

Worksheet 13: Kinetic Theory and the Ideal Gas Law

Objective F: Ideal Gas Law: $pV = nRT$, $R = 8.31 \text{ J}/(\text{mol K})$

1. What is the volume of one mol of an ideal gas at standard temperature and pressure (STP)? ($P = 1.000 \text{ atm} = 1.013 \times 10^5 \text{ Pa}$, $T = 0^\circ\text{C} = 273.15 \text{ K}$) What is the volume in liters? ($1 \text{ m}^3 = 1000 \text{ liters}$) (22.4 liters)
2. George Uss has 0.34 mols of Xenon tetrafluoride in a container with a volume of 0.159 m^3 at 78.0°C . What is the **pressure**? ($6.2\text{E}3 \text{ Pa}$)
3. Hugh Jass has a volume of 143 liters and 2.56 mols of Xenon gas at a pressure of 67,120 Pa. What must be the **temperature** in Kelvins? What is the temperature in $^\circ\text{C}$ (451 K, 178°C)
4. Anita Breke fills a large helium balloon with 2.18 grams of Helium gas. How many mols of He is this? What is the pressure in the balloon if the gas occupies a volume of 12.05 liters ($1000 \text{ liters} = 1 \text{ m}^3$) at a temperature of 18.0°C ? (Beware the ideo of Celsius!) What is that pressure in atmospheres? What is the gauge pressure in Pa and Atmospheres? (0.545 mols, $1.09 \times 10^5 \text{ Pa}$, 1.08 atm, $8 \times 10^3 \text{ Pa}$, .08 atm)
5. A reaction vessel operates at 3.14 atmospheres. What is that pressure in Pa? If the vessel has a volume of 0.113 m^3 , is at a temperature of 145°C , and contains pure Nitrogen gas, how many mols of nitrogen gas does it contain? How many grams of Nitrogen does it contain? (None Of Fred's Clients Bring Iron Hats – Nitrogen is a diatomic gas) ($3.18 \times 10^5 \text{ Pa}$, 10.3 mols, 290. g)
6. A container has a volume of 216 liters. ($1000 \text{ liters} = 1 \text{ m}^3$) If it can sustain a pressure of 13.5 atmospheres before bursting, and contains 89.1 grams of Hydrogen gas, a) what is its bursting pressure in Pa? b) how many mols of Hydrogen does it contain? and c) what is its maximum operating temperature in K and $^\circ\text{C}$? ($1.37 \times 10^6 \text{ Pa}$, 44.2 mols, 804 K, 531°C)
7. A 2.00 liter bottle contains 18.15 grams of Bromine gas and is at a gauge pressure of 0.153 atm. What is its temperature in Celsius? (-26°C)
8. George has 205 grams of Hydrogen gas at 1275 Torr Gauge pressure and 127.0°C . What must be the **volume** of the container? (1.25 m^3)
9. Jeanne has 1,529 grams of Xenon gas in 127 liters at a temperature of -16.0°C . What must be the **gauge pressure in psi**? (13.7 psi gauge)

Some molar masses:

H	1.0079
He	4.003
N	14.0067
Br	79.904
Xe	131.293

Objective G: Combined Gas Law: $\frac{PV}{nT} = \frac{PV}{nT}$

10. An aerosol can is at an absolute pressure of 603 Boogalas when it is at 312 K. If I put it in liquid nitrogen and lower its temperature to 77.0 K, what is the new **pressure** in Boogalas? (1000 milli Boogalas = 1 Boogala) (Assume it does not leak, and the volume remains constant) (149 Boogalas)
11. Air trapped in an airtight cylinder when the piston is 34.1 inches high is at 57.0 Jukkulas. How **high** must the piston be if the pressure is later at a pressure of 115 Jukkulas? Assume temperature remains constant. (16.9 inches)
12. A Tupperware container is at 1.00 atm at 21.0°C . (Convert to K) It is heated in a microwave to 99.5°C with the lid on. Assuming no gas escapes, what is the pressure inside in atm? (1.27 atm)
13. A quantity of ideal gas is compressed at constant temperature from 34.5 liters to 12.4 liters. What was the initial pressure if the final pressure was $2.45 \times 10^5 \text{ Pa}$? ($8.81 \times 10^4 \text{ Pa}$)
14. A balloon has a volume of 1.25 liters at 20.5°C . At what temperature does it have a volume of 1.02 liters, assuming the pressure and mols remain constant? (-33.5°C)
15. One mol of an ideal gas occupies 22.4 liters at STP. ($P = 1.000 \text{ atm}$ $T = 0.00^\circ\text{C}$) What volume does it occupy at 97.0°C and 1.29 atm? (23.5 liters)
16. My car tire has a gauge pressure of 32.0 PSI when the temperature is 23.0°C , what is the temperature in Celsius if the gauge pressure is later 48.0 PSI? (Assume that the tire does not leak, and that the volume remains constant) (124°C)
17. A container with a volume of 3.7 bushels is at a **gauge** pressure of 274 kPa and 57.0°C . If it does not leak, and later the **gauge** pressure is 117 kPa at 145°C , what is the new **volume** of the container? (8.06 bushels)
18. An airtight container has a sliding wall, so its volume can change. When the volume is 13.7 cc, the **gauge** pressure is 0.150 ATM and the temperature is 25.0°F . What must be the new **gauge pressure** if the container has a volume of 42.1 cc at $450.^\circ\text{F}$? (Absolute zero is -459.67°F) (-0.298 atm)
19. A steel nitrogen tank has a mass of 5.36 kg. When it is at 68.0°F , and 742 psi gauge, it has a mass of 9.83 kg because of the added nitrogen gas. If the gauge pressure is 347 psi, and the mass of the tank is 7.15 kg because some nitrogen was released, what must be the temperature? ($170.^\circ\text{F}$)

Objective H:

Questions:

20. When does the ideal gas law not work, and why does it not work?
21. Why is there almost no atmospheric helium and hydrogen?