

$$P_1 V_1 = P_2 V_2 \quad \text{so} \quad \frac{AB}{C} = D$$

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Boyle's Law Worksheet

1. A gas occupies 12.3 liters at a pressure of 40.0 mm Hg. What is the volume when the pressure is increased to 60.0 mm Hg?

$$P_1 = 40 \text{ mmHg} \quad V_2 = ? \quad ? = \frac{40 \text{ mmHg} \times 12.3 \text{ L}}{60 \text{ mmHg}} = 8.2 \text{ L}$$

$$V_1 = 12.3 \text{ L} \quad P_2 = 60 \text{ mmHg}$$

2. If a gas at 25.0 °C occupies 3.60 liters at a pressure of 1.00 atm, what will be its volume at a pressure of 2.50 atm?

$$P_1 = 1 \text{ atm} \quad V_2 = ? \quad \frac{1 \text{ atm} \times 3.6 \text{ L}}{2.5 \text{ atm}} = 1.44 \text{ L}$$

$$V_1 = 3.6 \text{ L} \quad P_2 = 2.5 \text{ atm}$$

3. To what pressure must a gas be compressed in order to get into a 3.00 cubic foot tank the entire weight of a gas that occupies 400.0 cu. ft. at standard pressure?

$$P_1 = 1 \text{ atm} \quad V_2 = 3 \text{ ft}^3 \quad \frac{400 \text{ ft}^3 \times 1 \text{ atm}}{3 \text{ ft}^3} = 133.3 \text{ atm}$$

$$V_1 = 400 \text{ ft}^3 \quad P_2 = ?$$

4. A gas occupies 1.56 L at 1.00 atm. What will be the volume of this gas if the pressure becomes 3.00 atm?

$$P_1 = 1 \text{ atm} \quad V_2 = ? \quad \frac{1 \text{ atm} \times 1.56 \text{ L}}{3 \text{ atm}} = 0.52 \text{ L}$$

$$V_1 = 1.56 \text{ L} \quad P_2 = 3 \text{ atm}$$

5. A gas occupies 11.2 liters at 0.860 atm. What is the pressure if the volume becomes 15.0 L?

$$P_1 = 0.860 \text{ atm} \quad V_2 = 15 \text{ L} \quad \frac{0.860 \text{ atm} \times 11.2 \text{ L}}{15 \text{ L}} = 0.642 \text{ atm}$$

$$V_1 = 11.2 \text{ L} \quad P_2 = ?$$

6. 500.0 mL of a gas is collected at 745.0 mm Hg. What will the volume be at standard pressure?

$$P_1 = 745 \text{ mmHg} \quad V_2 = ? \quad \frac{745 \text{ mmHg} \times 500 \text{ mL}}{760 \text{ mmHg}} = 490.1$$

$$V_1 = 500 \text{ mL} \quad P_2 = 760 \text{ mmHg}$$

7. Convert 350.0 mL at 740.0 mm of Hg to its new volume at standard pressure.

$$P_1 = 740 \text{ mmHg} \quad V_1 = 350 \text{ mL} \quad P_2 = 760 \quad V_2 = \frac{740 \times 350}{760} = 340.8 \text{ mL}$$

8. Convert 338 L at 63.0 atm to its new volume at standard pressure.

$$P_1 = 63 \text{ atm} \quad V_1 = 338 \text{ L} \quad P_2 = 1 \quad V_2 = ? \quad \frac{63 \times 338}{1} = 21,306 \text{ L}$$

9. Convert 273.15 mL at 166.0 mm of Hg to its new volume at standard pressure.

$$P_1 = 166 \text{ mmHg} \quad V_1 = 273.15 \text{ mL} \quad P_2 = 760 \text{ mmHg} \quad V_2 = ? \quad \frac{166 \times 273.15}{760} = 59.65 \text{ mL}$$

10. Convert 77.0 L at 18.0 mm of Hg to its new volume at standard pressure.

$$P_1 = 18 \text{ mmHg} \quad V_1 = 77 \text{ L} \quad P_2 = 760 \text{ mmHg} \quad V_2 = ? \quad \frac{18 \times 77}{760} = 1.82 \text{ L}$$

11. When the pressure on a gas increases, will the volume increase or decrease?

$P \uparrow \quad V \downarrow$

12. If the pressure on a gas is decreased by one-half, how large will the volume change be?

2x

13. A gas occupies 4.31 liters at a pressure of 0.755 atm. Determine the volume if the pressure is increased to 1.25 atm.

$$P_1 = 0.755 \text{ atm} \quad P_2 = 1.25 \text{ atm} \quad \frac{0.755 \text{ atm} \times 4.31 \text{ L}}{1.25 \text{ atm}} = 2.60 \text{ L}$$

$$V_1 = 4.31 \text{ L} \quad V_2 = ?$$

14. 600.0 mL of a gas is at a pressure of 8.00 atm. What is the volume of the gas at 2.00 atm?

$$P_1 = 8 \text{ atm} \quad P_2 = 2 \text{ atm} \quad \frac{600 \text{ mL} \times 8 \text{ atm}}{2 \text{ atm}} = 2400 \text{ mL}$$

$$V_1 = 600 \text{ mL} \quad V_2 = ?$$

15. 400.0 mL of a gas are under a pressure of 800.0 torr. What would the volume of the gas be at a pressure of 1000.0 torr?

$$P_1 = 800 \text{ torr} \quad P_2 = 1000 \text{ torr} \quad \frac{800 \text{ torr} \times 400 \text{ mL}}{1000} = 320 \text{ mL}$$

$$V_1 = 400 \text{ mL} \quad V_2 = ?$$

16. 4.00 L of a gas are under a pressure of 6.00 atm. What is the volume of the gas at 2.00 atm?

$$P_1 = 6 \text{ atm} \quad P_2 = 2 \text{ atm} \quad \frac{4 \text{ L} \times 6 \text{ atm}}{2 \text{ atm}} = 12 \text{ L}$$

$$V_1 = 4 \text{ L} \quad V_2 = ?$$

17. A gas occupies 25.3 mL at a pressure of 790.5 mm Hg. Determine the volume if the pressure is reduced to 0.804 atm.

$$P_1 = 790.5 \text{ mm Hg} \quad P_2 = \frac{0.804 \text{ atm} \times 760}{1} = 611 \text{ mm Hg} \quad \frac{790.5 \times 25.3}{611} = 32.7 \text{ mL}$$

$$V_1 = 25.3 \text{ mL} \quad V_2 = ?$$

18. A sample of gas has a volume of 12.0 L and a pressure of 1.00 atm. If the pressure of gas is increased to 2.00 atm, what is the new volume of the gas?

$$P_1 = 1 \quad P_2 = 2 \text{ atm}$$

$$V_1 = 12 \text{ L} \quad V_2 = 6 \text{ L}$$

19. A container of oxygen has a volume of 30.0 mL and a pressure of 4.00 atm. If the pressure of the oxygen gas is reduced to 2.00 atm and the temperature is kept constant, what is the new volume of the oxygen gas?

$$P_1 = 4 \text{ atm} \quad V_1 = 30 \text{ mL} \quad P_2 = 2 \text{ atm} \quad V_2 = 60 \text{ mL}$$

20. A tank of nitrogen has a volume of 14.0 L and a pressure of 760.0 mm Hg. Find the volume of the nitrogen when its pressure is changed to 400.0 mm Hg while the temperature is held constant.

$$P_1 = 760 \text{ mm} \quad P_2 = 400 \text{ mm} \quad \frac{P_1 V_1}{P_2} = V_2 = 26.6$$

$$V_1 = 14.0 \text{ L} \quad V_2 = 26.6 \text{ L}$$

21. A 40.0 L tank of ammonia has a pressure of 8.00 atm. Calculate the volume of the ammonia if its pressure is changed to 12.0 atm while its temperature remains constant.

$$P_1 = 8 \text{ atm} \quad P_2 = 12 \text{ atm} \quad \frac{P_1 V_1}{P_2} = 26.67 \text{ L}$$

$$V_1 = 40 \text{ L} \quad V_2 = 26.67 \text{ L}$$

22. Two hundred liters of helium at 2.00 atm and 28.0 °C is placed into a tank with an internal pressure of 600.0 kPa. Find the volume of the helium after it is compressed into the tank when the temperature of the tank remains 28.0 °C.

$$P_1 = 2 \text{ atm} \quad P_2 = 600 \text{ kPa} \quad 2 \text{ atm} = 202.6 \text{ kPa}$$

$$V_1 = 200 \text{ L} \quad V_2 = 67.5 \text{ L} \quad \frac{P_1 V_1}{P_2} = \frac{202.6 \text{ kPa} \times 200 \text{ L}}{600 \text{ kPa}} = 67.5 \text{ L}$$

23. You are now wearing scuba gear and swimming under water at a depth of 66.0 ft. You are breathing air at 3.00 atm and your lung volume is 10.0 L. Your scuba gauge indicates that your air supply is low so, to conserve air, you make a terrible and fatal mistake: you hold your breath while you surface. What happens to your lungs? Why?

$$P_1 = 3 \text{ atm} \quad P_2 = 1 \text{ atm}$$

$$V_1 = 10 \text{ L} \quad V_2 = 30 \text{ L}$$

Your lungs would burst from the 30 liters of air in them.

24. Solve Boyle's Law equation for V_2 .

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

25. Boyle's Law deals what quantities?

Pressure and volume

- a. pressure/temperature
- b. pressure/volume
- c. volume/temperature
- d. volume temperature/pressure

26. A 1.5 liter flask is filled with nitrogen at a pressure of 12 atmospheres. What size flask would be required to hold this gas at a pressure of 2.0 atmospheres?

$$P_1 = 12 \text{ atm} \quad V_1 = 1.5 \text{ L} \quad P_2 = 2 \text{ atm} \quad V_2 = 9 \text{ L} \quad \frac{P_1 V_1}{P_2} = V_2 = 9$$

27. 300 mL of O_2 are collected at a pressure of 645 mm of mercury. What volume will this gas have at one atmosphere pressure?

$$P_1 = 645 \text{ mmHg} \quad V_1 = 300 \text{ mL} \quad P_2 = 760 \quad V_2 = 254.6 \text{ mL}$$

28. How many cubic feet of air at standard conditions (1.00 atm.) are required to inflate a bicycle tire of 0.50 cu. ft. to a pressure of 3.00 atmospheres?

$$V_1 = ? \quad P_1 = 1 \text{ atm} \quad V_2 = 0.5 \quad P_2 = 3 \text{ atm} \quad V_1 = 1.5 \text{ L}$$

29. How much will the volume of 75.0 mL of neon change if the pressure is lowered from 50.0 torr to 8.00 torr?

30. A tank of helium has a volume of 50.0 liters and is under a pressure of 2000.0 p.s.i.. This gas is allowed to flow into a blimp until the pressure in the tank drops to 40.00 p.s.i. and the pressure in the blimp is 30.00 p.s.i.. What will be the volume of the blimp?

$$P_1 = 1960 \text{ psi} \quad V_1 = 50 \text{ L} \quad P_2 = 30 \text{ psi} \quad V_2 = ? \quad 3266.7$$

31. What pressure is required to compress 196.0 liters of air at 1.00 atmosphere into a cylinder whose volume is 26.0 liters?

$$P_1 = 1 \text{ atm} \quad P_2 = 7.54 \text{ atm}$$

$$V_1 = 196 \text{ L} \quad V_2 = 26 \text{ L}$$

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

Cross multiply +
isolate to solve

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Charles' Law Intro Sheet

1. A gas is collected and found to fill 2.85 L at 25.0°C. What will be its volume at standard temperature?

$$V_1 = 2.85 \text{ L} \quad V_2 = ? \quad \frac{V_1 T_2}{T_1} = V_2 = \frac{2.85 \text{ L} \cdot 273 \text{ K}}{298 \text{ K}} = 2.61 \text{ L}$$
$$T_1 = 25 + 273 = 298 \text{ K} \quad T_2 = 273 \text{ K}$$

2. 4.40 L of a gas is collected at 50.0°C. What will be its volume upon cooling to 25.0°C?

$$V_1 = 4.40 \text{ L} \quad V_2 = ? = \frac{V_1 T_2}{T_1} = 4.06 \text{ L}$$
$$T_1 = 50 + 273 = 323 \text{ K} \quad T_2 = 25 + 273 = 298 \text{ K}$$

3. 5.00 L of a gas is collected at 100 K and then allowed to expand to 20.0 L. What must the new temperature be in order to maintain the same pressure (as required by Charles' Law)??

$$V_1 = 5 \text{ L} \quad V_2 = 20 \text{ L} \quad T_2 = \frac{T_1 V_2}{V_1}$$
$$T_1 = 100 \text{ K} \quad T_2 = 400 \text{ K} = \frac{100 \text{ K} \cdot 20 \text{ L}}{5 \text{ L}}$$

(two doublings of vol = 2 doublings of temp)

(-273 = 127°C)

4. a 2.5 liter sample of gas is at STP. When the temperature is raised to 273°C and the pressure remains constant, what is the new volume?

$$V_1 = 2.5 \text{ L} \quad V_2 = ? = \frac{V_1 T_2}{T_1} = \frac{2.5 \text{ L} \cdot 546 \text{ K}}{273 \text{ K}} = 5 \text{ L}$$
$$T_1 = 273 \text{ K} \quad T_2 = 273 + 273 = 546 \text{ K}$$

(make sense, 2x temp = 2x Volume)

5. An ideal gas at 7.00 °C is in a spherical flexible container having a radius of 1.18 cm. The gas is heated at constant pressure to 88.0 °C. Determine the radius of the spherical container after the gas is heated. [Volume of a sphere = $(4/3)\pi r^3$]

~~T₁ = 0°C~~
T₁ = 7.00 °C = 275 K

$$V_1 = \frac{4}{3} \pi r^3 = \frac{(1.18)^3 \pi \cdot 4}{3} = 21.9 \text{ cm}^3$$

$$T_1 = 275 \text{ K}$$

$$V_2 = ?$$

$$T_2 = 88 + 273 = 361 \text{ K}$$

$$V_2 = \frac{V_1 T_2}{T_1} = \frac{21.9 \text{ cm}^3 \cdot 361 \text{ K}}{275 \text{ K}} = 28.7 \text{ cm}^3$$

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} \quad \frac{a}{b} = \frac{c}{d} \quad \begin{matrix} \nearrow \\ a = \frac{bc}{d} \\ \searrow \\ b = \frac{ad}{c} \end{matrix}$$

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Charles' Law Worksheet

Continued numbers from Boyle's Law Sheet

32. Calculate the decrease in temperature when 2.00 L at 20.0°C is shrunk due to cooling to 1.00 L.

$$T_1 = 20^\circ + 273 = 293\text{K} \quad T_2 = \frac{V_1 T_1}{V_2} = \frac{1.0 \times 293\text{K}}{2.0} = 146.5\text{K} \quad \Delta T = \frac{1}{2}$$

33. 600.0 mL of air is at 20.0 °C. What is the volume at 60.0 °C?

$$V_1 = 600\text{ml} \quad V_2 = \frac{V_1 T_2}{T_1} = 682\text{ml}$$

$$T_1 = 293\text{K} \quad T_2 = 273 + 60 = 333$$

34. A gas occupies 900.0 mL at a temperature of 27.0 °C. What is the volume at 132.0 °C?

$$V_1 = 900\text{ml} \quad V_2 = \frac{405\text{K}}{300\text{K}} \times 900 = 1215\text{ml}$$

$$T_1 = 300\text{K} \quad T_2 = 132 + 273 = 405\text{K}$$

35. What change in volume results if 60.0 mL of gas is cooled from 33.0 °C to 5.00 °C?

oops its like

$$T_1 = 273 + 33 = 306 \quad T_2 = 273 + 5 = 278$$

$$60\text{ml} \times \frac{278}{306} = 54.5\text{ml} \quad \Delta V = 6\text{ml} \quad 5.5\text{ml}$$

36. Given 300.0 mL of a gas at 17.0 °C. What is its volume at 10.0 °C?

same mistake

$$T_1 = 273 + 17 = 290\text{K} \quad T_2 = 273 + 10 = 283\text{K}$$

$$300\text{ml} \times \frac{283}{290} = 292.8\text{ml}$$

37. A gas occupies 1.00 L at standard temperature. What is the volume at 333.0 °C?

ratio down right

$$T_1 = 273 \quad T_2 = 333 + 273 = 606\text{K}$$

$$\frac{606\text{K}}{273\text{K}} \times 1\text{L} = 2.22\text{L}$$

38. At 27.00 °C a gas has a volume of 6.00 L. What will the volume be at 150.0 °C?

$$T_2 = 150^\circ\text{C} = 423\text{K} \quad T_1 = 27^\circ\text{C} = 300\text{K}$$

$$6\text{L} \times \frac{423}{300} = 8.46\text{L}$$

39. At 225.0 °C a gas has a volume of 400.0 mL. What is the volume of this gas at 127.0 °C?

$$T_2 = 127 + 273 = 400\text{K} \quad T_1 = 225 + 273 = 498\text{K}$$

$$400\text{ml} \times \frac{400}{498} = 321.3\text{ml}$$

40. At 210.0 °C a gas has a volume of 8.00 L. What is the volume of this gas at -23.0 °C?

$$T_2 = -23^\circ\text{C} + 273 = 250\text{K} \quad T_1 = 210^\circ\text{C} + 273\text{K} = 483\text{K}$$

$$8\text{L} \times \frac{250}{483} = 4.14\text{L}$$

41. The temperature of a 4.00 L sample of gas is changed from 10.0 °C to 20.0 °C. What will the volume of this gas be at the new temperature if the pressure is held constant?

$$T_2 = 20^\circ + 273 = 293\text{K} \quad T_1 = 10^\circ + 273 = 283\text{K}$$

$$4\text{L} \times \frac{293}{283} = 4.14\text{L}$$

42. Carbon dioxide is usually formed when gasoline is burned. If 30.0 L of CO₂ is produced at a temperature of 1.00 x 10³ °C and allowed to reach room temperature (25.0 °C) without any pressure changes, what is the new volume of the carbon dioxide?

$$T_2 = 25^\circ\text{C} + 273\text{K} = 298\text{K} \quad T_1 = 3000^\circ\text{C} + 273\text{K} = 3273\text{K}$$

$$30\text{L} \times \frac{298}{3273} = 2.73\text{L}$$

explosive force of small gas @ high temps

43. A 600.0 mL sample of nitrogen is warmed from 77.0 °C to 86.0 °C. Find its new volume if the pressure remains constant.

$$T_2 = 86^\circ\text{C} + 273 = 359\text{K}$$

$$T_1 = 77^\circ\text{C} + 273 = 350\text{K}$$

$$V_2 = \frac{359\text{K}}{350\text{K}} \times 600\text{ml} = 615.4\text{ml}$$

44. What volume change occurs to a 400.0 mL gas sample as the temperature increases from 22.0 °C to 30.0 °C?

$$T_2 = 30 + 273 = 303\text{K}$$

$$T_1 = 22 + 273 = 295\text{K}$$

$$V_2 = \frac{303\text{K}}{295\text{K}} \times 400\text{ml} = 410.8\text{ml}$$

$$\Delta V = 10.8\text{ml}$$

45. A gas syringe contains 56.05 milliliters of a gas at 315.1 K. Determine the volume that the gas will occupy if the temperature is increased to 380.5 K

$$T_2 = 380.5\text{K}$$

$$T_1 = 315.1\text{K}$$

$$V_2 = \frac{380.5\text{K}}{315.1\text{K}} \times 56.05\text{ml} = 67.66\text{ml}$$

46. A gas syringe contains 42.3 milliliters of a gas at 98.15 °C. Determine the volume that the gas will occupy if the temperature is decreased to -18.50 °C.

$$T_2 = -18.5^\circ\text{C} + 273 = 254.5\text{K}$$

$$T_1 = 98.15^\circ\text{C} + 273 = 371.15\text{K}$$

$$V_2 = \frac{254.5\text{K}}{371.15\text{K}} \times 42.3\text{ml} = 29\text{ml}$$

47. When the temperature of a gas decreases, does the volume increase or decrease?

$$TV = V \downarrow$$

48. If the Kelvin temperature of a gas is doubled, the volume of the gas will increase by 2x.

49. Solve the Charles' Law equation for V_2 .

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

50. Charles' Law deals with what quantities?

- a. pressure/temperature
 b. pressure/volume
 c. volume/temperature
 d. volume/temperature/pressure



51. If 540.0 mL of nitrogen at 0.00 °C is heated to a temperature of 100.0 °C what will be the new volume of the gas?

$$T_2 = 373\text{K}$$

$$T_1 = 273\text{K}$$

$$V_2 = \frac{373\text{K}}{273\text{K}} \times 540\text{ml} = 737.8\text{ml}$$

52. A balloon has a volume of 2500.0 mL on a day when the temperature is 30.0 °C. If the temperature at night falls to 10.0 °C, what will be the volume of the balloon if the pressure remains constant?

$$T_2 = 283\text{K}$$

$$T_1 = 303\text{K}$$

$$V_2 = \frac{283\text{K}}{303\text{K}} \times 2500\text{ml} = 2334.98 = 2335\text{ml}$$

53. When 50.0 liters of oxygen at 20.0 °C is compressed to 5.00 liters, what must the new temperature be to maintain constant pressure?

same ratio technique

$$\frac{5\text{L}}{50\text{L}} \times 293\text{K} = 29.3\text{K}$$

54. If 15.0 liters of neon at 25.0 °C is allowed to expand to 45.0 liters, what must the new temperature be to maintain constant pressure?

$$\frac{45\text{L}}{15\text{L}} \times 298\text{K} = 894\text{K}$$