RLP-CHEMA · RLP Chemistry A — Atoms, Bonding, Reactions, Gases and Solutions

Unit 4: Gases, Solutions and the Energy of Reactions

Practice Workbook. The same problems, in the same order, as the Practice sections of the online lessons.

Name _____ Period _____

Lesson 4.1 — The Tire Light on a Missouri Morning: Gas Particles and Gas Laws

FLUENCY

1. Convert 25 °C, −10 °C and 100 °C to kelvins.

2. In the kinetic-molecular model, what is assumed about the volume of the particles and the forces between them?

3. A gas at 1.0 atm occupies 2.0 L. At constant temperature it expands to 4.0 L. What is its new pressure?

4. A balloon holds 600 mL of air at 300 K. At constant pressure it is cooled to 250 K. What is its new volume?

5. A tire gauge reads 220 kPa. Atmospheric pressure is 101.325 kPa. What is the absolute pressure in the tire?

APPLICATION

6. A sealed 60.0 mL syringe of air at 101.3 kPa is pushed in to 24.0 mL at constant temperature. What is the new pressure, and what causes the increase in particle terms?

7. A tire is filled to 35 psi gauge at 25 °C. Overnight it cools to −5 °C with no leak and no volume change. What does the gauge read? (Atmospheric pressure 14.696 psi.)

8. How many moles of gas are in 2.50 L at 1.00 atm and 300 K? Use R = 0.082057 L·atm/(mol·K).

9. A gas sample of mass 0.850 g occupies 0.250 L at 100.0 kPa and 350 K. Find the molar mass (use R = 8.314 J/(mol·K) and convert to m^3 and Pa).

CHALLENGE

10. A 10.0 mL bubble at 3.0 atm and 275 K rises to 1.0 atm and 295 K. Find its new volume and say which change, pressure or temperature, matters more.

11. Compare the root-mean-square speeds of H_2 (2.016 g/mol) and N_2 (28.014 g/mol) at 293.15 K. Why does the lighter gas move faster although both have the same average kinetic energy?

REVIEW

12. How many moles are in 10.0 g of carbon dioxide (44.009 g/mol)?

13. What mass of CO_2 is 0.500 mol, and what volume does that much gas occupy at 293.15 K and 1.000 atm?

Lesson 4.2 — A Syringe in an Ice Bath: Finding Absolute Zero from Gas Volumes

FLUENCY

1. A sealed syringe holds 46.6 mL at 1.0 °C. At constant pressure, what is its volume at 21 °C?

2. Convert 12 °C to kelvins.

3. Why must temperature be in kelvins, not °C, in the equation $V_1/T_1 = V_2/T_2$?

4. A best-fit line has a slope of 0.17 mL per °C and passes through 50.0 mL at 21 °C. Predict the volume at 5 °C.

5. A reading of 46.5 mL has an uncertainty of ±0.5 mL. What is the percent uncertainty?

APPLICATION

6. Two of your runs are (11 °C, 48.0 mL) and (22 °C, 50.5 mL). Find the slope and the temperature at which the line reaches zero volume.

7. A student's extrapolation gives absolute zero at −246 °C. What is the percent error compared with −273.15 °C?

8. How many moles of air are in a 50.0 mL syringe at 101.325 kPa and 294.15 K? (R = 8.314462618 J/(mol·K))

9. Your plunger sticks, so the gas is at a slightly lower pressure than outside when you read the cold bath. Does your cold-bath volume read too high or too low, and how does that affect your estimate of absolute zero?

CHALLENGE

10. Starting from 50.0 mL at 21 °C (294.15 K), what is the ideal volume at 0 °C? The fitted line in this lesson's reading gives 46.14 mL at 0 °C. What is the difference?

11. Predict the ideal volume of the same syringe at 38 °C. Why would you not test it by heating the syringe at home?

REVIEW

12. A 50.0 mL sample of gas at 101.3 kPa is compressed to 20.0 mL at constant temperature. Find the new pressure.

13. Calculate the molar mass of N_2 using 14.007 g/mol for nitrogen.

Lesson 4.3 — Lead in the Tap: Concentration, Dilution and Parts per Billion

FLUENCY

1. What is the molarity of a solution with 0.250 mol of solute in 0.500 L?

2. What mass of NaCl (58.44 g/mol) is needed for 500 mL of 0.150 M solution?

3. Express 15 ppb of lead in mg/L.

4. How much 0.600 M stock is needed to make 250 mL of 0.150 M solution?

5. Calculate the molar mass of $CaCO_3$ from 40.078, 12.011 and 15.999 g/mol.

APPLICATION

6. USGS measured 62.0 mg/L of dissolved calcium in Missouri River water. Express this in mol/L (Ca 40.078 g/mol).

7. The same sample held 174 mg/L of sulfate (SO_4^{2-}, 96.056 g/mol using S 32.06 and O 15.999). Express this in mol/L.

8. Water hardness as $CaCO_3$ = (Ca ÷ 40.078 + Mg ÷ 24.305) × 100.09, with Ca and Mg in mg/L. Find it for Ca = 62.0 and Mg = 26.0 mg/L.

9. A laboratory dilutes a 5.00 mL tap sample to 50.0 mL and reads 1.30 µg/L of lead. What was the original concentration? Is it above 15 ppb? Above 10 ppb?

CHALLENGE

10. Use the 20 illustrative tap samples in this lesson's reading. How many exceed 10 µg/L? How many exceed 15 µg/L? Under the 'more than 10 percent of samples' trigger, which levels require action?

11. How many lead atoms are in a 250 mL glass of water at 15 µg/L? Use Pb = 207.2 g/mol and $6.02214076 \times 10^{23}$ per mole.

12. Carbon dioxide's Henry's constant is 0.034 mol/(kg·bar) at 298.15 K with a temperature factor of 2,400 K: $k(T) = 0.034 \times \exp[2400 \times (1/T - 1/298.15)]$. Compare the solubility at 1.4 °C and 29.7 °C at the same pressure.

REVIEW

13. How many moles are in 50.0 g of $CaCO_3$ (100.086 g/mol)?

14. A gas at 1.00 atm occupies 2.00 L. At constant temperature the pressure is lowered to 0.500 atm. What is the volume?

Lesson 4.4 — Bond Energies and Fuels: Why Ethanol Releases Less Energy than Gasoline

FLUENCY

1. Does breaking a bond absorb or release energy? Does forming a bond? What sign does ΔH have for an exothermic reaction?

2. Use bond energies (H–H 432, Cl–Cl 239, H–Cl 427 kJ/mol) to find ΔH for $H_2 + Cl_2 \rightarrow 2HCl$.

3. Use bond energies (O–H 467, H–H 432, O=O 495) to find ΔH for $2H_2O \rightarrow 2H_2 + O_2$. Is it endothermic or exothermic?

4. Ethanol burns with $\Delta H = -1{,}367.6$ kJ/mol. The molar mass is 46.069 g/mol. How much energy per gram?

5. On an energy diagram, which is higher in an exothermic reaction, the reactants or the products? What does the hump between them represent?

APPLICATION

6. Use bond energies to estimate ΔH for $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O(g)$ (C–H 413, O=O 495, C=O 799, O–H 467). The NIST-based value is −802.6 kJ/mol. Find the percent difference.

7. Estimate ΔH for propane, $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O(g)$, with 8 C–H and 2 C–C bonds (C–C 347). The NIST-based value is −2,044.0 kJ/mol.

8. Estimate ΔH for ethanol vapor burning to CO_2 and water vapor (5 C–H, 1 C–C, 1 C–O, 1 O–H in ethanol). Compare with the NIST-based −1,278.5 kJ/mol.

9. How much energy is released burning 1.00 kg of ethanol (29.69 kJ/g)? Give the answer in megajoules.

CHALLENGE

10. Liquid octane's enthalpy of combustion from NIST formation data is 8(−393.51) + 9(−285.83) − (−250.0) = −5,470.6 kJ/mol (octane 114.232 g/mol). Find kJ per gram and the ratio of ethanol's energy per gram to octane's.

11. A U.S. Department of Energy table lists 76,330 Btu/gal for ethanol and 112,114 to 116,090 Btu/gal for gasoline. Calculate the range of the ratio, and explain what it means for a driver filling a tank.

12. Burning ethanol gives 64.4 g of CO_2 per MJ, and burning octane gives 64.4 g per MJ. Show the arithmetic for ethanol, and say what this does and does not tell you about the climate effect of the fuels.

REVIEW

13. How many moles are in 10.0 g of ethanol (46.069 g/mol)?

14. How many moles of gas are in 0.500 L at 2.00 atm and 293.15 K? (R = 0.082057 L·atm/(mol·K))

Unit 4 checkpoint

1. A sealed rigid tank of gas is warmed. The pressure rises because
   A. the particles get larger
   B. the particles move faster and hit the walls more often and harder
   C. there are more particles
   D. the walls get colder
2. A gas at 2.00 atm and 4.00 L is compressed to 1.00 L at constant temperature. The new pressure is
   A. 0.500 atm
   B. 8.00 atm
   C. 2.00 atm
   D. 4.00 atm
3. Gas-law calculations must use temperature in _____ and absolute pressure.
4. A 600 mL balloon at 300 K is cooled to 250 K at constant pressure. Its new volume is _____ mL.
5. True or false: A trend line through gas-volume data extended to zero volume gives an estimate of absolute zero, about −273 °C.
6. How many grams of NaCl (58.44 g/mol) make 250 mL of 0.200 M solution?
   A. 2.92 g
   B. 11.7 g
   C. 0.0500 g
   D. 29.2 g
7. Lead at 15 µg/L is 15 parts per _____.
8. True or false: A result below an action level shows that tap water contains no lead.
9. A reaction has bonds broken totaling 679.5 kJ and bonds formed totaling 934 kJ. ΔH is
   A. +254.5 kJ
   B. −254.5 kJ
   C. +1,613.5 kJ
   D. −679.5 kJ
10. True or false: Splitting water into hydrogen and oxygen is endothermic because the bonds broken are stronger in total than the bonds formed.
11. Ethanol releases 1,367.6 kJ/mol at 46.069 g/mol, which is _____ kJ/g (one decimal place).
12. Per gram, burning octane releases more energy than ethanol mainly because
    A. octane has more oxygen atoms
    B. ethanol is already partly oxidized, so it gains less from forming new bonds
    C. octane has weaker bonds
    D. ethanol is a gas

Sejal Learning Systems · Royal Legacy Preparatory School · Generated from the course's practice files; generated problems are checked by computer, authored problems by their author.