Chapter 5 Review Problems

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Go to first question

5.1) As the temperature of a substance increases, ____.

a) the velocity of particles that make up the substance increases

b) the velocity of particles that make up the substance decreases

c) there is no change in the velocity of the particles that make up the substance.

Go back

Click here for a **hint**

Click here to **check your answer**

Go to next question

5.1) As the temperature of a substance increases, ______________________________________.

a) the velocity of particles that make up the substance increases

b) the velocity of particles that make up the substance decreases

c) there is no change in the velocity of the particles that make up the substance.

HINT:

Kinetic energy is *the energy of* **motion**. Whenever matter is moving, it has kinetic energy. Kinetic energy can be thought of as the energy of the **motion of atoms or ions.**

You can think of **temperature** as being a measure of how **fast** the atoms, ions, or molecules in a substance are moving.

For more help: See chapter 5 part 1 video or chapter 5 section 2 in the textbook.

Go back

Click here to **check your answer**

Go to next question

5.1) As the temperature of a substance increases, ______________________________________.

[✓ a) the velocity of particles that make up the substance increases]

b) the velocity of particles that make up the substance decreases

c) there is no change in the velocity of the particles that make up the substance.

EXPLANATION:

Kinetic energy is *the energy of* **motion**. Whenever matter is moving, it has kinetic energy. Kinetic energy can be thought of as the energy of the **motion of atoms or ions.**

You can think of **temperature** as being a measure of how **fast** the atoms, ions, or molecules in a substance are moving.

More Kinetic Energy = More Atomic Motion = Higher Temperature

For more details: See chapter 5 part 1 video or chapter 5 section 2 in the textbook.

Go back

Go to next question

5.2) The boiling point of a substance is the temperature at which the substance boils (liquid becomes gas). The noncovalent interactions between *pentane* molecules are stronger than the noncovalent interactions between *butane* molecules. Which of the following statements would you expect to be true?

a) *butane* has a greater boiling point than *pentane*.

b) *pentane* has a greater boiling point than *butane*.

c) *pentane* and *butane* have at the same boiling point.

Go back

Click here for a **hint**

Click here to **check your answer**

Go to next question

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a) *butane* has a greater boiling point than *pentane*.

b) *pentane* has a greater boiling point than *butane*.

c) *pentane* and *butane* have at the same boiling point.

HINT:

Stronger noncovalent interactions = greater melting/boiling points.

Whether a molecular compound exists in the gas, liquid, or solid phase is determined by a ***competition*** between *noncovalent interactions* (working to keep the molecules close to one another) and *temperature* (kinetic energy working to separate the particles).

For more help: See chapter 5 part 1 video or chapter 5 section 2 in the textbook.

Go back

Click here to **check your answer**

Go to next question

5.2) The boiling point of a substance is the temperature at which the substance boils (liquid becomes gas). The noncovalent interactions between *pentane* molecules are stronger than the noncovalent interactions between *butane* molecules. Which of the following statements would you expect to be true?

a) *butane* has a greater boiling point than *pentane*.

[✓ b) *pentane* has a greater boiling point than *butane*.]

c) *pentane* and *butane* have at the same boiling point.

EXPLANATION:

Stronger noncovalent interactions = greater melting/boiling points.

Whether a molecular compound exists in the gas, liquid, or solid phase is determined by a ***competition*** between *noncovalent interactions* (working to keep the molecules close to one another) and *temperature* (kinetic energy working to separate the particles).

Because the *noncovalent interactions* between pentane molecules are stronger than those between butane molecules, pentane has the greater (higher) boiling point.

For more details: See chapter 5 part 1 video or chapter 5 section 2 in the textbook.

Go back

Go to next question

5.3) The two energy units that you will use in this course are the **calorie** (cal) and the **Joule** (J).

a) Convert 56.2 Joules to calories.

b) Convert 0.023 calories to Joules.

Go back

Click here for a **hint**

Click here to **check your answer**

Go to next question

5.3) The two energy units that you will use in this course are the **calorie** (cal) and the **Joule** (J).

a) Convert 56.2 Joules to calories.

b) Convert 0.023 calories to Joules.

HINT: These are **unit conversion problems**.

1 calorie is equal to exactly 4.184 Joules.

Use this relationship as a *conversion factor*.

For more help: See chapter 5 part 1 video or chapter 5 section 2 in the textbook.

Go back

Click here to **check your answer**

Go to next question

5.3) The two energy units that you will use in this course are the **calorie** (cal) and the **Joule** (J).

a) Convert 56.2 Joules to calories. **ANSWER: 13.4 cal (three significant figures)**

b) Convert 0.023 calories to Joules. **ANSWER: 0.096 J (two significant figures)**

CLICK HERE to see the **complete solution** for this problem

Go back

Go to next question

5.3) The two energy units that you will use in this course are the **calorie** (cal) and the **Joule** (J).

a) Convert 56.2 Joules to calories. **ANSWER: 13.4 call (three significant figures)**

$$\frac{56.2\ \cancel{J}}{} \left| \frac{1\ \text{cal}}{4.184\ \cancel{J}} \right| = 13.4\ \text{cal}$$

b) Convert 0.023 calories to Joules. **ANSWER: 0.096 J (two significant figures)**

$$\frac{0.023\ \cancel{\text{cal}}}{} \left| \frac{4.184\ \text{J}}{1\ \cancel{\text{cal}}} \right| = 0.096\ \text{J}$$

EXPLANATION: These are **unit conversion problems**. 1 calorie is equal to exactly 4.184 Joules; this relationship is used as a *conversion factor*.

For more details: See chapter 5 part 1 video or chapter 5 section 2 in the textbook.

Go back

Go to next question

5.4) Nutritionists and food-labeling practices use the “food Calorie” notation with capital “C” in the spelling and unit. A “food “Calorie” is equal to 1000 calories (1 Cal = 1000 cal). A glass of wine contains about 123,000 calories; how may “food Calories (Cal)” is this?

Go back

Click here for a **hint**

Click here to **check your answer**

Go to next question

5.4) Nutritionists and food-labeling practices use the “food Calorie” notation with capital “C” in the spelling and unit. A “food “Calorie” is equal to 1000 calories (1 Cal = 1000 cal). A glass of wine contains about 123,000 calories; how may “food Calories (Cal)” is this?

HINT: This is a **unit conversion problem**. 1000 cal is equal to exactly 1 Cal. Use this relationship as a *conversion factor*.

For more help: See chapter 5 part 1 video or chapter 5 section 2 in the textbook.

Go back

Click here to **check your answer**

Go to next question

5.4) Nutritionists and food-labeling practices use the “food Calorie” notation with capital “C” in the spelling and unit. A “food “Calorie” is equal to 1000 calories (1 Cal = 1000 cal). A glass of wine contains about 123,000 calories; how may “food Calories (Cal)” is this?

ANSWER: 123 Cal (three significant figures)

CLICK HERE to see the **complete solution** for this problem

Go back

Go to next question

5.4) Nutritionists and food-labeling practices use the “food Calorie” notation with capital “C” in the spelling and unit. A “food “Calorie” is equal to 1000 calories (1 Cal = 1000 cal). A glass of wine contains about 123,000 calories; how may “food Calories (Cal)” is this?

ANSWER: 123 Cal (three significant figures)

$$\begin{array}{c|c|} 123{,}000\ \cancel{\text{cal}} & 1\ \text{Cal} \\ \hline & 1000\ \cancel{\text{cal}} \end{array} = 123\ \text{Cal}$$

EXPLANATION: This is a **unit conversion problem**. 1000 cal is equal to exactly 1 Cal; this relationship is used as a *conversion factor*.

For more details: See chapter 5 part 1 video or chapter 5 section 2 in the textbook.

Go back

Go to next question

5.5) *One* of *two* things will happen if energy is added or removed from matter (assuming no chemical change takes place):

1) Change the ***phase*** of the substance.
2) Change the ***temperature*** of the substance.

a) Write the equation that describes the relationship between the *amount of energy that is added or removed from matter in order to* ***melt*** *it* and the *amount (mass) of the matter*.

b) Write the equation that describes the relationship between the *amount of energy that is added or removed from matter* and the *temperature change*.

Go back

Click here for a **hint**

Click here to **check your answer**

Go to next question

5.5) *One* of *two* things will happen if energy is added or removed from matter (assuming no chemical change takes place):

1) Change the ***phase*** of the substance.
2) Change the ***temperature*** of the substance.

a) Write the equation that describes the relationship between the *amount of energy that is added or removed from matter in order to* ***melt*** *it* and the *amount (mass) of the matter*.

HINT: $\Delta E = m \cdot ?$

b) Write the equation that describes the relationship between the *amount of energy that is added or removed from matter* and the *temperature change*.

HINT: $Q = ? \cdot ? \cdot (\Delta T)$

For more help: See chapter 5 part 2 and part 3 videos or chapter 5 section 2 in the textbook.

Go back

Click here to **check your answer**

Go to next question

5.5) *One* of *two* things will happen if energy is added or removed from matter (assuming no chemical change takes place):

1) Change the ***phase*** of the substance.
2) Change the ***temperature*** of the substance.

a) Write the equation that describes the relationship between the *amount of energy that is added or removed from matter in order to* ***melt*** *it* and the *amount (mass) of the matter*.

$$\Delta E = m \cdot (H_{fus})$$

In this equation,

- "**ΔE**" is used to represent the *energy* added or removed from a substance (or heat).
- "**m**" is the *mass* of the substance.
- "H_{fus}" is the "*heat of fusion*" of the substance.

b) Write the equation that describes the relationship between the *amount of energy that is added or removed from matter* and the *temperature change*.

$$Q = S \cdot m \cdot (\Delta T)$$

In this equation,

- "**Q**" is used to represent the *energy* added or removed from a substance (or heat).
- "**S**" is the *specific heat* of the substance.
- "**m**" is the *mass* of the substance.
- "**(ΔT)**" is the amount of the ***change in temperature*** (in °C units) that occurs when the energy is added or removed from the substance. (**ΔT**) is defined as the *final temperature* **minus** the *initial temperature* ($\Delta T = T_{final} - T_{initial}$).

For more details: See chapter 5 part 2 and part 3 videos or chapter 5 section 2 in the textbook.

Go back

Go to next question

5.6) Define the following:

a) heat of fusion ($\mathbf{H}_{fus}$)

b) heat of vaporization ($\mathbf{H}_{vap}$)

c) specific heat ($\mathbf{S}$)

Go back

Click here for a **hint**

Click here to **check your answer**

Go to next question

5.6) Define the following:

a) heat of fusion ($\mathbf{H}_{fus}$)

HINT: The *amount of* ______________ required to ______________ **one gram** of a substance.

b) heat of vaporization ($\mathbf{H}_{vap}$)

HINT: The *amount of* ______________ required to ______________ **one gram** of a substance.

c) specific heat (**S**)

HINT: The *amount of energy* that must be added (or removed) from ***one*** ______________ of a substance to result in a ______________ change of **one ^{o}C**.

For more help: See chapter 5 part 2 and part 3 videos or chapter 5 section 2 in the textbook.

Go back

Click here to **check your answer**

Go to next question

5.6) Define the following:

a) heat of fusion (**H_{fus}**)

The *amount of energy* required to ***melt*** **one gram** of a substance.

b) heat of vaporization (**H_{vap}**)

The *amount of energy* required to ***vaporize*** **one gram** of a substance.

- ***Vaporization*** is the conversion of a liquid to a gas.

c) specific heat (**S**)

The *amount of energy* that must be added (or removed) from ***one gram*** of a substance to result in a temperature change of **one °C**.

For more details: See chapter 5 part 2 and part 3 videos or chapter 5 section 2 in the textbook.

Go back

Go to next question

5.7) How much energy (calories) is required to be added to 12.5 grams of water that is initially at 27.0 ^{o}C in order to raise the temperature to 65.0 ^{o}C?

Go back

Click here for a **hint**

Click here to **check your answer**

Go to next question

5.7) How much energy (calories) is required to be added to 12.5 grams of water that is initially at 27.0 ^{o}C in order to raise the temperature to 65.0 ^{o}C?

HINT: Begin with the equation that relates the ***amount of energy*** added or removed from a substance and the ***temperature change*** is.

For more help: See chapter 5 part 2 video or chapter 5 section 2 in the textbook.

Go back

Click here to **check your answer**

Go to next question

5.7) How much energy (calories) is required to be added to 12.5 grams of water that is initially at 27.0 ^{o}C in order to raise the temperature to 65.0 ^{o}C? **ANSWER: 475 cal**

CLICK HERE to see the **complete solution** for this problem

Go back

Go to next question

5.7) How much energy (calories) is required to be added to 12.5 grams of water that is initially at 27.0 °C in order to raise the temperature to 65.0 °C? **ANSWER: 475 cal**

EXPLANATION: The equation that relates the ***amount of energy*** added or removed from a substance and the ***temperature change*** is:

$$\mathbf{Q = S \cdot m \cdot (\Delta T)}$$

The value of **S** for water is 1.000 cal/g °C.

$\mathbf{\Delta T} = \mathbf{T_{final} - T_{initial}}$
$= 65.0\ ^{o}C - 27.0\ ^{o}C$
$= 38.8\ ^{o}C$

$$\mathbf{Q} = \left(\frac{1.000\ \text{cal}}{\cancel{\text{g}}\ \cancel{^{o}\text{C}}}\right)(12.5\ \cancel{\text{g}})(38.0\ \cancel{^{o}\text{C}}) = \mathbf{475\ cal}$$

For more details: See chapter 5 part 2 video or chapter 5 section 2 in the textbook.

Go back

Go to next question

5.8) Suppose that 1450 calories of energy transferred to 75.0 grams of water. By how many °C would the temperature change? Assume that there is not a phase change, only the temperature changes.

Go back

Click here for a **hint**

Click here to **check your answer**

Go to next question

5.8) Suppose that 1450 calories of energy transferred to 75.0 grams of water. By how many °C would the temperature change? Assume that there is not a phase change, only the temperature changes.

HINT: Solve $Q = S \cdot m \cdot (\Delta T)$ for the change in temperature (ΔT).

For more help: See chapter 5 part 2 video or chapter 5 section 2 in the textbook.

Go back

Click here to **check your answer**

Go to next question

5.8) Suppose that 1450 calories of energy transferred to 75.0 grams of water. By how many °C would the temperature change? Assume that there is not a phase change, only the temperature changes.

ANSWER: The temperature would change by 19.3 °C

CLICK HERE to see the **complete solution** for this problem

Go back

Go to next question

5.8) Suppose that 1450 calories of energy transferred to 75.0 grams of water. By how many ^{o}C would the temperature change? Assume that there is not a phase change; only the temperature changes.

ANSWER: The temperature would change by 19.3 ^{o}C

EXPLANATION: You are given **Q** and **m**. You know the value of **S** for water. Solve $\mathbf{Q = S \bullet m \bullet (\Delta T)}$ for the change in temperature $\mathbf{(\Delta T)}$.

$$\mathbf{Q = S \bullet m \bullet \enclose{circle}{(\Delta T)}}$$

To solve for $\mathbf{(\Delta T)}$, divide both sides of the equation by $\mathbf{S \bullet m}$.

$$\mathbf{(\Delta T)} = \frac{\mathbf{Q}}{\mathbf{S \bullet m}} = \frac{1450\ \cancel{\text{cal}}}{\left(\dfrac{1.000\ \cancel{\text{cal}}}{\cancel{\text{g}}\ {}^{o}\text{C}}\right) 75.0\ \cancel{\text{g}}} = \mathbf{19.3\ {}^{o}C}$$

For more details: See chapter 5 part 2 video or chapter 5 section 2 in the textbook.

Go back

Go to next question

5.9) How much energy would be required to vaporize (boil) 50.0 grams of each of the following substances?

a) water

b) ethanol

c) 2-propanol

Substance	**heat of fusion (H_{fus})**	**heat of vaporization (H_{vap})**
H_2O	79.7 cal/g	540 cal/g
ethanol (ethyl alcohol)	26.05 cal/g	230 cal/g
2-propanol (rubbing alcohol)	21.37 cal/g	159 cal/g

Go back

Click here for a **hint**

Click here to **check your answer**

Go to next question

5.9) How much energy would be required to vaporize (boil) 50.0 grams of each of the following substances?

HINT: The equation that describes the relationship between the *amount of energy that is added or removed from matter in order to* ***boil*** *it* and the *amount (mass) of the matter* is: $\Delta E = m \cdot (H_{vap})$.

a) water

For more help: See chapter 5 part 3 video or chapter 5 section 2 in the textbook.

b) ethanol

c) 2-propanol

Substance	heat of fusion (H_{fus})	heat of vaporization (H_{vap})
H_2O	79.7 cal/g	540 cal/g
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Go back

Click here to check your answer

Go to next question

5.9) How much energy would be required to vaporize (boil) 50.0 grams of each of the following substances?

a) water **ANSWER: 27000 cal (two significant figures)**

b) ethanol **ANSWER: 12000 cal (two significant figures)**

Substance	**heat of fusion (H_{fus})**	**heat of vaporization (H_{vap})**
H_2O	79.7 cal/g	540 cal/g
ethanol (ethyl alcohol)	26.05 cal/g	230 cal/g
2-propanol (rubbing alcohol)	21.37 cal/g	159 cal/g

c) 2-propanol **ANSWER: 7950 cal (three significant figures)**

CLICK HERE to see the **complete solution** for this problem

Go back

Go to next question

5.9) How much energy would be required to vaporize (boil) 50.0 grams of each of the following substances?

EXPLANATION: The equation that describes the relationship between the *amount of energy that is added or removed from matter in order to **boil** it* and the *amount (mass) of the matter* is: $\Delta E = m \cdot (H_{vap})$.

Substance	heat of fusion (H_{fus})	heat of vaporization (H_{vap})
H_2O	79.7 cal/g	540 cal/g
ethanol (ethyl alcohol)	26.05 cal/g	230 cal/g
2-propanol (rubbing alcohol)	21.37 cal/g	159 cal/g

a) water **ANSWER: 27000 cal (two significant figures)**

$$\Delta E = m \cdot (H_{vap})$$

$$\Delta E = 50.0\,\cancel{g} \cdot 540\,\frac{cal}{\cancel{g}} = 27000\text{ cal}$$

Because the heat of vaporization (540 cal/g) has ***two** significant figures*, the answer will have ***two** significant figures*.

b) ethanol **ANSWER: 12000 cal (two significant figures)**

$$\Delta E = m \cdot (H_{vap})$$

$$\Delta E = 50.0\,\cancel{g} \cdot 230\,\frac{cal}{\cancel{g}} = 12000\text{ cal}$$

Because the heat of vaporization (230 cal/g) has ***two** significant figures*, the answer will have ***two** significant figures*.

c) 2-propanol **ANSWER: 7950 cal (three significant figures)**

$$\Delta E = m \cdot (H_{vap})$$

$$\Delta E = 50.0\,\cancel{g} \cdot 159\,\frac{cal}{\cancel{g}} = 7950\text{ cal}$$

The heat of vaporization (159 cal/g) has ***three** significant figures*, the answer will have ***three** significant figures*.

Go back

For more details: See chapter 5 part 3 video or chapter 5 section 2 in the textbook.

Go to next question

5.10) Would it require more energy to *melt* 10.0 grams of ice **or** to bring 10.0 grams of water that is originally at room temperature (22.0 ^{o}C) to its boiling point (100 ^{o}C)?

Go back

Click here for a **hint**

Click here to **check your answer**

Go to next question

5.10) Would it require more energy to *melt* 10.0 grams of ice **or** to bring 10.0 grams of water that is originally at room temperature (22.0 ^{o}C) to its boiling point (100 ^{o}C)?

HINT: Calculate and then compare the amount of energy required for each of these processes.

1) Energy required to *melt* 10.0 grams of ice:

2) Energy required to bring 10.0 grams of water that is originally at room temperature (22.0 ^{o}C) to its boiling point (100 ^{o}C):

For more help: See chapter 5 part 2 and part 3 videos or chapter 5 section 2 in the textbook.

Go back

Click here to **check your answer**

Go to next question

5.10) Would it require more energy to *melt* 10.0 grams of ice **or** to bring 10.0 grams of water that is originally at room temperature (22.0 °C) to its boiling point (100 °C)? **ANSWER:** It would require more energy to **melt 10.0 grams of ice.**

CLICK HERE to see the **complete solution** for this problem

Go back

Go to next question

5.10) Would it require more energy to *melt* 10.0 grams of ice **or** to bring 10.0 grams of water that is originally at room temperature (22.0 °C) to its boiling point (100 °C)? **ANSWER:** It would require more energy to **melt 10.0 grams of ice.**

EXPLANATION: Calculate and then compare the amount of energy required for each of these processes.

1) Energy required to *melt* 10.0 grams of ice:

$$\Delta E = m \cdot (H_{fus})$$

$$\Delta E = 10.0\,\cancel{g} \cdot 79.7\,\frac{cal}{\cancel{g}} = 797\ cal$$

2) Energy required to bring 10.0 grams of water that is originally at room temperature (22.0 °C) to its boiling point (100 °C):

$$Q = S \cdot m \cdot (\Delta T)$$

$$\Delta T = T_{final} - T_{initial}$$
$$= 100.0\ ^{o}C - 22.0\ ^{o}C$$
$$= 78.0\ ^{o}C$$

$$Q = \left(\frac{1.000\ cal}{\cancel{g}\ \cancel{^{o}C}}\right)(10.0\,\cancel{g})(78.0\ ^{o}\cancel{C}) = 780.\ cal$$

For more details: See chapter 5 part 2 and part 3 videos or chapter 5 section 2 in the textbook.

Go back

Go to next question

5.11) Gaseous particles travel at high speeds in all directions and will mix with other types of gas particles in a process called ____________________.

a) socialization

b) pressure

c) diffusion

d) melting

Go back

Click here for a **hint**

Click here to **check your answer**

Go to next question

5.11) Gaseous particles travel at high speeds in all directions and will mix with other types of gas particles in a process called ___________________.

a) socialization

HINT: Socialization is ***not*** the correct choice.

b) pressure

c) diffusion

d) melting

For more help: See chapter 5 part 4 video or chapter 5 section 3 in the textbook.

Go back

Click here to **check your answer**

Go to next question

5.11) Gaseous particles travel at high speeds in all directions and will mix with other types of gas particles in a process called ____________________.

a) socialization

b) pressure

[✓ c) diffusion]

d) melting

Learn more about ***diffusion*** in [chapter 5 part 4 video] or chapter 5 section 3 in the textbook.

Go back

Go to next question

5.12) The *pressure units that we will use in this course* are **atmospheres (atm), pounds per square inch (psi), millimeters of mercury (mm Hg),** and **Torr**.

The relationships between these units are:

- 1 atm = 760 mm Hg (exact, infinite significant figures)
- 1 mm Hg = 1 Torr (exact, infinite significant figures)
- 1 atm = 760 Torr (exact, infinite significant figures)
- 1 atm = 14.7 psi (three significant figures shown here)

Convert 754.3 Torr to atmospheres (atm).

Go back

Click here for a **hint**

Click here to **check your answer**

Go to next question

5.12) The *pressure units that we will use in this course* are **atmospheres (atm), pounds per square inch (psi), millimeters of mercury (mm Hg),** and **Torr**.

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- 1 mm Hg = 1 Torr (exact, infinite significant figures)
- 1 atm = 760 Torr (exact, infinite significant figures)
- 1 atm = 14.7 psi (three significant figures shown here)

Convert 754.3 Torr to atmospheres (atm).

HINT: This is a **unit conversion problem**. 1 atm is equal to **exactly** 760 Torr; use this relationship as a *conversion factor*.

For more help: See chapter 5 part 4 video or chapter 5 section 3 in the textbook.

Go back

Click here to **check your answer**

Go to next question

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The relationships between these units are:

- 1 atm = 760 mm Hg (exact, infinite significant figures)
- 1 mm Hg = 1 Torr (exact, infinite significant figures)
- 1 atm = 760 Torr (exact, infinite significant figures)
- 1 atm = 14.7 psi (three significant figures shown here)

Convert 754.3 Torr to atmospheres (atm). **ANSWER: 0.9925 atm (four significant figures)**

CLICK HERE to see the **complete solution** for this problem

Go back

Go to next question

5.12) The *pressure units that we will use in this course* are **atmospheres (atm), pounds per square inch (psi), millimeters of mercury (mm Hg),** and **Torr**.

The relationships between these units are:

- 1 atm = 760 mm Hg (exact, infinite significant figures)
- 1 mm Hg = 1 Torr (exact, infinite significant figures)
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- 1 atm = 14.7 psi (three significant figures shown here)

Convert 754.3 Torr to atmospheres (atm). **ANSWER: 0.9925 atm (four significant figures)**

EXPLANATION: This is a **unit conversion problem**. 1 atm is equal to **exactly** 760 Torr; this relationship is used as a *conversion factor*.

$$\begin{array}{c|c|} 754.3\ \cancel{\text{Torr}} & 1\ \text{atm} \\ \hline & 760\ \cancel{\text{Torr}} \end{array} = 0.9925\ \text{atm}$$

***four* significant figures**

exact: ***infinite*** number of significant figures

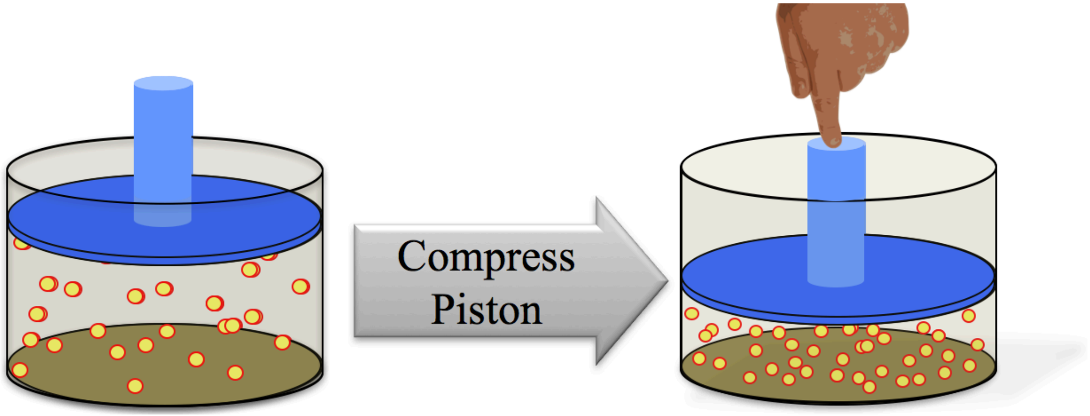
***four* significant figures**

For more details: See chapter 5 part 4 video or chapter 5 section 3 in the textbook.

Go back

Go to next question

5.13) Consider the compression of a gas at constant temperature as illustrated below. The initial volume (V_1) is 2.50 L and the initial pressure (P_1) is 0.035 atm, then the piston is compressed to give a final volume (V_2) of 1.20 L. What is the value of the final pressure (P_2)?



Before Compression
$P_1 = 0.035$ atm
$V_1 = 2.50$ L

After Compression
$P_2 =$??? atm
$V_2 = 1.20$ L

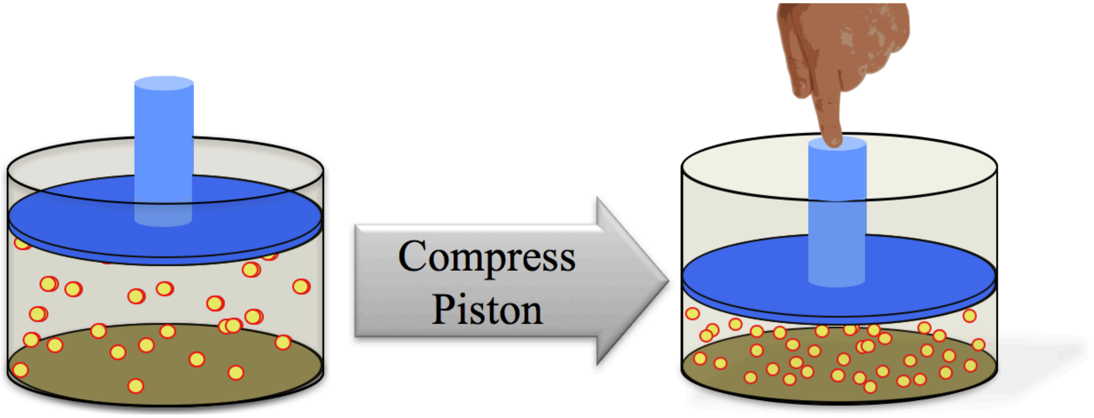
Go back

Click here for a **hint**

Click here to **check your answer**

Go to next question

5.13) Consider the compression of a gas at constant temperature as illustrated below. The initial volume (V_1) is 2.50 L and the initial pressure (P_1) is 0.035 atm, then the piston is compressed to give a final volume (V_2) of 1.20 L. What is the value of the final pressure (P_2)?



Before Compression
$P_1 = 0.035$ atm
$V_1 = 2.50$ L

After Compression
$P_2 =$??? atm
$V_2 = 1.20$ L

HINT: Use Boyle's Law: $\mathbf{P_1 \bullet V_1 = P_2 \bullet V_2}$

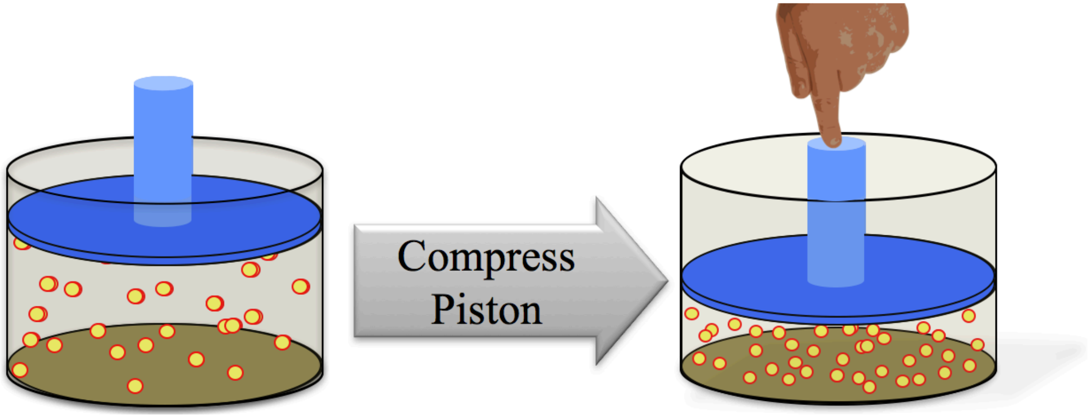
For more help: See chapter 5 part 5 video or chapter 5 section 3 in the textbook.

Go back

Click here to **check your answer**

Go to next question

5.13) Consider the compression of a gas at constant temperature as illustrated below. The initial volume (V_1) is 2.50 L and the initial pressure (P_1) is 0.035 atm, then the piston is compressed to give a final volume (V_2) of 1.20 L. What is the value of the final pressure (P_2)? **ANSWER: 0.073 atm** (two significant figures)



Compress
Piston

Before Compression
$P_1 = 0.035$ atm
$V_1 = 2.50$ L

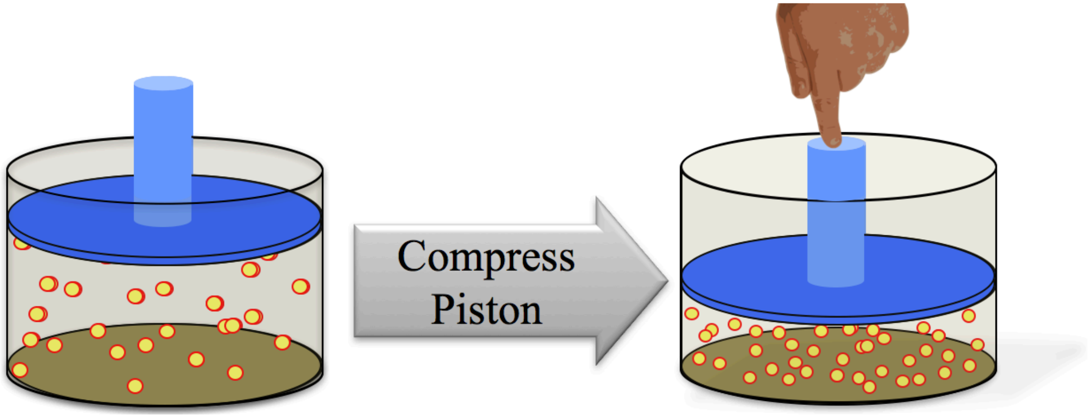
After Compression
$P_2 = ???$ atm
$V_2 = 1.20$ L

CLICK HERE to see the **complete solution** for this problem

Go back

Go to next question

5.13) Consider the compression of a gas at constant temperature as illustrated below. The initial volume (V_1) is 2.50 L and the initial pressure (P_1) is 0.035 atm, then the piston is compressed to give a final volume (V_2) of 1.20 L. What is the value of the final pressure (P_2)? **ANSWER: 0.073 atm** (two significant figures)



Before Compression
$P_1 = 0.035$ atm
$V_1 = 2.50$ L

After Compression
$P_2 =$??? atm
$V_2 = 1.20$ L

EXPLANATION:

Use Boyle's Law: $\mathbf{P_1 \bullet V_1 = P_2 \bullet V_2}$

Solve for $\mathbf{P_2}$ by dividing both sides of the equation by $\mathbf{V_2}$.

$$\frac{P_1 \bullet V_1}{V_2} = P_2$$

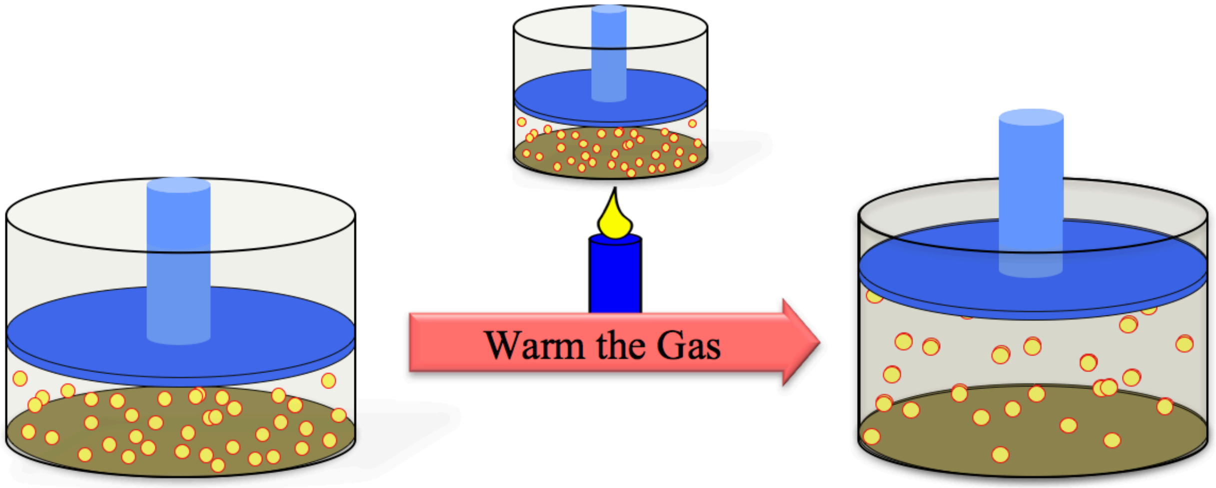
$$P_2 = \frac{P_1 \bullet V_1}{V_2} = \frac{(0.035\ \text{atm}) \bullet (2.50\ \cancel{\text{L}})}{(1.20\ \cancel{\text{L}})} = \mathbf{0.073\ atm}$$

For more details: See chapter 5 part 5 video or chapter 5 section 3 in the textbook.

Go back

Go to next question

5.14) The initial volume of gas in a cylinder with a piston is 14.4 liters. The gas is heated from 295 K to 476 K (at constant pressure). What is the final volume?



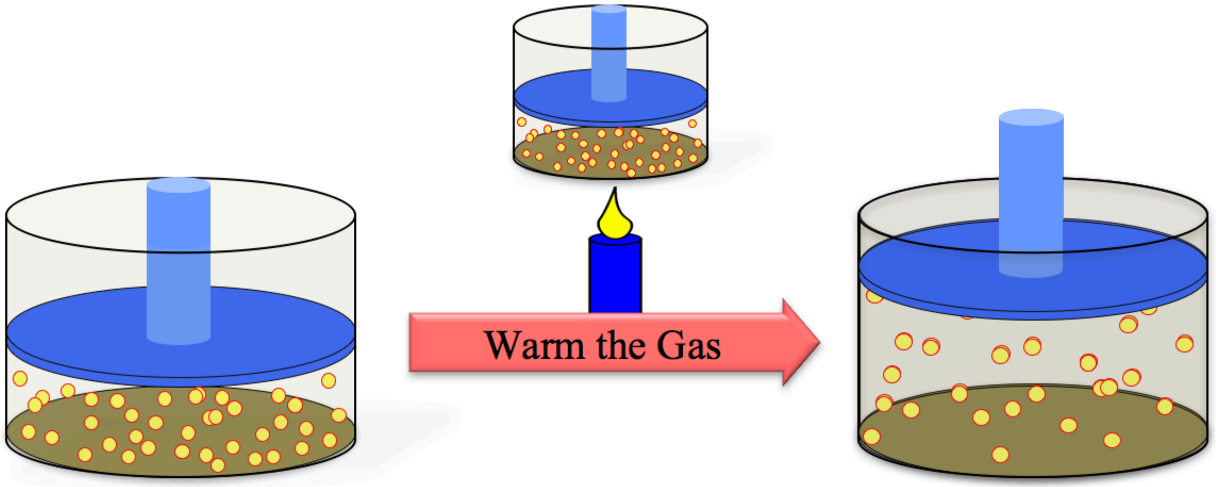
Go back

Click here for a **hint**

Click here to **check your answer**

Go to next question

5.14) The initial volume of gas in a cylinder with a piston is 14.4 liters. The gas is heated from 295 K to 476 K (at constant pressure). What is the final volume?



HINT: Use Charles' Law:

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

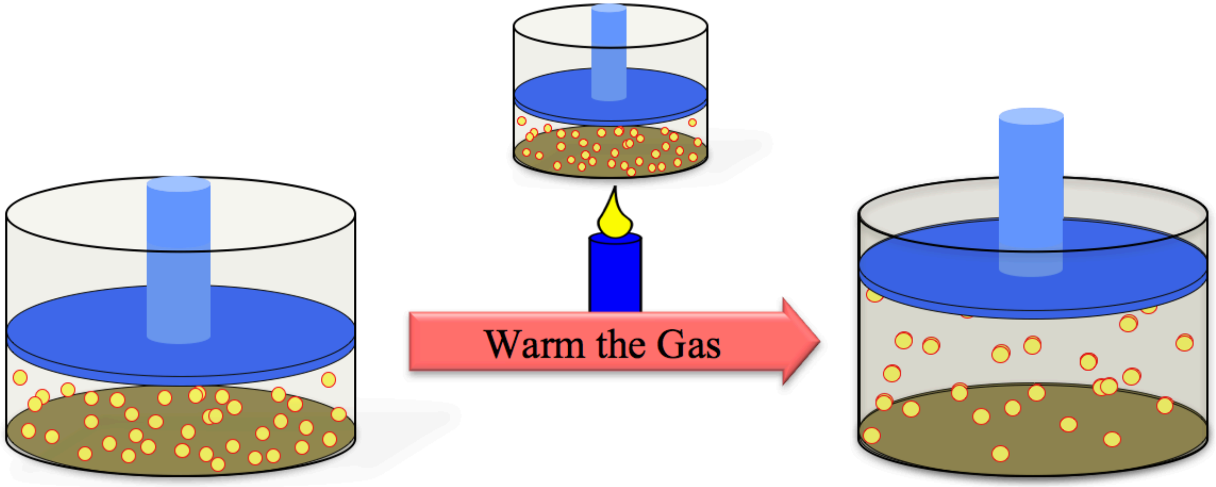
For more help: See chapter 5 part 6 video or chapter 5 section 3 in the textbook.

Go back

Click here to check your answer

Go to next question

5.14) The initial volume of gas in a cylinder with a piston is 14.4 liters. The gas is heated from 295 K to 476 K (at constant pressure). What is the final volume? **ANSWER: 23.2 L** (three significant figures)

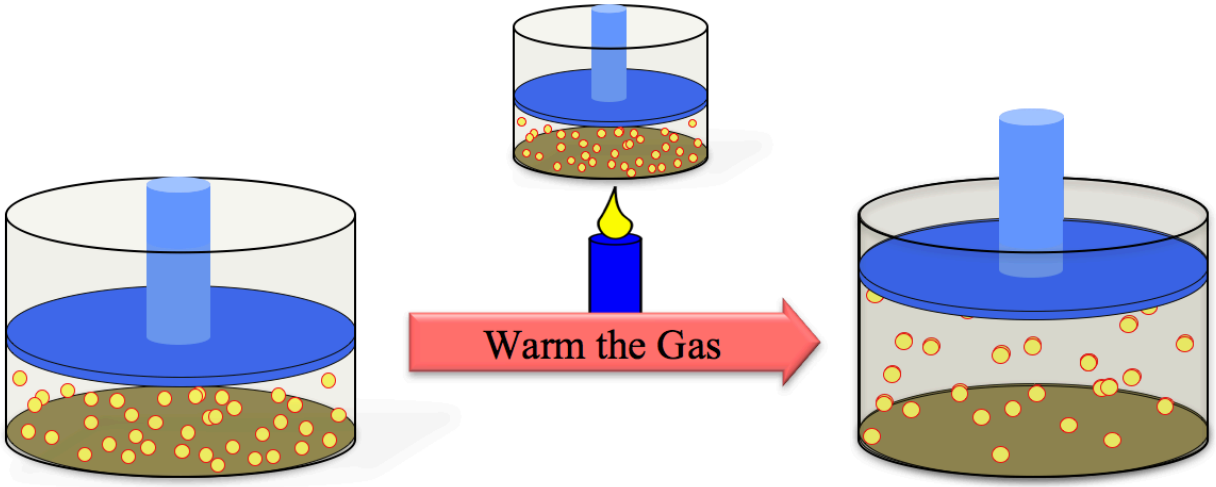


CLICK HERE to see the **complete solution** for this problem

Go back

Go to next question

5.14) The initial volume of gas in a cylinder with a piston is 14.4 liters. The gas is heated from 295 K to 476 K (at constant pressure). What is the final volume? **ANSWER: 23.2 L** (three significant figures)



Before Heating
Initial Volume (V_1) = 14.4 L
Initial Temperature (T_1) = 295 K

After Heating
Final Volume (V_2) = **?**
Final Temperature (T_2) = 476 K

EXPLANATION:

Use Charles' Law: $$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

Solve for V_2 by multiplying both sides of the equation by T_2:

$$\frac{T_2 \cdot V_1}{T_1} = \frac{V_2 \cdot \cancel{T_2}}{\cancel{T_2}}$$

$$\frac{T_2 \cdot V_1}{T_1} = V_2$$

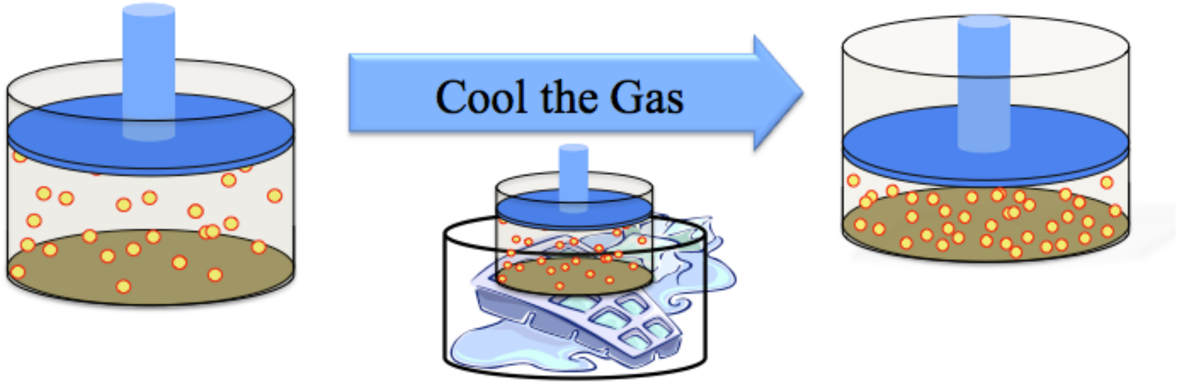
$$V_2 = \frac{T_2 \cdot V_1}{T_1} = \frac{(476\ \cancel{K}) \cdot (14.4\ L)}{(295\ \cancel{K})} = 23.2\ L$$

For more details: See chapter 5 part 6 video or chapter 5 section 3 in the textbook.

Go back

Go to next question

5.15) The initial volume of gas in a cylinder with a piston is 4.15 liters. The gas is ***cooled*** from 225 ^{o}C to 22 ^{o}C (at constant pressure). What is the final volume? CAUTION: Which temperature units must be used in gas law calculations?



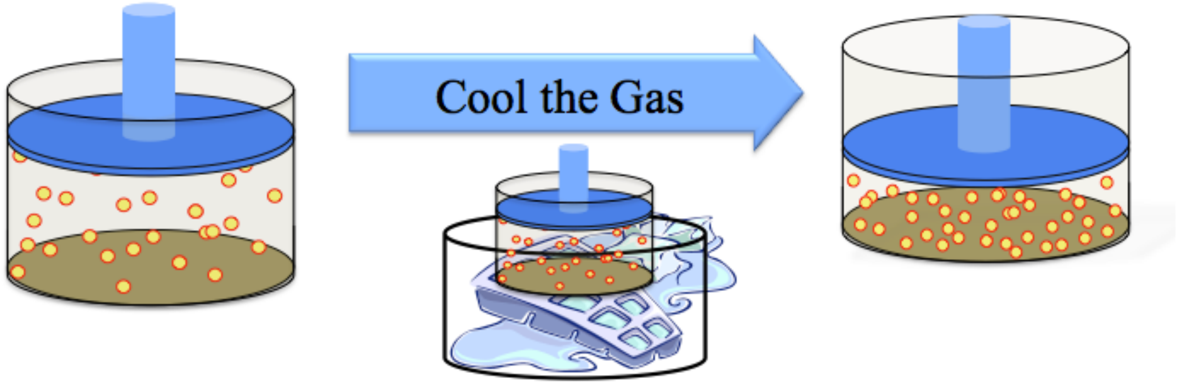
Go back

Click here for a **hint**

Click here to **check your answer**

Go to next question

5.15) The initial volume of gas in a cylinder with a piston is 4.15 liters. The gas is ***cooled*** from 225 °C to 22 °C (at constant pressure). What is the final volume? CAUTION: Which temperature units must be used in gas law calculations?



HINT: Use Charles' Law: $$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

When using the gas laws, kelvin (K) temperature units must be used.

K = °C + 273.15

For more help: See chapter 5 part 6 video or chapter 5 section 3 in the textbook.

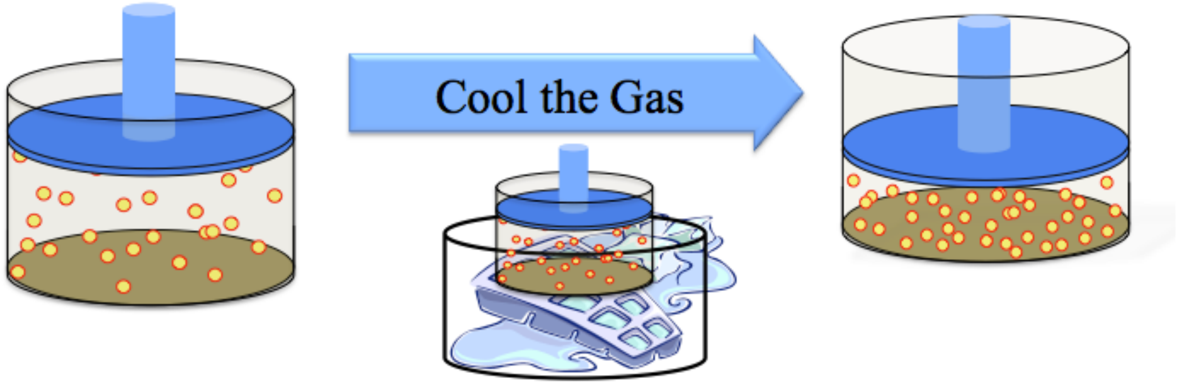
Go back

Click here to **check your answer**

Go to next question

5.15) The initial volume of gas in a cylinder with a piston is 4.15 liters. The gas is ***cooled*** from 225 ^{o}C to 22 ^{o}C (at constant pressure). What is the final volume? CAUTION: Which temperature units must be used in gas law calculations?

ANSWER: 2.46 L (three significant figures)



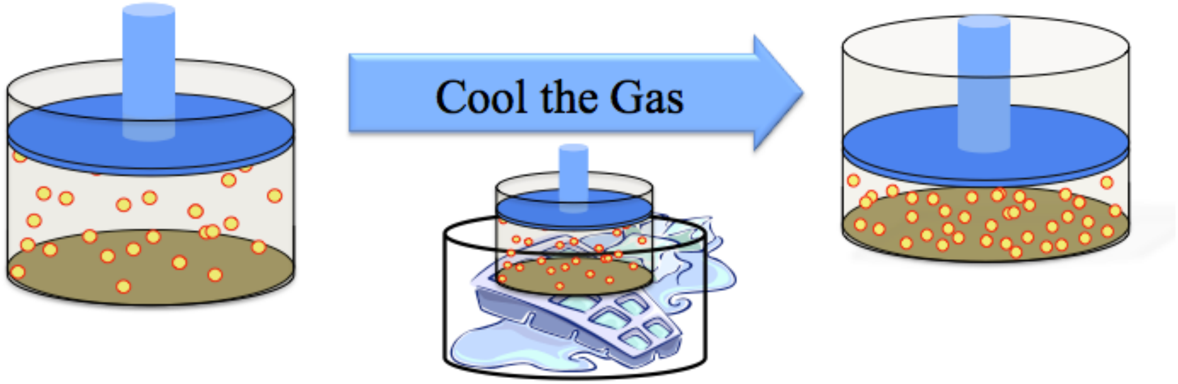
CLICK HERE to see the **complete solution** for this problem

Go back

Go to next question

5.15) The initial volume of gas in a cylinder with a piston is 4.15 liters. The gas is ***cooled*** from 225 °C to 22 °C (at constant pressure). What is the final volume? CAUTION: Which temperature units must be used in gas law calculations?

ANSWER: 2.46 L (three significant figures)



Before Heating
Initial Volume (V_1) = 4.15 L
Initial Temperature (T_1) = 498 K

After Heating
Final Volume (V_2) = ?
Final Temperature (T_2) = 295 K

When using the gas laws, kelvin (K) temperature units must be used.

K = °C + 273.15
Initial Temperature (T_1) = 225 + 273.15 = 498 K
Final Temperature (T_2) = 22 + 273.15 = 295 K

EXPLANATION:

Use Charles' Law: $$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

Solve for V_2 by multiplying both sides of the equation by T_2:

$$\frac{T_2 \cdot V_1}{T_1} = \frac{V_2 \cdot \cancel{T_2}}{\cancel{T_2}}$$

$$\frac{T_2 \cdot V_1}{T_1} = V_2$$

$$V_2 = \frac{T_2 \cdot V_1}{T_1} = \frac{(295\ \cancel{K}) \cdot (4.15\ L)}{(498\ \cancel{K})} = 2.46\ L$$

Go back

For more details: See chapter 5 part 6 video or chapter 5 section 3 in the textbook.

Go to next question

5.16) The initial pressure of a gas tank is 4.50 atm and the initial temperature is 295 K. To what temperature must the gas be heated in order to increase the pressure to 8.80 atm (at constant volume)?

Go back

Click here for a **hint**

Click here to **check your answer**

Go to next question

5.16) The initial pressure of a gas tank is 4.50 atm and the initial temperature is 295 K. To what temperature must the gas be heated in order to increase the pressure to 8.80 atm (at constant volume)?

Hint: Use Gay-Lussac's Law

For more help: See chapter 5 part 7 video or chapter 5 section 3 in the textbook.

Go back

Click here to **check your answer**

Go to next question

5.16) The initial pressure of a gas tank is 4.50 atm and the initial temperature is 295 K. To what temperature must the gas be heated in order to increase the pressure to 8.80 atm (at constant volume)? **ANSWER: 577 K** (three significant figures)

CLICK HERE to see the **complete solution** for this problem

Go back

Go to next question

5.16) The initial pressure of a gas tank is 4.50 atm and the initial temperature is 295 K. To what temperature must the gas be heated in order to increase the pressure to 8.80 atm (at constant volume)? **ANSWER: 577 K** (three significant figures)

Before Heating
$P_1 = 4.50$ atm
$T_1 = 295$ K

After Heating
$P_2 = 8.80$ atm
$T_2 = ?$

EXPLANATION: Use Gay-Lussac's Law

$$\frac{\mathbf{P_1}}{\mathbf{T_1}} = \frac{\mathbf{P_2}}{\boxed{\mathbf{T_2}}} \Longleftarrow$$

Solve for $\mathbf{T_2}$ using "**cross-multiplication,**"

If $\dfrac{\mathbf{P_1}}{\mathbf{T_1}} = \dfrac{\mathbf{P_2}}{\mathbf{T_2}}$, then $\mathbf{P_1} \bullet \mathbf{T_2} = \mathbf{T_1} \bullet \mathbf{P_2}$

and then dividing both sides of the equation by $\mathbf{P_1}$

$$\frac{\cancel{\mathbf{P_1}} \bullet \mathbf{T_2}}{\cancel{\mathbf{P_1}}} = \frac{\mathbf{T_1} \bullet \mathbf{P_2}}{\mathbf{P_1}}$$

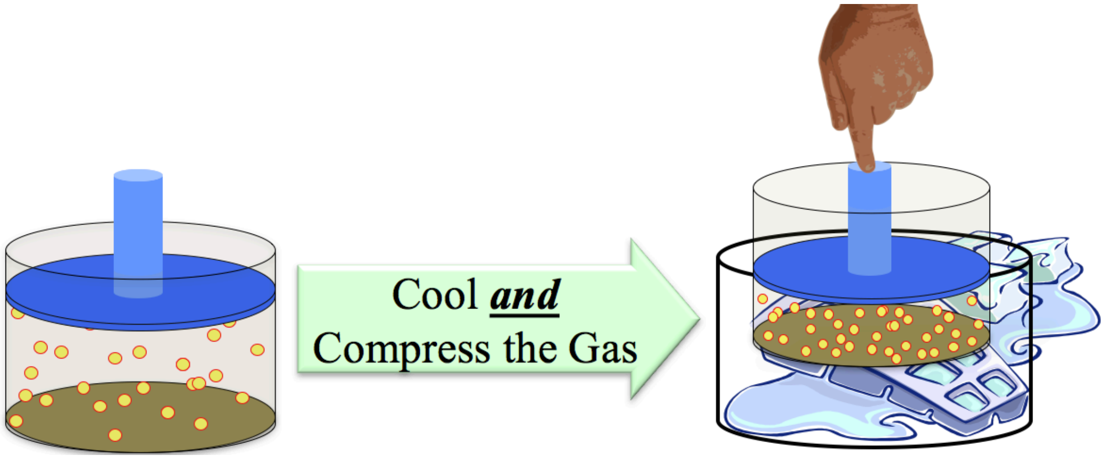
$$\mathbf{T_2} = \frac{\mathbf{T_1} \cdot \mathbf{P_2}}{\mathbf{P_1}} = \frac{(295\ \text{K}) \cdot (8.80\ \cancel{\text{atm}})}{(4.50\ \cancel{\text{atm}})} = \mathbf{577\ K}$$

Go back

For more details: See chapter 5 part 7 video or chapter 5 section 3 in the textbook.

Go to next question

5.17) A gas in a cylinder with a piston has an initial pressure of 2.40 atm and an initial volume of 13.0 liters. The gas is cooled from 298 K to 365 K and the piston is compressed to give a final volume of 9.0 L (as illustrated below). What is the final pressure?


Cool ***and***
Compress the Gas

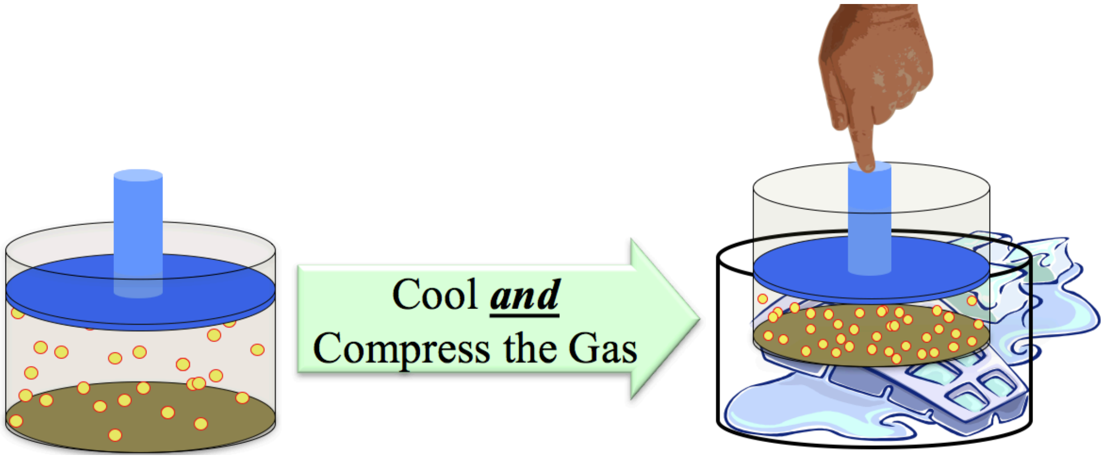
Go back

Click here for a **hint**

Click here to **check your answer**

Go to next question

5.17) A gas in a cylinder with a piston has an initial pressure of 2.40 atm and an initial volume of 13.0 liters. The gas is cooled from 298 K to 365 K and the piston is compressed to give a final volume of 9.0 L (as illustrated below). What is the final pressure?



Cool ***and*** Compress the Gas

HINT: In this problem, the pressure, volume, and temperature are changing. Use the "combined gas law."

For more help: See chapter 5 part 7 video or chapter 5 section 3 in the textbook.

Go back

Click here to check **your answer**

Go to next question

5.17) A gas in a cylinder with a piston has an initial pressure of 2.40 atm and an initial volume of 13.0 liters. The gas is cooled from 298 K to 365 K and the piston is compressed to give a final volume of 9.0 L (as illustrated below). What is the final pressure? **ANSWER: 4.2 atm** (two significant figures)

CLICK HERE to see the **complete solution** for this problem

Go back

Go to next question

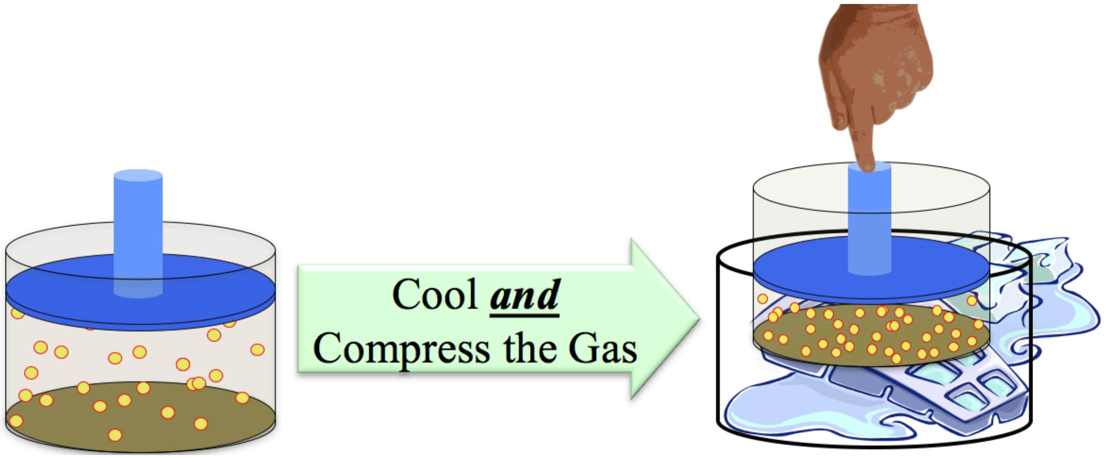
5.17) A gas in a cylinder with a piston has an initial pressure of 2.40 atm and an initial volume of 13.0 liters. The gas is cooled from 298 K to 365 K and the piston is compressed to give a final volume of 9.0 L (as illustrated below). What is the final pressure? **ANSWER: 4.2 atm** (two significant figures)

EXPLANATION: In this problem, the pressure, volume, and temperature are changing. Use the "combined gas law."

$$\frac{P_1 \cdot V_1}{T_1} = \frac{P_2 \cdot V_2}{T_2}$$

Solve for P_2 by dividing both sides by V_2 and multiplying both sided by T_2:

$$\frac{T_2 \cdot P_1 \cdot V_1}{V_2 \cdot T_1} = \frac{P_2 \cdot \cancel{V_2} \cdot \cancel{T_2}}{\cancel{T_2} \cdot \cancel{V_2}}$$



Initial State
Initial Pressure = 2.40 atm
Initial Volume = 13.0 L
Initial Temperature = 298 K

Final State
Final Pressure = ???
Final Volume = 9.0 L
Final Temperature = 365 K

$$P_2 = \frac{T_2 \cdot P_1 \cdot V_1}{V_2 \cdot T_1} = \frac{(365\ \cancel{\text{K}}) \cdot (2.40\ \text{atm}) \cdot (13.0\ \cancel{\text{L}})}{(9.0\ \cancel{\text{L}}) \cdot (298\ \cancel{\text{K}})} = 4.2\ \text{atm}$$

For more details: See chapter 5 part 7 video or chapter 5 section 3 in the textbook.

Go back

Go to next question

5.18) 3.6 moles of gas are contained in a cylinder with a piston and the volume of gas is 8.0 L. If 2.90 moles of gas are added to this cylinder (at constant pressure and temperature), what is the final volume?

CAUTION: The final number of moles (n_2) is not 2.90 moles; 2.90 moles of gas were *added* to the existing gas!

Go back

Click here for a **hint**

Click here to **check your answer**

Go to next question

5.18) 3.6 moles of gas are contained in a cylinder with a piston and the volume of gas is 8.0 L. If 2.90 moles of gas are added to this cylinder (at constant pressure and temperature), what is the final volume?

CAUTION: The final number of moles (n_2) is not 2.90 moles; 2.90 moles of gas were *added* to the existing gas!

HINT: Use Avogadro's Law.

For more help: See chapter 5 part 7 video or chapter 5 section 3 in the textbook.

Go back

Click here to **check your answer**

Go to next question

5.18) 3.6 moles of gas are contained in a cylinder with a piston and the volume of gas is 8.0 L. If 2.90 moles of gas are added to this cylinder (at constant pressure and temperature), what is the final volume? **ANSWER: 14 L** (two significant figures)

CLICK HERE to see the **complete solution** for this problem

Go back

Go to next question

5.18) 3.6 moles of gas are contained in a cylinder with a piston and the volume of gas is 8.0 L. If 2.90 moles of gas are added to this cylinder (at constant pressure and temperature), what is the final volume? **ANSWER: 14 L** (two significant figures)

CAUTION: The final number of moles (n_2) is not 2.90 moles; 2.90 moles of gas were *added* to the existing gas!

EXPLANATION: Use Avogadro's Law.

$$\frac{\mathbf{V_1}}{\mathbf{n_1}} = \frac{\mathbf{V_2}}{\mathbf{n_2}}$$

Solve for $\mathbf{V_2}$ by multiplying both sides of the equation by $\mathbf{n_2}$:

$$\frac{\mathbf{n_2 \cdot V_1}}{\mathbf{n_1}} = \frac{\mathbf{V_2 \cdot \cancel{n_2}}}{\cancel{\mathbf{n_2}}}$$

Before Adding More Gas
Initial Volume (V_1) = 8.0 L
Initial moles (n_1) = 3.6 moles

After Adding More Gas
Final Volume (V_2) = ?
Final moles (n_2) = 3.6 moles + 2.90 moles
= 6.5 moles

$$\mathbf{V_2} = \frac{\mathbf{n_2 \cdot V_1}}{\mathbf{n_1}} = \frac{(6.5\ \cancel{\text{moles}}) \cdot (8.0\ \text{L})}{(3.6\ \cancel{\text{moles}})} = \mathbf{14\ L}$$

Go back

For more details: See chapter 5 part 7 video or chapter 5 section 3 in the textbook.

Go to next question

5.19) According to Boyle's law when the pressure on a gas is doubled (at constant temperature), its volume will ______________.

A) quadruple

B) double

C) remain the same

D) be reduced by a factor of 1/2

Go back

Click here for a **hint**

Click here to **check your answer**

Go to next question

5.19) According to Boyle's law when the pressure on a gas is doubled (at constant temperature), its volume will ______________.

A) quadruple

B) double

C) remain the same

D) be reduced by a factor of 1/2

HINT: Boyle found that **P** and **V** are ***inversely proportional***. If two parameters are "inversely proportional," when one parameter (pressure in this case) *increases*, the other parameter (volume in this case) *decreases*.

To learn more about Boyles' Law: See chapter 5 part 6 video or chapter 5 section 3 in the textbook.

Go back

Click here to **check your answer**

Go to next question

5.19) According to Boyle's law when the pressure on a gas is doubled (at constant temperature), its volume will ______________.

A) quadruple

B) double

C) remain the same

[✓ D) be reduced by a factor of 1/2]

EXPLANATION: Boyle found that **P** and **V** are ***inversely proportional***. If two parameters are "inversely proportional," when one parameter (pressure in this case) *increases*, the other parameter (volume in this case) *decreases*. *Choice* **"D"** *is the* ***only*** *selection in which this occurs.*

Furthermore, Using Boyle's Law, $\mathbf{P_1 \bullet V_1 = P_2 \bullet V_2}$,

consider what happens to the final volume ($\mathbf{V_2}$) when the pressure is doubled. Solving Boyle's Law for $\mathbf{V_2}$ gives:

$$\mathbf{V_2 = \frac{P_1 \bullet V_1}{P_2}}$$

If the pressure is ***doubled***, then $\mathbf{P_2} = (\mathbf{2 \bullet P_1})$. Substituting $(\mathbf{2 \bullet P_1})$ for $\mathbf{P_2}$ in the equation above gives:

$$\mathbf{V_2 = \frac{P_1 \bullet V_1}{2 \bullet P_1}}$$

$\mathbf{P_1}$ cancels to give:

$$\mathbf{V_2 = \frac{1}{2} V_1}$$

Go back

Go to next question

5.20) 3.50 moles of gas at a temperate of 395 K are contained in a 2.00 liter tank. What is the pressure of the gas?

Go back

Click here for a **hint**

Click here to **check your answer**

Go to next question

5.20) 3.50 moles of gas at a temperate of 395 K are contained in a 2.00 liter tank. What is the pressure of the gas?

HINT: When considering a static (non changing) gas system, use th**e ideal gas law.**

For more help: See chapter 5 part 8 video or chapter 5 section 3 in the textbook.

Go back

Click here to **check your answer**

Go to next question

5.20) 3.50 moles of gas at a temperate of 395 K are contained in a 2.00 liter tank. What is the pressure of the gas?

ANSWER: 56.8 atm (three significant figures)

CLICK HERE to see the **complete solution** for this problem

Go back

Go to next question

5.20) 3.50 moles of gas at a temperate of 395 K are contained in a 2.00 liter tank. What is the pressure of the gas?

ANSWER: 56.8 atm (three significant figures)

EXPLANATION: When considering a static (non changing) gas system, use the **ideal gas law.**

$$\mathbf{P \cdot V = n \cdot R \cdot T}$$

In this problem, you were given the volume, number of moles, and temperature.

Variables:

P = ??? atm

V = 2.00 L

n = 3.50 moles

T = 395 K

Solving the ideal gas law equation for pressure (**P**) gives:

$$\mathbf{P = \frac{n \cdot R \cdot T}{V}}$$

The value of the gas constant (**R**) = $\mathbf{0.0821 \left(\frac{L \cdot atm}{K \cdot mole} \right)}$

$$\mathbf{P = \frac{(3.50\ \cancel{mole}) \cdot \left(0.0821\ \frac{\cancel{L} \cdot atm}{\cancel{K} \cdot \cancel{mole}} \right) \cdot (395\ \cancel{K})}{(2.00\ \cancel{L})} = 56.8\ atm}$$

Go back

For more details: See chapter 5 part 8 video or chapter 5 section 3 in the textbook.

Go to next question

5.21) The amount of pressure exerted by an individual gas in a mixture is called that gas’s ____________________.

a) vapor pressure
b) atmospheric pressure
c) barometer reading
d) partial pressure
e) volume

Go back

Click here for a **hint**

Click here to **check your answer**

Go to next question

5.21) The amount of pressure exerted by an individual gas in a mixture is called that gas's ___________________.

HINT:

a) vapor pressure

~~b) atmospheric pressure~~

~~c) barometer reading~~

d) partial pressure

~~e) volume~~

For more help: See chapter 5 part 9 video or chapter 5 section 4 in the textbook.

Go back

Click here to **check your answer**

Go to next question

5.21) The amount of pressure exerted by an individual gas in a mixture is called that gas's ________________.

a) vapor pressure

b) atmospheric pressure

c) barometer reading

[✓ d) partial pressure]

e) volume

You will likely hear the term "partial pressure" in some of your biology books and in other health applications.

For more details: See chapter 5 part 9 video or chapter 5 section 4 in the textbook.

Go back

Go to next question

5.22) A sample of CO_2 gas in 10.0 liter container has a pressure of 548 Torr. In another 10.0 L container, a sample of argon gas has a pressure of 475 Torr. If the two gas samples are combined in a 10.0 L container, what would be the pressure of the gas mixture?

Go back

Click here for a **hint**

Click here to **check your answer**

Go to next question

5.22) A sample of CO_2 gas in 10.0 liter container has a pressure of 548 Torr. In another 10.0 L container, a sample of argon gas has a pressure of 475 Torr. If the two gas samples are combined in a 10.0 L container, what would be the pressure of the gas mixture?

HINT: Dalton's Law states that the total pressure of a mixture of gases in a container is equal to the ***sum*** of the pressures that each gas in the mixture would exert if that gas were alone in the container.

For more help: See chapter 5 part 9 video or chapter 5 section 4 in the textbook.

Go back

Click here to **check your answer**

Go to next question

5.22) A sample of CO_2 gas in 10.0 liter container has a pressure of 548 Torr. In another 10.0 L container, a sample of argon gas has a pressure of 475 Torr. If the two gas samples are combined in a 10.0 L container, what would be the pressure of the gas mixture? **ANSWER: 1023 Torr**

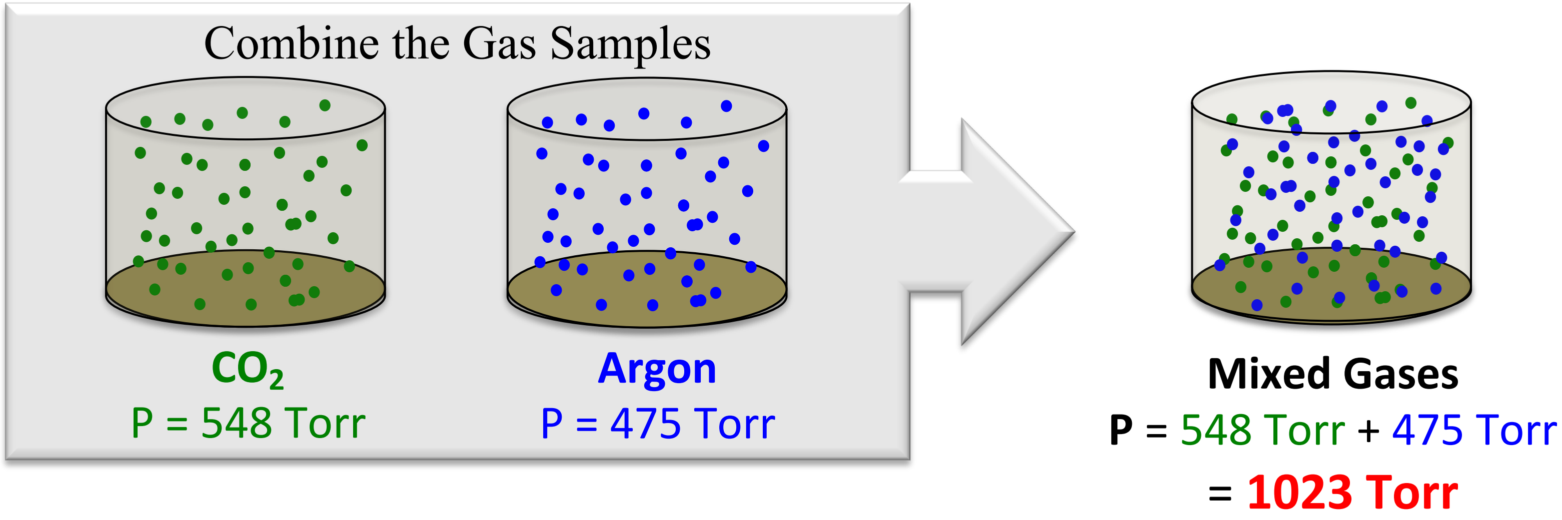
CLICK HERE to see the **complete solution** for this problem

Go back

Go to next question

5.22) A sample of CO_2 gas in 10.0 liter container has a pressure of 548 Torr. In another 10.0 L container, a sample of argon gas has a pressure of 475 Torr. If the two gas samples are combined in a 10.0 L container, what would be the pressure of the gas mixture? **ANSWER: 1023 Torr**

EXPLANATION: Dalton's Law states that the total pressure of a mixture of gases in a container is equal to the ***sum*** of the pressures that each gas in the mixture would exert if that gas were alone in the container.



Combine the Gas Samples

CO_2
P = 548 Torr

Argon
P = 475 Torr

Mixed Gases
P = 548 Torr + 475 Torr
= **1023 Torr**

If these two samples, CO_2 and Ar, were combined in a ten-liter container, the total pressure would be the ***sum*** of the pressures that each gas exerted *when it was alone in the container*.

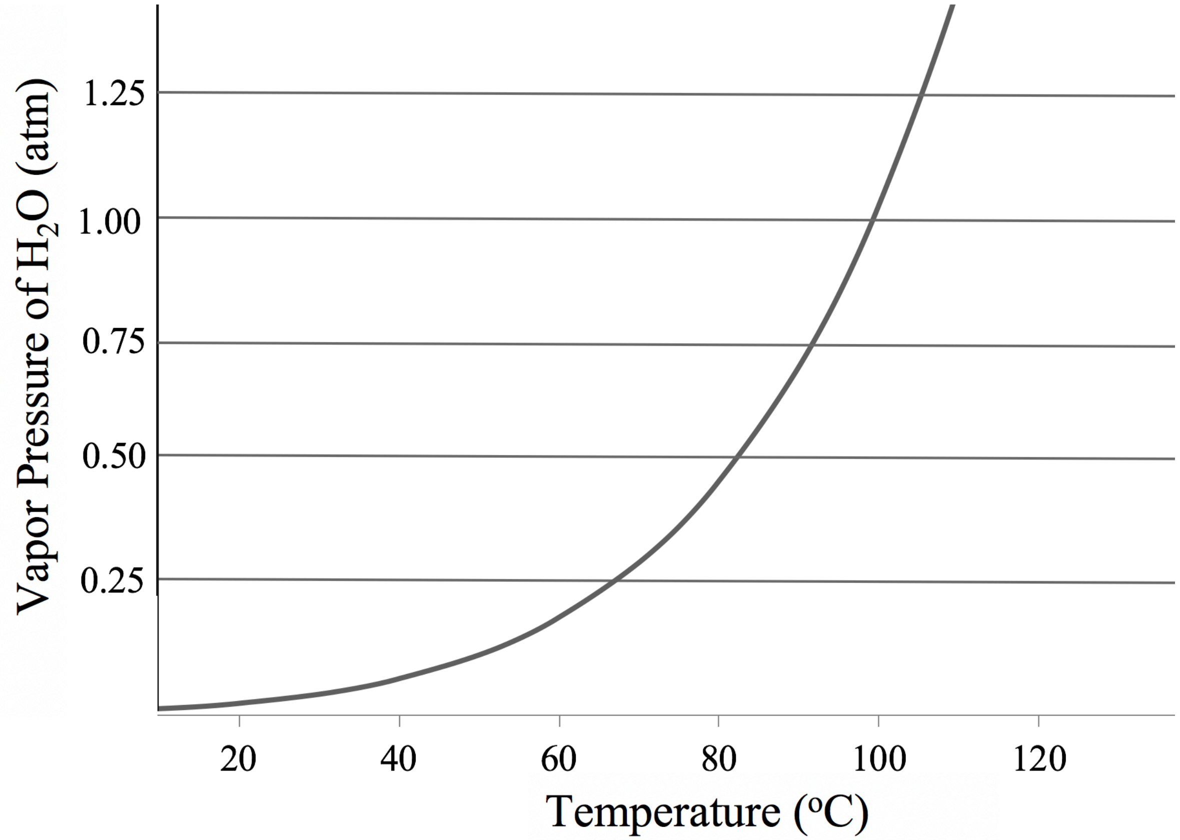
Total pressure of the mixture = 548 Torr + 475 Torr = **1023 Torr**

For more details: See chapter 5 part 9 video or chapter 5 section 4 in the textbook.

Go back

Go to next question

5.23) The boiling point of a liquid in an open container is the temperature at which its ***vapor pressure*** equals the ***atmospheric pressure***. In closed containers, liquids boil when their vapor pressure equals the pressure of the gas above them. A graph of the vapor pressure of water vs. temperature is shown here.



In a mountain location where the atmospheric pressure is ***less*** than 1.00 atm, water in an open container will boil at:

a) a temperature greater than 100°C

b) a temperature less than 100°C

c) 100°C

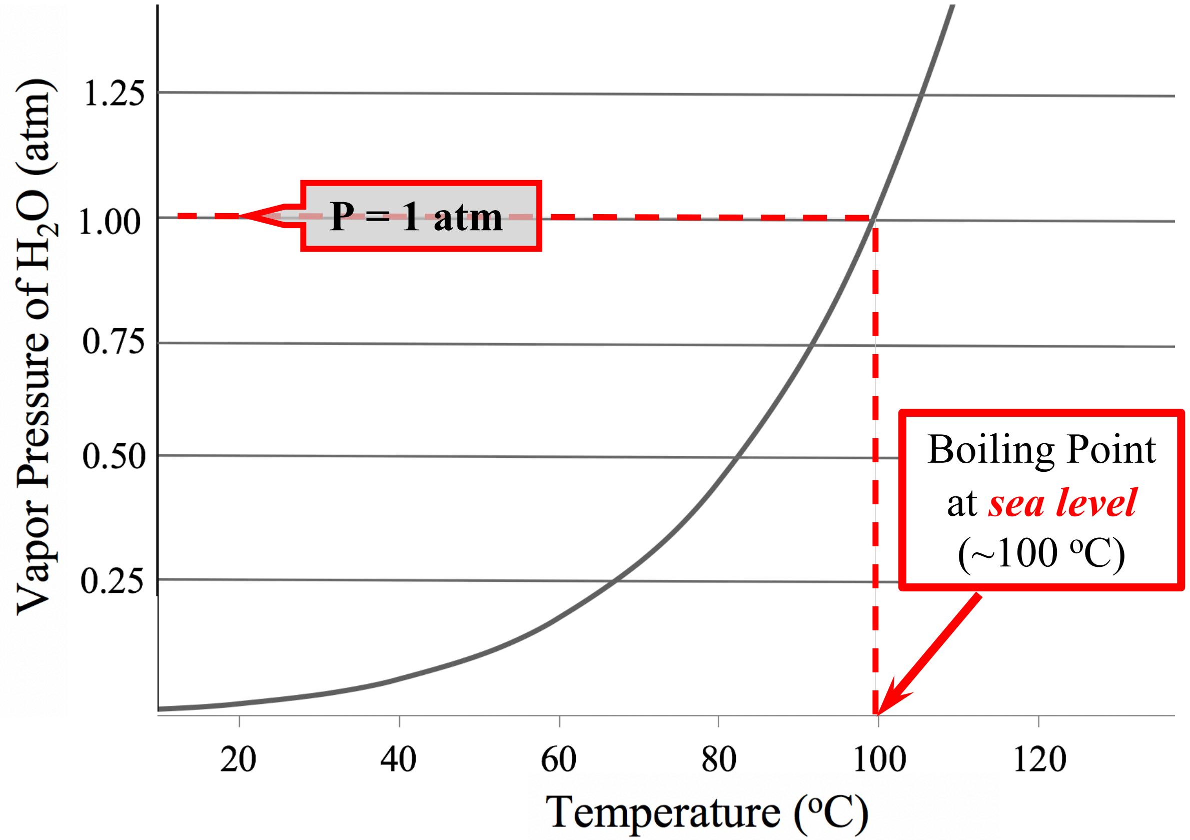
Go back

Click here for a **hint**

Click here to **check your answer**

Go to next question

5.23) The boiling point of a liquid in an open container is the temperature at which its ***vapor pressure*** equals the ***atmospheric pressure***. In closed containers, liquids boil when their vapor pressure equals the pressure of the gas above them. A graph of the vapor pressure of water vs. temperature is shown here.



In a mountain location where the atmospheric pressure is ***less*** than 1.00 atm, water in an open container will boil at:

a) a temperature greater than 100°C

b) a temperature less than 100°C

c) 100°C

HINT: The ***dashed red lines*** in the figure indicates that the vapor pressure of water at 100 °C is equal to1 atm. This is why water will boil at 100 °C in an open container at ***sea-level*** where the atmospheric pressure is **1 atm**. Using the graph, consider the vapor pressure and the resulting boiling point at a ***mountain location***, where the atmospheric pressure is less than 1 atm.

Go back

For more help: See chapter 5 part 9 video or chapter 5 section 4 in the textbook.

Click here to **check your answer**

Go to next question

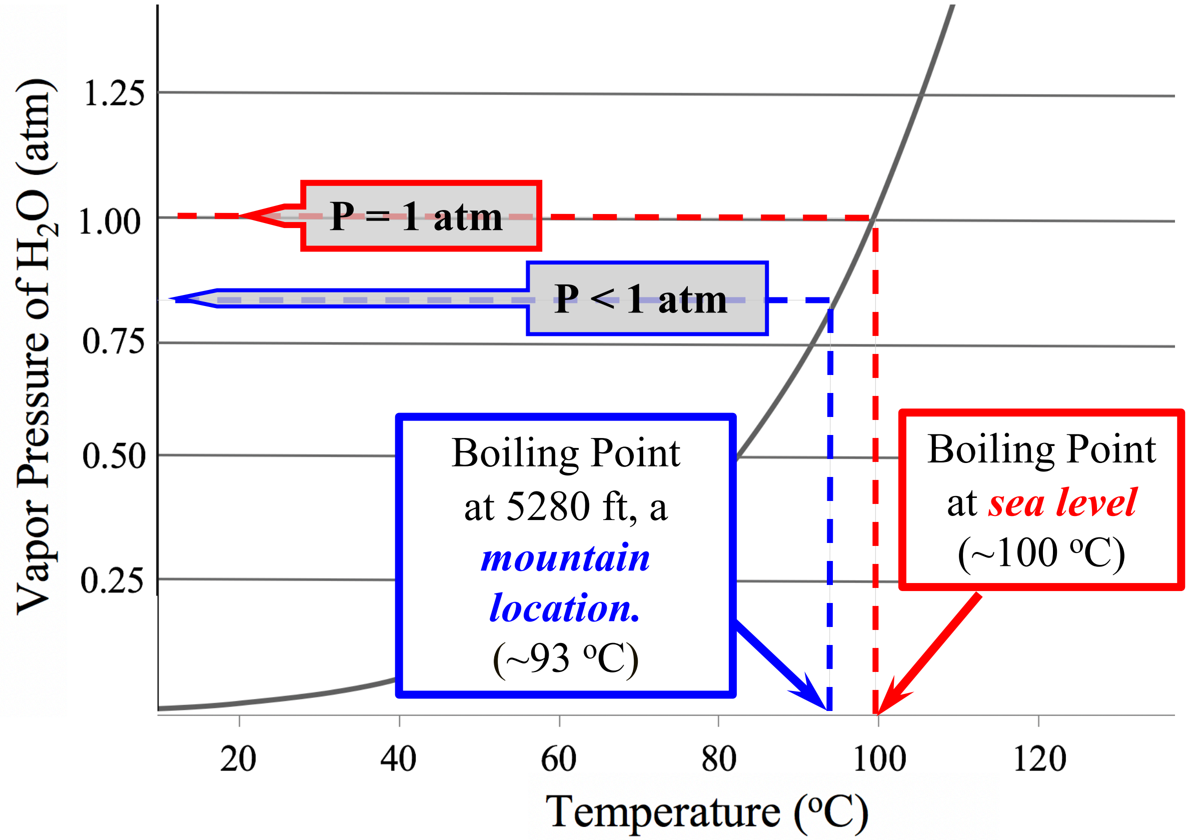
5.23) The boiling point of a liquid in an open container is the temperature at which its ***vapor pressure*** equals the ***atmospheric pressure***. In closed containers, liquids boil when their vapor pressure equals the pressure of the gas above them. A graph of the vapor pressure of water vs. temperature is shown here.

In a mountain location where the atmospheric pressure is ***less*** than 1.00 atm, water in an open container will boil at:

a) a temperature greater than 100°C

[✓ b) a temperature less than 100°C]

c) 100°C



P = 1 atm

P < 1 atm

Boiling Point at 5280 ft, a ***mountain location.*** (~93 °C)

Boiling Point at ***sea level*** (~100 °C)

EXPLANATION: The ***dashed red lines*** in the figure indicates that the vapor pressure of water at 100 °C is equal to1 atm. This is why water will boil at 100 °C in an open container at ***sea-level*** where the atmospheric pressure is 1 atm. In a ***mountain location***, such as Denver, Colorado (elevation 5280 ft), where the atmospheric pressure is about 0.82 atm, water boils at about 93°C, as indicated by the ***blue dashed lines*** in the figure.

For more details: See chapter 5 part 9 video or chapter 5 section 4 in the textbook.

Go back

Go to next question

5.24) Viscosity is a measure of a substance’s resistance to flow. The nanometer scale explanation for the existence of viscosity is that molecules in a liquid need to “slide” past the molecules that surround them in order for the liquid to flow.

With very few exceptions, the higher the temperature, the ____________ a substance’s viscosity.

a) lower

b) greater

Go back

Click here for a **hint**

Click here to **check your answer**

Go to next question

5.24) Viscosity is a measure of a substance’s resistance to flow. The nanometer scale explanation for the existence of viscosity is that molecules in a liquid need to “slide” past the molecules that surround them in order for the liquid to flow.

With very few exceptions, the higher the temperature, the ___________ a substance’s viscosity.

a) lower

b) greater

HINT: Noncovalent interactions attract the molecules to each other and impede their ability to slide past each other. The stronger the noncovalent interactions, the more viscous a liquid is. Temperature (kinetic energy) aids molecules in overcoming the noncovalent interactions in order to more easily slide past each other, therefore a liquid’s viscosity is temperature dependent.

For more help: See chapter 5 part 9 video or chapter 5 section 4 in the textbook.

Go back

Click here to **check your answer**

Go to next question

5.24) Viscosity is a measure of a substance’s resistance to flow. The nanometer scale explanation for the existence of viscosity is that molecules in a liquid need to “slide” past the molecules that surround them in order for the liquid to flow.

With very few exceptions, the higher the temperature, the ___________ a substance’s viscosity.

[✓ a) lower]

b) greater

EXPLANATION: Noncovalent interactions attract the molecules to each other and impede their ability to slide past each other. The stronger the noncovalent interactions, the more viscous a liquid is. Temperature (kinetic energy) aids molecules in overcoming the noncovalent interactions in order to more easily slide past each other, therefore a liquid’s viscosity is temperature dependent. With very few exceptions, the higher the temperature, the **lower** a substance’s viscosity. You may have observed this if you compared hot and cold syrup’s ability to flow (viscosity).

For more details: See chapter 5 part 9 video or chapter 5 section 4 in the textbook.

Go back

Go to next question

5.25) Predict order of the following molecules when ranked from *highest boiling point* to *lowest boiling point*.

dimethyl ether $CH_3CH_2-O-CH_2CH_3$

butane $CH_3CH_2CH_2CH_3$

1-*butanol* $CH_3CH_2CH_2CH_2-OH$

highest boiling point

1. ______________________________

2. ______________________________

3. ______________________________

lowest boiling point

Go back

Click here for a **hint**

Click here to **check your answer**

Go to next question

5.25) Predict order of the following molecules when ranked from *highest boiling point* to *lowest boiling point*.

dimethyl ether $CH_3CH_2-O-CH_2CH_3$

butane $CH_3CH_2CH_2CH_3$

1-*butanol* $CH_3CH_2CH_2CH_2-OH$

highest boiling point

1. ____________________
2. ____________________
3. ____________________

lowest boiling point

HINT:

The boiling points and melting points of substances are determined by a ***competition*** between *noncovalent interactions* (working to keep the molecules close to one another) and *temperature* (kinetic energy working to separate the particles).

The stronger the *noncovalent interactions*, the higher the boiling point and melting point.

For more help: See chapter 5 part 9 video or chapter 5 section 4 in the textbook.

Go back

Click here to **check your answer**

Go to next question

5.25) Predict order of the following molecules when ranked from *highest boiling point* to *lowest boiling point*.

dimethyl ether $CH_3CH_2{-}O{-}CH_2CH_3$

butane $CH_3CH_2CH_2CH_3$

1-*butanol* $CH_3CH_2CH_2CH_2{-}OH$

highest boiling point

1. 1-*butanol* $CH_3CH_2CH_2CH_2{-}OH$
2. *dimethyl ether* $CH_3CH_2{-}O{-}CH_2CH_3$
3. *butane* $CH_3CH_2CH_2CH_3$

lowest boiling point

EXPLANATION:

The boiling points and melting points of substances are determined by a ***competition*** between *noncovalent interactions* (working to keep the molecules close to one another) and *temperature* (kinetic energy working to separate the particles). **The stronger the *noncovalent interactions,* the higher the boiling point and melting point.**

Butane will have the lowest boiling point because *butane* molecules can only interact with each other though London forces. Furthermore, of all three molecules, *butane* has the weakest London forces because it is the smallest molecule.

Dimethyl ether is in the middle of the ranking because, in addition to London forces, *dimethyl ether* molecules can interact with each other through ***dipole-dipole forces***. D*imethyl ether* molecules can interact with each other through ***dipole-dipole forces*** because they are **polar**.

1-*butanol* will have the highest boiling point because, in addition to London forces and dipole-dipole forces, 1-*butanol* molecules can interact with each other through ***hydrogen bonding***.

Go back

For more details: See chapter 5 part 9 video or chapter 5 section 4 in the textbook.

Go to next question

5.26) Match each of the **solid types** (on the left) with its **description** (on the right).

***i*) Ionic Solids**

***ii*) Molecular Solids**

***iii*) Covalent Network Solids**

***iv*) Metallic Solids**

***v*) Amorphous Solids**

Description Choices:

a) The nuclei and their core electrons are in lattice positions and the valence electrons are mobile and dispersed throughout the entire crystal.

b) The particles are not arranged in an ordered pattern.

c) The entire bulk of the crystalline solid is composed of atoms that are all covalently bonded to their neighbors.

d) Composed of molecules that are arranged in a lattice pattern such that the noncovalent interactions are maximized.

e) Composed of cations and anions that are arranged in a lattice pattern such that the attraction of unlike charges is maximized and the repulsion of like charges is minimized (ionic bonding).

Go back

Click here for a **hint**

Click here to **check your answer**

This is the last chapter 5 review problem

5.26) Match each of the **solid types** (on the left) with its **description** (on the right).

- *i*) **Ionic Solids (e)**
- *ii*) **Molecular Solids**
- *iii*) **Covalent Network Solids**
- *iv*) **Metallic Solids**
- *v*) **Amorphous Solids (b)**

HINT:

Description Choices:

a) The nuclei and their core electrons are in lattice positions and the valence electrons are mobile and dispersed throughout the entire crystal.

b) The particles are not arranged in an ordered pattern.

c) The entire bulk of the crystalline solid is composed of atoms that are all covalently bonded to their neighbors.

d) Composed of molecules that are arranged in a lattice pattern such that the noncovalent interactions are maximized.

e) Composed of cations and anions that are arranged in a lattice pattern such that the attraction of unlike charges is maximized and the repulsion of like charges is minimized (ionic bonding).

Go back

For more help: See chapter 5 part 10 video or chapter 5 section 5 in the textbook.

Click here to **check** **your answer**

This is the last chapter 5 review problem

5.26) Match each of the **solid types** (on the left) with its **description** (on the right).

i) **Ionic Solids (e)**

ii) **Molecular Solids (d)**

iii) **Covalent Network Solids (c)**

iv) **Metallic Solids (a)**

v) **Amorphous Solids (b)**

Description Choices:

a) The nuclei and their core electrons are in lattice positions and the valence electrons are mobile and dispersed throughout the entire crystal.

b) The particles are not arranged in an ordered pattern.

c) The entire bulk of the crystalline solid is composed of atoms that are all covalently bonded to their neighbors.

d) Composed of molecules that are arranged in a lattice pattern such that the noncovalent interactions are maximized.

e) Composed of cations and anions that are arranged in a lattice pattern such that the attraction of unlike charges is maximized and the repulsion of like charges is minimized (ionic bonding).

For more details: See chapter 5 part 10 video or chapter 5 section 5 in the textbook.

Go back

This is the last chapter 5 review problem