AgNO_3$ because the reaction between $AgNO_3$ and $Pb(NO_3)_2$ would produce two soluble substances.

(ii) No precipitate in one would mean that one was $AgNO_3$ because the reaction would produce two soluble substances. And the other would therefore be $BaCl_2$.

(iii) The observations would allow me to see that in one two NO_3 substances are produced and they would dissolve in the solution, and the other would produce $PbCl_2$ precipitate.

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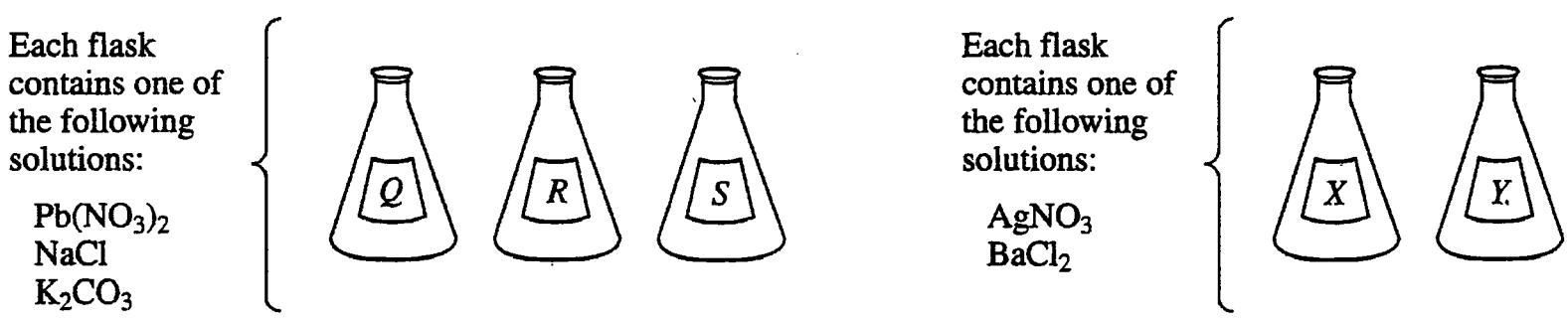

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5.a) i) $Q = K_2CO_3$

ii) $K^+ + CO_3^{-2}{}_{(aq)} + Ag^+ + NO_3^-{}_{(aq)} \rightarrow K^+ + NO_3^- + Ag_2CO_{3(s)}$

$K^+ + CO_3^{-2} + Ba^{+2} + Cl^- \rightarrow K^+ + Cl^- + BaCO_{3(s)}$

GO ON TO THE NEXT PAGE.

ADDITIONAL PAGE FOR ANSWERING QUESTION 5.

b) i) R = $Pb(NO_3)_2$

S = NaCl

ii) $K^+ + CO_3^{-2} + Pb^{+2} + NO_3^- \rightarrow K^+ + NO_3^- + PbCO_3$

c) i) mix each flask ~~separated~~ with $Pb(NO_3)_2$, NaCl, and K_2CO_3 in different containers for each mixture. First mix flask X with $Pb(NO_3)_2$ then flask Y. Then mix NaCl with X, then Y. Then mix flask X with K_2CO_3, Then mix flask Y.

ii) The observations would make either a precipite or just a solution. The observations of a solid or even a gas would help to distinguish. If it just created a solution then the observation wouldn't necessarily help except to know that the solution did not change form

iii) If the observation for either flask had a precipitate when mixed with NaCl then the flask would hold either Pb^{+2}, Hg^{+2} or Ag^+ since Cl is not soluble with these if a ppt was formed when mixed with $Pb(NO_3)_2$ Then Cl^-, Br^-, SO_4^{-2} I^-, would be part of the solution. If K_2CO_3 formed a ppt then it could be anything except alkeline metal and NH_4^+.

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