Lesson Check Answers

1. Gases are easily compressed because of the space between gas particles.
2. temperature, pressure, and amount of gas
3. Because the gas in the inflated air bag can be compressed, the bag absorbs some of the energy from the impact of a collision. The solid steering wheel cannot do this.
4. If the temperature decreases, the pressure will also decrease.
5. The volume would need to increase by a factor of four.
6. Increase the amount of gas in the container a hundredfold.
7. Sample answer: The pressure of the gas inside the sprayer is greater than atmospheric pressure. As the gas propels the contents out, the number of gas particles in the sprayer decreases and the gas pressure decreases.
8. **BIGIDEA** According to kinetic theory, the particles in a gas have insignificant volume, and the distance between particles in a gas is much greater than the distance between particles in a liquid or solid. Under pressure, the particles in a gas are forced closer together, resulting in a smaller overall volume.

Sample Problems

$P_1V_1 = P_2V_2$ Boyle's Law

$\mathbf{V_2 = P_1V_1 / P_2}$

9. $105 \text{ kPa} \times 2.50 \text{ L} = 40.5 \text{ kPa} \times V_2$
   $V_2 = 105 \text{ kPa} \times 2.50 \text{ L}/40.5 \text{ kPa} = 6.48 \text{ L}$

$\mathbf{P_1 = P_2V_2 / V_1}$

10. $205 \text{ kPa} \times 4.00 \text{ L} = P_2 \times 12.0 \text{ L}$
    $P_2 = 205 \text{ kPa} \times 4.00 \text{ L}/12.0 \text{ L} = 68.3 \text{ kPa}$

$V_1 / T_1 = V_2 / T_2$ Charles's Law

Must use K temperature

$\mathbf{V_2 = T_2V_1 / T_1}$

11. T_1 = 325°C + 273 = 598 K
T_2 = 25°C + 273 = 298 K
6.80 L/598 K = V_2/298 K
V_2 = 298 K × 6.80 L/598 K = 3.39 L

12. T_1 = −50.0°C + 273 = 223 K
T_2 = 100.0°C + 273 = 373 K
5.00 L/223 K = V_2/373 K
V_2 = 373 K × 5.00 L/223 K = 8.36 L

$P_1 / T_1 = P_2 / T_2$ Gay-Lussac's Law

Must use K temperature

$\mathbf{P_2 = P_1 T_2 / T_1}$

13. T_1 = 41°C + 273 = 314 K
T_2 = 22°C + 273 = 295 K
108 kPa/314 K = P_2/295 K
P_2 = 295 K × 108 kPa/314 K = 101 kPa

$P_1 / T_1 = P_2 / T_2$ … $\mathbf{T_2 = P_2 T_1 / P_1}$

14. T_1 = 27°C + 273 = 300 K
198 kPa/300 K = 225 kPa/T_2
T_2 = 225 kPa × 300 K/198 kPa = 341 K *(68°C)*

$P_1V_1 / T_1 = P_2V_2 / T_2$ Combined Gas Law

Must use K temperature

$\mathbf{V_2 = P_1 V_1 T_2 / P_2 T_1}$

15. $T_1 = 25°C + 273 = 298$ K
$T_2 = 125°C + 273 = 398$ K
155 kPa × 1.00 L/298 K = 605 kPa × V_2/398 K
V_2 = 398 K × 155 kPa × 1.00 L/(298 K × 605 kPa) = 0.342 L

$\mathbf{P_2 = P_1 V_1 T_2 / V_2 T_1}$

16. $T_1 = -50°C + 273 = 223$ K
$T_2 = 102°C + 273 = 375$ K
107 kPa × 5.00 L/223 K = P_2 × 7.00 L/375 K
P_2 = 375 K × 107 kPa × 5.00 L/(223 K × 7.00 L) = 1.29×10^2 kPa

Lesson Check Answers

17. At constant temperature, volume decreases as pressure increases.

18. At constant pressure, volume increases as temperature increases.

19. At constant volume, pressure increases as temperature increases.

20. The combined gas law allows you to do calculations when the only constant is the amount of gas.

21. $P_1 \times V_1 = P_2 \times V_2$; P_1 = initial pressure; V_1 = initial volume; P_2 = final pressure; V_2 = final volume

23. When the pressure is constant, $P_1 = P_2$, so the pressure terms cancel, leaving an equation for Charles's law.

24. The outside pressure decreases, causing a greater increase in the balloon's volume.

25. **BIGIDEA** As temperatures decrease toward absolute zero, particles in the gas slow down, and attractions between particles increase. A gas would liquefy and then solidify as it cooled to temperatures near absolute zero.

22. $P_1V_1 = P_2V_2$ Boyle's Law
$\mathbf{V_2 = P_1V_1 / P_2}$
V_2 = 101 kPa x 6.00 L / 25.0 kPa
V_2 = 24.2 L

Sample Problems

26. PV = nRT Ideal Gas Law … **n = PV/RT**
R = 8.31 L·kPa/K·mol based on the units given for the other variables

$n = 1.89 \times 10^3$ kPa x 685 L / 8.31 L·kPa/K·mol x 621 K
$n = 2.51 \times 10^2$ moles He

27. PV = nRT Ideal Gas Law … **P = nRT/V**
Must use K temperature
R = 8.31 L·kPa/K·mol based on the units given for the other variables

P = 0.450 mol x 8.31 L·kPa/K·mol x (273 + 25) K / 0.650 L
$P = 1.71 \times 10^3$ kPa

28. PV = nRT Ideal Gas Law … **n = PV/RT**
Must use K temperature
R = 8.31 L·kPa/K·mol based on the units given for the other variables

n = 102 kPa x 2.20 L / 8.31 L·kPa/K·mol x (273 + 37) K
n = 0.087 moles Air x 29 g/mol = 2.5 g Air

29. PV = nRT Ideal Gas Law … **V = nRT/P**
Must use K temperature
R = 8.31 L·kPa/K·mol based on the units given for the other variables

12 g x 1 mol/32 O_2 = 0.375 mol
V = 0.375 mol x 8.31 L·kPa/K·mol x (273 + 25) K / 52.7 kPa
V = 17.6 L

Lesson Check Answers

30. by using the equation for the ideal gas law *(PV = nRT)*

31. Real gases deviate from ideal behavior at low temperatures and high pressures.

32. 17.0 L

33. 4.48 kg

34. An ideal gas obeys the assumptions of kinetic theory. A real gas deviates from ideal behavior except within a small range of conditions.

35. The nitrogen molecule is nonpolar and the ammonia molecule is polar. So there are stronger intermolecular attractions in ammonia.

36. **BIGIDEA** In real gases, there are attractions between molecules, and the molecules have volume. At low temperatures, attractions between molecules pull them together and reduce the volume. At high pressures, the volume occupied by the molecules is a significant part of the total volume.

32. PV = nRT Ideal Gas Law … **V = nRT/P**
Must use K temperature
R = 8.31 L·kPa/K·mol based on the units given for the other variables

V = 0.582 mol x 8.31 L·kPa/K·mol x (273 + 15) K / 81.9 kPa
V = 17.1 L

33. PV = nRT Ideal Gas Law … **n = PV/RT**
Must use K temperature
R = 8.31 L·kPa/K·mol based on the units given for the other variables

n = 2.00 x 10^4 kPa x 20.0 L / 8.31 L·kPa/K·mol x (273 + 28) K
n = 159.9 moles N_2 (g) x 28 g/mol = 4478 g = 4.48 kg N_2 (g)

Sample Problems

Figure 14.6 The ratios are equal

37. Dalton's Law of Partial Pressure → $P_{total} = P_{O_2} + P_{N_2} + P_{CO_2}$

$P_{CO_2} = P_{total} - (P_{O_2} + P_{N_2})$

37. 32.9 kPa – 6.6 kPa – 23.0 kPa = 3.3 kPa

38. 20.0 kPa + 46.7 kPa + 26.7 kPa = 93.4 kPa, or 9.34×10^1 kPa

39. Graham's Law of Diffusion/Effusion

Rate H_2 (g) / Rate CO_2 (g) = √(molar mass CO_2) / √(molar mass H_2)

Rate H_2 (g) / Rate CO_2 (g) = √(44.0 g/mol) / √(2.00 g/mol)

Rate H_2 (g) / Rate CO_2 (g) = 6.6 / 1.4 = 4.7 / 1

40. Total pressure is equal to the sum of the partial pressures of the components.

41. Gases with lower molar masses diffuse and effuse faster than gases with higher molar masses.

42. Subtract the partial pressures of the other gases from the total pressure.

43. 191.3 kPa

44. During effusion, a gas escapes through a tiny hole in its container. In both cases, the rate depends on the molar mass.

45. Carbon monoxide and nitrogen have almost identical molar masses when the masses are rounded to two significant figures (28 g).

46. Both tables report data for dry air as mainly nitrogen and oxygen. Table 14.1 uses percents and includes a compound. The table on R1 uses ppm and provides specific data for elements.

43. Dalton's Law of Partial Pressure → $P_{total} = P_{O_2} + P_{N_2} + P_{CO_2} + P_{others}$

$P_{N_2} = P_{total} - (P_{O_2} + P_{CO_2} + P_{others})$

P_{N_2} = 245.0 kPa – 51.3 kPa – 0.10 kPa – 2.3 kPa = 191.3 kPa