CONCEPT 3: ORIGIN OF THE MOTION OF PARTICLES (worth a maximum of 5 pts)

This part of the scoring scheme assesses student's assumptions about the origin of the perfume particles' motion (i.e., why do the perfume molecules move?).

Score	0	1
Student's Assumption	**Not Coherent**	**Motion of molecules is caused by external forces:** Student assumes that external forces are the cause of particles movement
Indicators	Student does not express any relevant information or the expression is so confusing as to be uninterpretable Student writes: "I don't know" Irrelevant answer Incomprehensible answer	Student explains through drawings and/or words that **external forces/agents outside of the perfume molecules cause the perfume molecules to move.** *Possible types of external forces (*any of the following; *this list is not inclusive) - usually found in answers to question 1c*: - **air current, wind**: student draws fans, windows, circular motion in the room, and/or writes that temperature makes the AIR molecules go faster and therefore the perfume moves faster - **inhaling/breathing:** student explains that inhaling air through the nose attracts the molecules and thus makes them move toward the nose - **diffusion**: diffusion is considered as a force that pushes molecules from one area of the room to another - **difference in concentration**: student writes that molecules need/have to go from an area of higher concentration to an area of lower concentration - **lack of containment AND external forces involvement**: student writes that since perfume molecules are not confined to the perfume bottle they can move because they are picked up by the air - **Heat is considered as a force:** student writes that heat puts pressure on the molecules *Types of agents (*any of the following; *this list is not inclusive) - usually found in answers to question 1c*: - **Other molecules:** collisions with other molecules push the perfume molecules (similar to Air Hockey where the air molecules are your hand) **OR** collisions with other molecules give energy to the perfume molecules to move **OR** Student writes in 1c that motion comes from kinetic energy but fails to explicitly recognize the relationship between kinetic energy and speed of molecules

Descriptions of scores 2 and 3 on the next page

Score	2	3
Student's Assumption	**Molecules' motion is conditioned by certain properties or features of the substance but external forces are the main agent of movement:** Student recognizes implicitly that molecules move but still mentions an external force as the cause of movement	**Molecules' motion is conditioned by certain properties or features of the substance**: Student expresses the idea that molecules move by themselves but does not explicitly say that they are in constant motion
Indicators	Student states **explicitly** that **external forces/agents outside of the perfume molecules cause them to move** (see score 1 for examples of external forces) **AND** **implicitly** recognizes that the **molecules of perfume move by themselves** by (any of the following; *this list is not inclusive*): - writing in 2c that an **increase in temperature or higher temperatures** results in <u>higher kinetic energy</u> and/or increase in the <u>speed of the perfume molecules</u> - saying that molecules takes longer to go through <u>dense air.</u> - writing in 3c that molecules <u>with less mass</u> move faster **OR** explains (usually in question 1c) that molecules move **because** of some **properties/ features** of the substance. <u>*Possible Features*</u> *(*any of the following; *this list is not inclusive):* - molecules are in the **gas phase** - molecules have certain **atoms** that allows them to move - molecules have something **within/about themselves** that makes them move (size, electrons, weight, size, etc.) - molecules have a **natural tendency/want** to move - phase change (vaporization) causes the molecules to move **AND** **does not explicitly** say that molecules are in constant motion	Student **explicitly** recognizes that the **molecules of perfume move by themselves** by *(*any of the following; *this list is not inclusive):* - writing that **perfume molecules move** in several questions - writing in 2c that an **increase in temperature or higher temperatures** results in <u>higher kinetic energy</u> and/or increase in the <u>speed of the perfume molecules</u> - writing in 3c that molecules <u>with less mass</u> move faster **AND** explains (usually in question 1c) that molecules move **because** of some **properties/ features** of the substance (see score 2 for examples of features). **AND** **does not explicitly** say that molecules are in **constant motion**.

Descriptions of scores 4 and 5 on the next page

CONCEPT 3: ORIGIN OF THE MOTION OF PARTICLES (worth a maximum of 5 pts)

Score	4	5
Student's Assumption	**Molecules' motion is conditioned by certain properties or features of the substance** **AND** **Molecules are always in motion**	**Molecules are always in motion**: Student explicitly recognizes that molecules' motion is an intrinsic property of the molecules
Indicators	Student **explicitly** recognizes that the **molecules of perfume move by themselves** by *(*any of the following; *this list is not inclusive):* - writing that **perfume molecules move** in several questions - writing in 2c that an **increase in temperature or higher temperatures** results in <u>higher kinetic energy</u> and/or increase in the <u>speed of the perfume molecules</u> - writing in 3c that molecules <u>with less mass</u> move faster **AND** explains (usually in question 1c) that molecules move **because** of some **properties/ features** of the substance (see score 2 for examples of features). **AND** **explicitly** says that molecules are in **constant motion**.	Student **explicitly** recognizes that the **molecules of perfume move by themselves** by (any of the following; *this list is not inclusive*): - writing in 2c that an **increase in temperature or higher temperatures** results in <u>higher kinetic energy</u> and/or increase in the <u>speed of the perfume molecules</u> - writing in 3c that molecules <u>with less mass</u> move faster **AND** **explicitly** says that molecules are in **<u>constant motion</u>** **BUT** **<u>does not</u>** think that molecules move **because** of some **properties/ features** of the substance (see score 2 for examples of features).