2025

AP® Chemistry

Sample Student Responses and Scoring Commentary

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Free-Response Question 5

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Question 5: Short Answer — 4 points

A — **Point 01**

For the correct answer:

Tetrahedral

B — **Point 02**

For the correct answer and a valid justification:

Agree. Compound Y *has a larger, more polarizable electron cloud because the* Si *atom has more occupied electron shells than the* C *atom, giving compound* Y *stronger London dispersion forces and a higher boiling point than compound* X.

C — **Point 03**

For the correct answer and a valid justification.

Examples of acceptable responses may include the following:

- *Compound* X. *Compound* X *has weaker intermolecular forces than compound* Y, *so molecules of* X *are more likely to be in the gas phase at* 82°C *and would therefore have a higher vapor pressure.*
- *Compound* X. *At* 82°C, *compound* X *has reached its boiling point, but compound* Y *has not. Therefore, the proportion of* X *molecules in the vapor phase would be much greater than that of compound* Y, *giving compound* X *the higher vapor pressure.*

D — **Point 04**

For the correct calculated value:

$$PV = nRT$$

$$n = \frac{PV}{RT} = \frac{(2.30\text{ atm})(12.5\text{ L})}{(0.08206\frac{\text{L}\cdot\text{atm}}{\text{K}\cdot\text{mol}})(471\text{K})} = 0.744\text{ mol}$$

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

Question 5

Part A

tetrahedral because there are 4 electron domains around Si

Part B

Yes, Si has more electron shells than C, so it has a more polarizable electron cloud than C, so compound Y must be more polarizable than compound X, so compound Y will have greater london dispersion forces and a higher boiling point than compound X.

Part C

Compound X will have the higher vapor pressure because more of compound X will be in vapor form at 82°C than compound Y because compound X's boiling point is equal to 82°C and compound Y's boiling point is greater than 82°C (98°C).

Question 5 is continued on the next page.

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

Question 5

Part D

$PV = nRT$

$(2.30\ atm)(12.5\ L) = n\ (0.08206\ L\,atm\,K^{-1}\,mol^{-1})(471.15\ K)$

$n = 0.744$ moles

Continue to Question 6.

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

Question 5

Part A

Tetrahedral

Part B

Yes that is correct. Since both compounds have the same types of IMFs, the higher boiling point goes to the compound w/ the larger LDF which is directly related to the larger molar mass.

Part C

Compound X will have a higher vapor pressure when heated b/c it has weaker IMF forces leading to a lower boiling point & therefore needing less energy to vaporize thus causing the higher vapor pressure.

Question 5 is continued on the next page.

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

Question 5

Part D

$$\frac{PV = nRT}{RT}$$

$$n = \frac{(2.30\text{ atm})(12.5\text{ L})}{(.08201\text{ L atm K}^{-1}\text{ mol}^{-1})(471\text{ K})}$$

$$= .744 \text{ mols}$$

Continue to Question 6.

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

Question 5

Part A

The geometry around the atom or Si in compound Y is mostly made of 120° angles

Part B

I agree because the London dispersion forces will cause a higher boiling point the stronger they are. [illegible]

Part C

Compound X will have the greater vapor pressure because it will have reached its boiling point, while compound Y has not yet.

Question 5 is continued on the next page.

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

Question 5

Part D

74.1 g/mol + 40.2 g/mol

When the mixture is both gases, the moles of gas particles will be 164.3 mols, because they both have become gases

Continue to Question 6.

Question 5

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

Overview

NEW for 2025: The question overviews can be found in the *Chief Reader Report on Student Responses* on AP Central.

Sample: 5A
Score: 4

Point 01: 1
Part A: The point was earned for correctly identifying the geometry around the Si atom as tetrahedral.

Point 02: 1
Part B: The point was earned for stating "Yes" followed by a valid justification that "Si has more electron shells than C, so it has a more polarizable electron cloud than C, so compound Y must be more polarizable than compound X."

Point 03: 1
Part C: The point was earned for correctly choosing compound X along with a valid justification that "more of Compound X will be in vapor form at 82°C than Compound Y" along with a valid comparison of the boiling points: "Compound Y's boiling point is greater than 82°C."

Point 04: 1
Part D: The point was earned for correctly calculating the number of moles and showing the supporting setup.

Sample: 5B
Score: 3

Point 01: 1
Part A: The point was earned for correctly identifying the geometry around the Si atom as tetrahedral.

Point 02: 0
Part B: The point was not earned because the response attributes the larger London dispersion forces to the "larger molar mass" rather than the larger, more polarizable electron cloud.

Point 03: 1
Part C: The point was earned for correctly choosing compound X along with a valid justification that compound X has "weaker IMF forces" leading to a lower boiling point and higher vapor pressure. The justification is valid for all temperatures, including 82°C.

Point 04: 1
Part D: The point was earned for correctly calculating the number of moles and showing the supporting setup. The incorrect value of R (0.08201 instead of 0.0821 or 0.08206) does not affect the calculated value of n when the correct kelvin temperature is used and the answer is reported to three significant figures.

Question 5 (continued)

Sample: 5C
Score: 1

Point 01: 0
Part A: The point was not earned because the response does not identify the geometry around the Si atom as tetrahedral.

Point 02: 0
Part B: The point was not earned. While the response correctly agrees with the claim, it does not provide a justification.

Point 03: 1
Part C: The point was earned for correctly identifying that compound X has the greater vapor pressure because it has reached its boiling point, while compound Y has not yet reached its boiling point.

Point 04: 0
Part D: The point was not earned because the response does not demonstrate a correct calculation for the moles of gas in the container. The response adds the molar masses.