Test

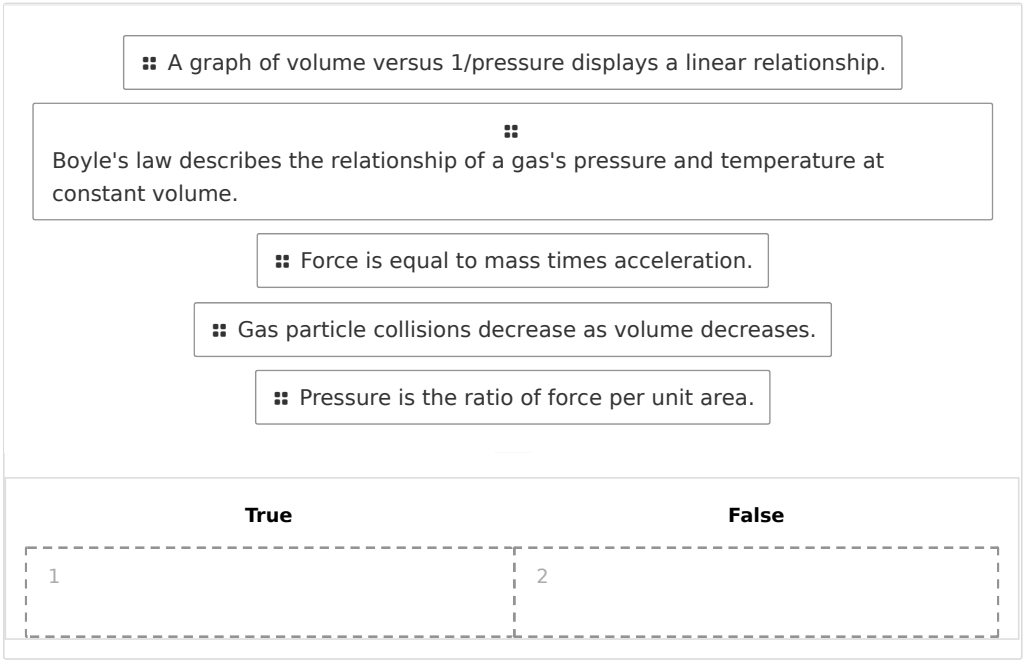
Digital Ideal Gas Law

Final Report - Answer Guide

Institution	SI Curriculum Development University
Session	Test
Course	Test
Instructor	Corinne Brown

Test Your Knowledge

Classify each statement as true or false.



Correct answers:

1 Force is equal to mass times acceleration.

Pressure is the ratio of force per unit area.

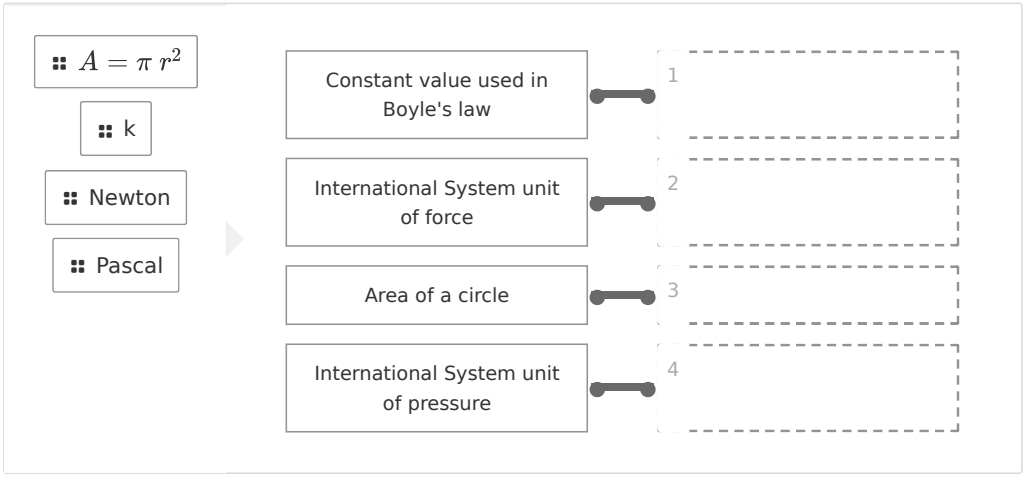
A graph of volume versus 1/pressure displays a linear relationship.

2

Boyle's law describes the relationship of a gas's pressure and temperature at constant volume.

Gas particle collisions decrease as volume decreases.

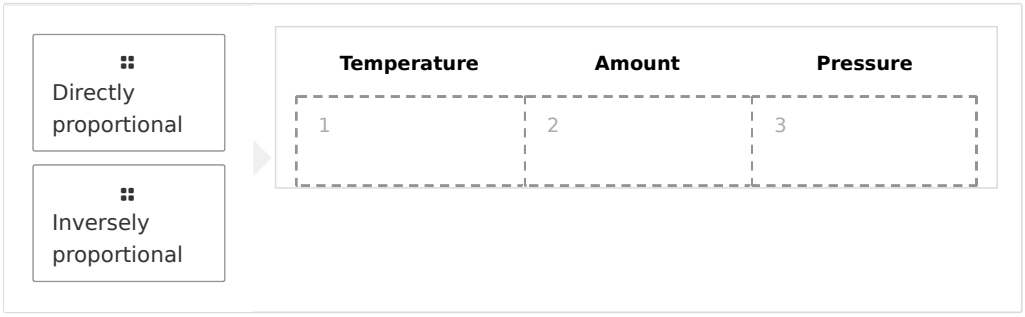
Match each term with the best description.



Correct answers:

1 k 2 Newton 3 $A = \pi\, r^2$ 4 Pascal

According to the ideal gas law, match the relationship between the following properties and how they relate to volume of an ideal gas.



Correct answers:

1 Directly proportional 2 Directly proportional

3 Inversely proportional

Exploration

The gas phase of matter has no fixed volume or shape.

- True ✔
- False

When volume of gas in a closed system decreases, the pressure of the gas in the system _____.

- decreases
- increases ✔
- remains constant

When pressure is plotted against volume, the relationship is _____.

- linear
- nonlinear ✔
- exponential
- static

What is the relationship between temperature and volume?

- Inverse
- Direct ✔
- No Relationship

For defining standard temperature and pressure of an ideal gas, what is the temperature for STP?

- 0 K
- 100 K
- 273 K ✔
- 1000 K

The relationship between volume and moles of ideal gas is a direct relationship.

- [x] True
- [ ] False

Exercise 1

What variables were being held constant when you collected data for:

1. **Data Table 1**
2. **Data Table 2**
3. **Data Table 3**
4. **Data Table 4**
5. **Data Table 5**

1. volume and number of moles
2. temperature and number of moles
3. pressure and number of moles
4. pressure and number of moles
5. pressure and temperature

Decide whether the following are directly or inversely proportional based on the data you collected.

1. **Pressure and temperature**
2. **Pressure and volume**
3. **Volume and temperature**
4. **Number of moles and volume**

1. directly
2. inversely
3. directly
4. directly

Would the results gathered in the data tables be different if a different ideal gas was used? (Ex: the red "light" particles in the simulation.)

No, they wouldn't be different. We can see this principle in Avogadro's Law: different ideal gases in the same chamber will contain the same number of moles. Ideal gases may travel faster or slower, as shown in the simulation, but their resultant properties (also as shown in the simulation) with respect to the ideal gas law remain the same.

Why does the simulation make it difficult to turn the temperature down to 0 K? Hint: What would happen to gas particles in real life at these temperatures and why is this a departure from ideal gas behavior?

Actual gases would condense to a liquid and eventually a solid that has no motion at all by 0 K. Condensation is not a part of ideal gas behavior because it breaks the law that ideal gas particles will remain fairly far apart and be neither attracted or repulsed by each other.

Why is the width of the chamber an adequate substitute for volume?

The chamber has a constant height. As such, changing the width of the chamber proportionally changes the "volume" of the chamber (which is only represented in 2D by the area of the chamber anyway in this simulation).

Describe how the simulation is (or is not) able to represent the following qualities of ideal gases:

1. **Gas particles are separated by relatively large distances.**
2. **Gas particles are constantly in random motion.**
3. **Gas particles undergo elastic collisions.**
4. **Gas particles are not attracted to nor repulsed by each other.**
5. **The average speed/energy of gas molecules in any sample is proportional to the temperature.**

0 / 10000 Word Limit

Data Table 1: Relationship Between Temperature and Pressure
(SAMPLE ANSWER BELOW)

Temperature (K)	Pressure (atm)
300	17.5
200	11.7
100	5.9
500	29.2
700	40.9
900	52.6

Data Table 2: Relationship Between Volume and Pressure
(SAMPLE ANSWER BELOW)

Volume (Width) (nm)	Pressure (atm)

15.0	11.7
12.0	14.7
9.0	19.5
6.0	29.2

Data Table 3: Relationship Between Temperature and Volume
(SAMPLE ANSWER BELOW)

Temperature (K)	Volume (Width) (nm)
150	5.0
250	8.3
350	11.7
450	15.0

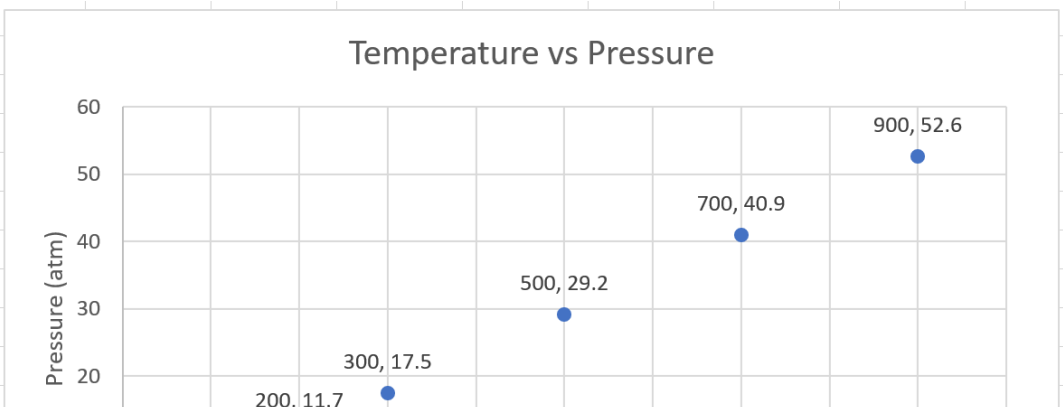
Data Table 4: Relationship Between Volume and Temperature
(SAMPLE ANSWER BELOW)

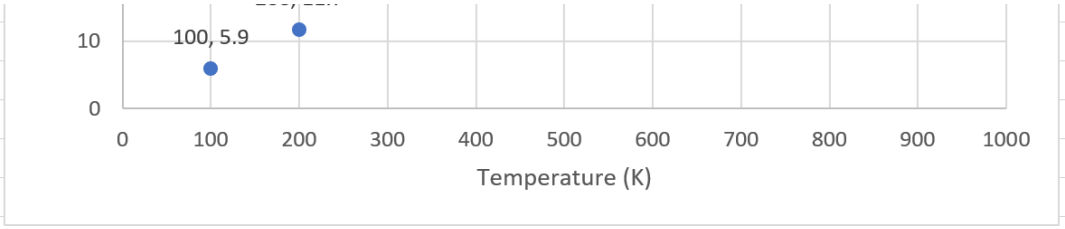
Volume (Width) (nm)	Temperature (K)
10.0	300
15.0	450
12.0	360
9.0	270
6.0	180

Data Table 5: Relationship Between Number of Particles and Volume
(SAMPLE ANSWER BELOW)

Number of Particles	Volume (Width) (nm)
50	5.0
100	10.0
150	15.0
Constant temperature:	150

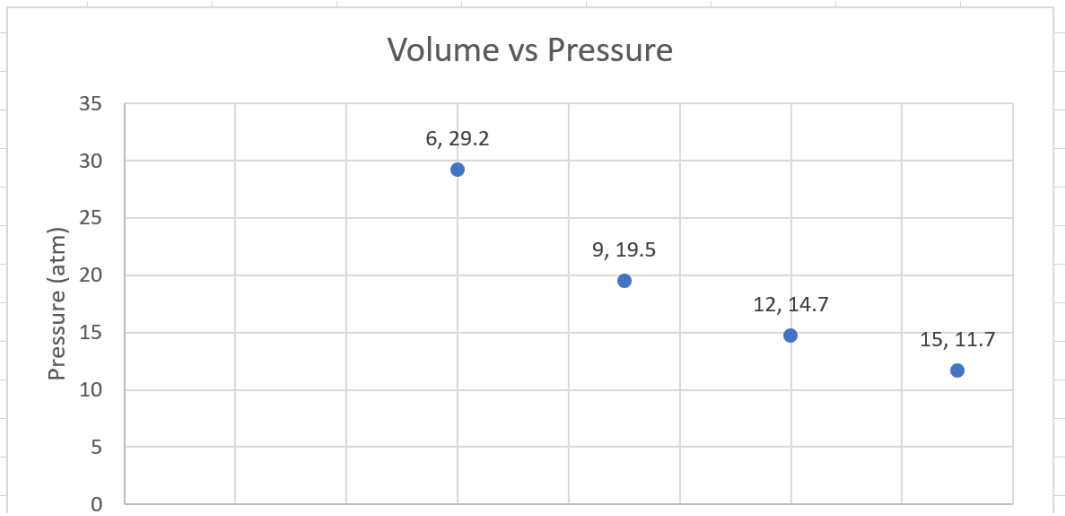
Graph 1: Relationship Between Temperature and Pressure
(SAMPLE ANSWER BELOW)





Graph 2: Relationship Between Volume and Pressure

(SAMPLE ANSWER BELOW)



Graph 3: Relationship Between Temperature and Volume

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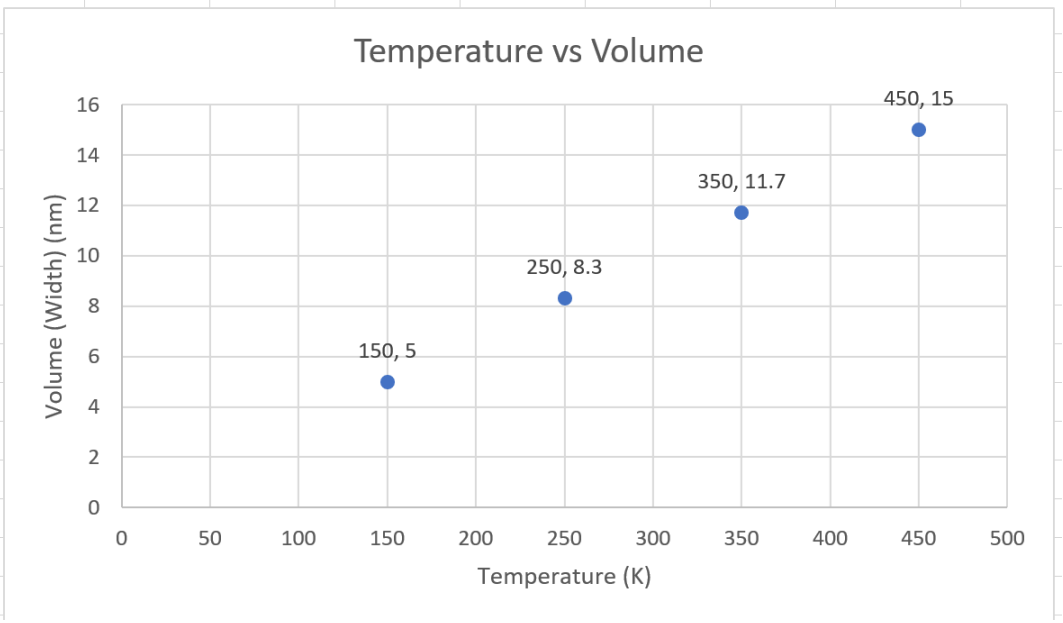
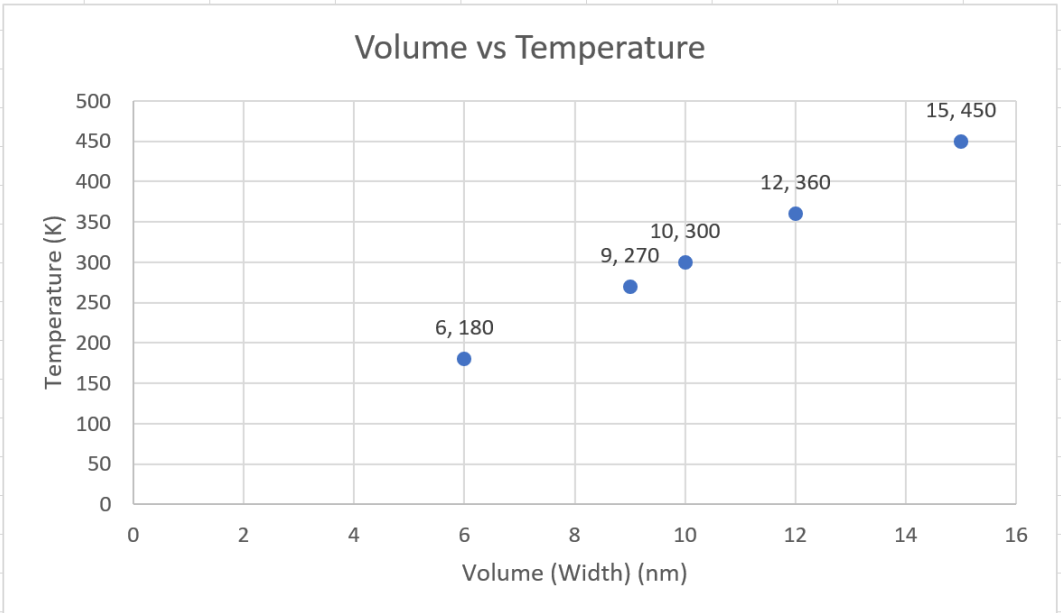


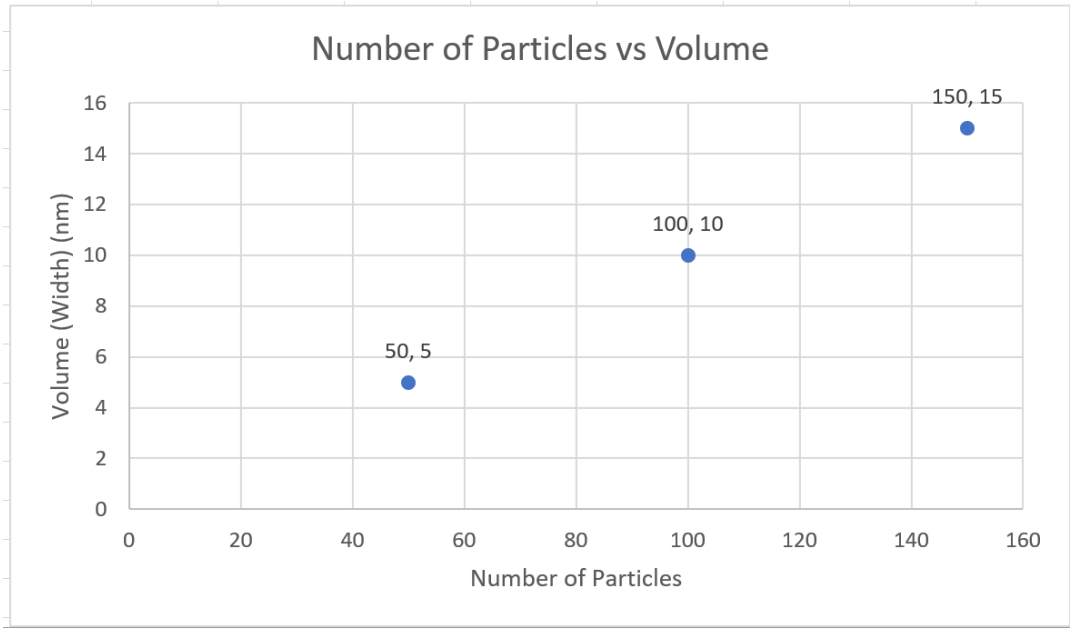
Graph 4: Relationship Between Volume and Temperature

(SAMPLE ANSWER BELOW)



Graph 5: Relationship Between Number of Particles and Volume

(SAMPLE ANSWER BELOW)



Competency Review

Gas particles in a closed system _____.

- are in constant motion
- move randomly
- collide with one another and the sides of the container
- All of the above ✔

A graph that describes the relationship of volume versus the inverse value of pressure (1/P) displays a linear relationship.

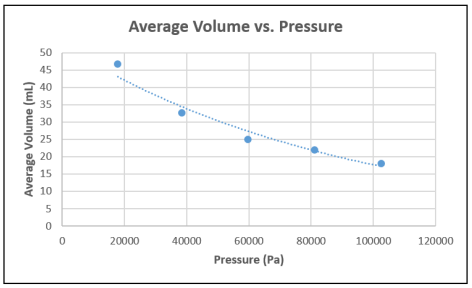
- True ✔
- False

A syringe is filled with gas and sealed to create a closed system. What will happen when the plunger of the syringe is depressed?

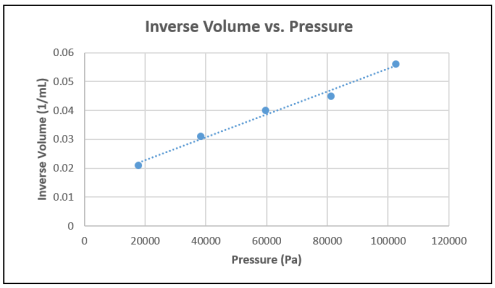
- The volume of the gas will increase.
- The number of gas particles will decrease.
- Gas particles will have an increased rate of collisions. ✔
- Pressure will decrease slightly.

Which scatter plot describes a linear relationship?

A:



B:



- A
- B ✔
- Both A and B
- Neither A nor B

At a constant temperature, there are two containers: one can contain 2 liters of gas and the second can contain 20 liters of gas. If the pressure is the same in both vessels, the second container must hold _____ the number of moles of ideal gas compared to the first.

- 10 times ✔
- 20 times
- 1/20th the
- the same number

Charles Law states that _____ and ____ are directly proportional.

- temperature; volume ✔
- volume; number of moles
- volume; pressure
- temperature; pressure

In the ideal gas law equation, what unit of measurement represents volume?

- mililiter
- liter ✔
- ounce
- moles

_____ states that temperature and pressure are directly proportional.

- Boyle's Law
- Charles' Law
- Gay-Lussac's law ✔
- Avogadro's Law

Pressure and volume are _____ proportional.

- directly
- inversely ✔
- sometimes
- not

Temperature and number of moles are _____ proportional.

- directly
- inversely ✔
- sometimes
- not

In a chamber with constant pressure and temperature, adding additional moles of ideal gas to the system will result in _____.

- increased pressure
- decreased proportionality
- decreased volume
- increased volume ✔

Extension Questions

A car engine is powered by burning octane (C_8H_{18}) with oxygen (O_2). The combustion reaction forms carbon dioxide (CO_2) and water (H_2O).

a) Write the balanced chemical equation for this combustion reaction.

b) Assuming a reaction starts with 1 mole of octane, which burns at 220°C, and is at a pressure of 1 atm, what volume will the products occupy upon reaction completion?

(SAMPLE ANSWER BELOW)

a. The balanced chemical equation is $2C_8H_{18} + 25\ O_2 \rightarrow 16\ CO_2 + 18\ H_2O$
b. 1 mole of C_8H_{18} yields 8 moles CO_2 and 9 moles H_2O with a total of 17 moles. Solving the ideal gas equation PV = nRT
V = 17 moles (0.082 L*atm/K*mol)(493K)/(1atm)
V = 687 L