

2024



AP[®] Chemistry

Sample Student Responses and Scoring Commentary

Inside:

Free-Response Question 7

- Scoring Guidelines**
- Student Samples**
- Scoring Commentary**

Question 7: Short Answer**4 points**

(a) For the correct calculated value: **1 point**

$$0.1000 \text{ L} \times \frac{0.340 \text{ mol}}{1 \text{ L}} \times \frac{58.44 \text{ g}}{1 \text{ mol}} = 1.99 \text{ g NaCl}$$

(b) For a correct description of step 2: **1 point**

Combine the solid NaCl and some distilled water in a 100.0 mL volumetric flask.

For a correct description of step 4: **1 point**

Fill the volumetric flask with distilled water to the calibration (100.0 mL) mark.

Total for part (b) 2 points

(c) For the correct prediction and a valid explanation: **1 point**

It would decrease. The solvent front will not travel as far in the second experiment, so the separation will be smaller.

Total for question 7 4 points

Question 7

Begin your response to QUESTION 7 on this page.

7. A student conducts a chromatography experiment and needs to prepare 100.0 mL of 0.340 M NaCl(aq) to use as the solvent.

(a) Calculate the mass of solid NaCl (molar mass 58.44 g/mol) needed to prepare the 100.0 mL of 0.340 M NaCl(aq).

$$0.340 \text{ M NaCl} \times \frac{.1000 \text{ L}}{1} \times \frac{58.44 \text{ g}}{1 \text{ mol}} = 1.99 \text{ g NaCl}$$

(b) In the following table, briefly list the additional steps necessary to prepare the 100.0 mL of 0.340 M NaCl(aq) solution using only materials selected from the choices given. Assume that all appropriate safety measures are already in place. Not all materials in the list may be needed.

- Solid NaCl
- Distilled water
- Weighing paper and scoop
- Balance
- 100.0 mL volumetric flask
- 50.0 mL graduated cylinder
- Pipet
- 150 mL beakers
- Chromatography paper

Step	Step Description and Materials Used
1.	Use the weighing paper and scoop to measure the correct mass of solid NaCl on the balance.
2.	Add the measured mass of solid NaCl to the 100.0 mL volumetric flask along with enough distilled water to submerge the NaCl
3.	Swirl the mixture to dissolve the solid NaCl.
4.	Continue to fill the volumetric flask with distilled water until the solution reaches the tick marks
5.	Stopper and invert the mixture several times to ensure that the mixture is homogeneous.

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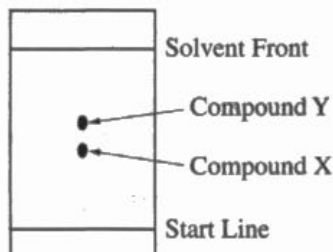
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Question 7

Continue your response to **QUESTION 7** on this page.

The student uses the $\text{NaCl}(aq)$ solvent to separate a mixture of compounds X and Y in a chromatography experiment. After 30 minutes, the student removes the chromatography paper from the chamber. The results of the experiment are shown.



- (c) A second student conducts the same chromatography experiment but removes the chromatography paper from the chamber after 15 minutes instead of 30 minutes. Predict the effect, if any, this would have on the separation distance between compounds X and Y in the new experiment. Explain your reasoning.

Compounds X and Y would be closer to one another because they would have less time to move up the paper & separate

STOP

END OF EXAM

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Question 7

Begin your response to **QUESTION 7** on this page.

7. A student conducts a chromatography experiment and needs to prepare 100.0 mL of 0.340 M NaCl(aq) to use as the solvent.

(a) Calculate the mass of solid NaCl (molar mass 58.44 g/mol) needed to prepare the 100.0 mL of 0.340 M NaCl(aq). → 0.1 L

$$(0.340 M)(0.1 L) = 0.034 \text{ mol NaCl} \left(\frac{58.44 \text{ g}}{1 \text{ mol NaCl}} \right) = \boxed{1.99 \text{ g NaCl}}$$

(b) In the following table, briefly list the additional steps necessary to prepare the 100.0 mL of 0.340 M NaCl(aq) solution using only materials selected from the choices given. Assume that all appropriate safety measures are already in place. Not all materials in the list may be needed.

- | | | |
|-------------------------|------------------------------|------------------------------|
| • Solid NaCl | • Distilled water | • Weighing paper and scoop |
| • Balance | • 100.0 mL volumetric flask | • 50.0 mL graduated cylinder |
| • Pipet | • 150 mL beakers | • Chromatography paper |

Step	Step Description and Materials Used
1.	Use the weighing paper and scoop to measure the correct mass of solid NaCl on the balance.
2.	Prepare 100.0 mL of distilled water using the 100.0 mL volumetric flask.
3.	Swirl the mixture to dissolve the solid NaCl.
4.	Pour the mixture into a 150 mL beaker to swirl and mix thoroughly.
5.	Stopper and invert the mixture several times to ensure that the mixture is homogeneous.

Use a pencil or a pen with black or dark blue ink. Do NOT write your name. Do NOT write outside the box.

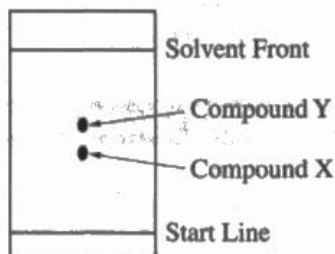
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Question 7

Continue your response to **QUESTION 7** on this page.

The student uses the $\text{NaCl}(aq)$ solvent to separate a mixture of compounds X and Y in a chromatography experiment. After 30 minutes, the student removes the chromatography paper from the chamber. The results of the experiment are shown.



- (c) A second student conducts the same chromatography experiment but removes the chromatography paper from the chamber after 15 minutes instead of 30 minutes. Predict the effect, if any, this would have on the separation distance between compounds X and Y in the new experiment. Explain your reasoning.

Removing the chromatography paper earlier would result in the distance between compound X and Y to be closer to the starting line and less separated. Without sufficient time, the mixture could not be separated thoroughly and the mixture would not travel as far on the chromatography paper.

STOP

END OF EXAM

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Question 7

Begin your response to QUESTION 7 on this page.

7. A student conducts a chromatography experiment and needs to prepare 100.0 mL of 0.340 M NaCl(aq) to use as the solvent.

(a) Calculate the mass of solid NaCl (molar mass 58.44 g/mol) needed to prepare the 100.0 mL of 0.340 M NaCl(aq).

$$0.340 \frac{\text{mol}}{\text{L}} \times 0.1 \text{ L} = 0.0340 \text{ mol NaCl} \times \frac{58.44 \text{ g}}{1 \text{ mol NaCl}} = 1.99 \text{ g}$$

(b) In the following table, briefly list the additional steps necessary to prepare the 100.0 mL of 0.340 M NaCl(aq) solution using only materials selected from the choices given. Assume that all appropriate safety measures are already in place. Not all materials in the list may be needed.

- | | | |
|-------------------------|------------------------------------|---|
| • Solid NaCl | • Distilled water | • Weighing paper and scoop |
| • Balance | • <u>100.0 mL volumetric flask</u> | • 50.0 mL graduated cylinder |
| • Pipet | • <u>150 mL beakers</u> | • Chromatography paper |

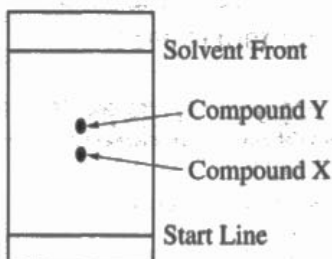
Step	Step Description and Materials Used
1.	Use the weighing paper and scoop to measure the correct mass of solid NaCl on the balance.
2.	<u>150 mL beakers</u> <u>distilled water</u>
3.	Swirl the mixture to dissolve the solid NaCl.
4.	<u>pipet</u> <u>50 mL graduated cylinder</u>
5.	Stopper and invert the mixture several times to ensure that the mixture is homogeneous.



Question 7

Continue your response to **QUESTION 7** on this page.

The student uses the $\text{NaCl}(aq)$ solvent to separate a mixture of compounds X and Y in a chromatography experiment. After 30 minutes, the student removes the chromatography paper from the chamber. The results of the experiment are shown.



- (c) A second student conducts the same chromatography experiment but removes the chromatography paper from the chamber after 15 minutes instead of 30 minutes. Predict the effect, if any, this would have on the separation distance between compounds X and Y in the new experiment. Explain your reasoning.

the only effect will be the compounds will not have climbed as high on the solvent front and a possibility for an inaccuracy

STOP

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Question 7

Note: Student samples are quoted verbatim and may contain spelling and grammatical errors.

Overview

Question 7 required students to describe how to prepare a sodium chloride solution then use this solution in a chromatography experiment. Students also are asked to predict the outcome of an experiment when a single variable is adjusted.

Part (a) asks students to calculate the mass of NaCl required to prepare a solution given the molarity and the volume. The intent of the question is to examine the ability to solve problems using mathematical relationships (Learning Objective SPQ-3.A/3.7.A, Skill 5.F from the *AP Chemistry Course and Examination Description*).

Part (b) provides students with a list of materials that they can choose from to accurately prepare a 100.0 mL NaCl solution. The intent is to demonstrate knowledge of proper laboratory technique when quantitatively preparing a standard solution (SPQ-3.A/3.7.A, 2.C).

Part (c) provides students with a diagram representing the results from a paper chromatography experiment lasting 30 minutes. Students are then to address how the separation between the spots (labeled X and Y) will change in a second experiment lasting 15 minutes (SPQ-3.C/3.9.A, 2.F).

Sample: 7A

Score: 4

The response earned 4 points. In part (a) a point was earned for correctly setting up the calculation and determining the mass of sodium chloride. In part (b) the first point was earned for stating that the solid NaCl is added to a volumetric flask with enough water to submerge the solid. The second point was earned for filling the flask to the 100 mL tick mark. In part (c) a point was earned for stating that the distance between X and Y is closer because of the decreased time allowed for the substances to move up the paper.

Sample: 7B

Score: 2

The response earned 2 points. In part (a) the point was earned for a correct calculation of the mass of sodium chloride. In part (b) the first point was not earned due to not indicating adding the solid NaCl to the flask, and the second point was not earned because the volumetric flask is not filled to the 100 mL mark after dissolving the solid. In part (c) the point was earned for stating that the distance between X and Y is closer because the “mixture would not travel as far.”

Question 7 (continued)

Sample: 7C

Score: 1

The response earned 1 point. In part (a) the point was earned for a correct calculation of the sodium chloride mass. In part (b) the first point was not earned because there is no indication of adding the solid NaCl, and the second point was not earned because volumetric glassware is not used, which precludes the ability to fill precisely to 100 mL. In part (c) the point was not earned for failing to compare the distance between X and Y in the two experiments.