Unit 4 Review

Knowledge/Understanding

In your notebook, write the letter of the best answer for each of the following questions.

1. Which of the following statements is not consistent with the kinetic molecular theory?
   - **(a)** Gases react with each other in simple whole number ratios of volumes.
   - **(b)** Particles in the gaseous state move slower than particles in the liquid state.
   - **(c)** The particles of a solid are strongly attracted to each other.
   - **(d)** Gas particles move in all directions, in straight lines.
   - **(e)** Elements combine in simple ratios to form compounds.

2. Gases that obey the postulates of the kinetic molecular theory:
   - **(a)** are not affected by pressure
   - **(b)** behave according to Charles' law at very low temperatures only
   - **(c)** are called ideal gases
   - **(d)** are affected by a change in pressure, which causes particles to move faster
   - **(e)** are called real gases

3. After it has been driven for several hours, a car tire heats up. As a result, the tire pressure increases. This is an example of:
   - **(a)** Boyle's law
   - **(b)** Charles' law
   - **(c)** Avogadro's law
   - **(d)** Gay-Lussac's law
   - **(e)** Torricelli's relationship

4. At 20°C, a moving piston reduces the volume of a cylinder by one half. The gas pressure inside the cylinder will:
   - **(a)** decrease by one half
   - **(b)** double
   - **(c)** increase by one half
   - **(d)** remain the same
   - **(e)** cause the gas particles to speed up

5. A weather balloon floats up into the atmosphere. The air pressure decreases as the balloon floats higher. Assuming the temperature remains constant, the balloon:
   - **(a)** increases in volume
   - **(b)** decreases in volume
   - **(c)** maintains a steady height in the moving air currents
   - **(d)** maintains a constant volume
   - **(e)** remains in the stratosphere

6. An engineer experiments with different air mixtures in a car tire. First, she removes the air from a tire and fills it with pure nitrogen. She measures the pressure exerted inside the tire, then adds a measured amount of helium. After measuring the pressure a second time, she adds a certain amount of argon. This engineer is investigating:
   - **(a)** Boyle's law
   - **(b)** Dalton's law of partial pressures
   - **(c)** Charles' law
   - **(d)** Gay-Lussac's law
   - **(e)** The combined gas law

7. Avogadro made an important contribution to the understanding of gases when he concluded that:
   - **(a)** The molar volume of a gas is 24.8 L at STP.
   - **(b)** Any volume of a gas contains molecules.
   - **(c)** At the same temperature and pressure, equal volumes of gases contain equal numbers of molecules.
   - **(d)** $PV = nRT$
   - **(e)** As the temperature of a gas increases, so does its pressure and volume.

8. At constant temperature, the pressure-volume relationship of an ideal gas is governed by:
   - **(a)** Boyle's law
   - **(b)** Avogadro's law
   - **(c)** The fact that pressure and temperature are directly related
   - **(d)** Gay-Lussac's law
   - **(e)** The fact that temperature and volume are directly related

9. Which if the following sets of coefficients will balance this chemical equation?

   - **(a)** 3, 2, 2
   - **(b)** 2, 2, 3
   - **(c)** 1, 2, 1.5
   - **(d)** 1, 2, 3
   - **(e)** 1, 1, 2

10. Which of the following compounds is not responsible for removing ozone from the stratosphere?
    (a) carbon dioxide
    (b) chlorofluorocarbons
    (c) methyl bromide
    (d)
    (e) carbon tetrachloride

11. The main reason why the Montreal Protocol is so important is:
    (a) It cuts down on greenhouse gases in our atmosphere.
    (b) It protects our oceans.
    (c) It brought industrialized countries together to sign an environmental agreement reducing the production of carbon dioxide from fuel emissions from vehicles and industries.
    (d) It preserves our Arctic regions.
    (e) It cuts down on ozone depleting gases in our atmosphere.

Inquiry

12. A group of students measured the effect of pressure on the volume of different gases. One group observed the effect of pressure on pure oxygen gas. The other group observed pure nitrogen gas. The results obtained are shown below.

Pressure (kPa)	Volume O_2 (mL)	Volume N_2 (mL)
60.0	333.0	212.8
80.0	250.0	156.2
120.0	166.5	104.0
160.0	125.0	78.8
200.0	100.0	63.4

    (a) On the same set of axes, plot a graph of P versus V for oxygen and for nitrogen. Use a different colour for each gas.
    (b) For each of the volumes given, calculate a value for the inverse of the volume ($1/V$).
    (c) On the same set of axes, plot a graph of P versus $1/V$. Use a different colour for each gas.
    (d) What conclusions can you make from the graphs that you have drawn?

13. What is a real gas? How does it differ in the laboratory from an ideal gas?

14. Boyle's law gives the relationship between the pressure and volume of a gas at constant temperature. Avogadro's law gives the relationship between the number of moles and the volume of a gas.
    (a) Write these two relationships in equation form, using k as a constant.
    (b) What is the relationship between pressure and number of moles?

15. (a) At constant pressure, the temperature, in kelvins, is doubled. What effect will this have on a gas? Explain.
    (b) At constant pressure, the temperature, in degrees Celcius, is doubled. How is this different from the situation in part (a)? How will the effect on a gas be different? Explain.
    (c) At constant temperature, the pressure on a gas is reduced by a factor of 5. What effect will this have on the volume of a gas? Why?

16. A sample of oxygen gas occupies a volume of 10.0 L at 546 K. At what temperature (in ˚C) would the gas occupy a volume of 5.0 L?

17. A sample of nitrogen gas occupies 11.20 L at 0˚C and 101.3 kPa. How many moles of nitrogen are there in this sample? Explain.

18. The chemical equation below describes what happens when a match is struck against a rough surface to produce light and heat.

$$S_8 + O_2 \rightarrow SO_2$$

    (a) Balance this chemical equation.
    (b) If 5.3 L of oxygen gas were consumed, how many litres of sulfur dioxide would be produced?

19. A 250.0 mL balloon, full of pure helium at 101.3 kPa, is subjected to a pressure of 125.0 kPa at a constant temperature. What is the final volume of the balloon?

20. A sample of chlorine gas is used as a pool disinfectant. The sample occupies a volume of 500 mL in a cylinder with a moveable piston. The piston forces the gas out into the water when needed. The gas is stored at 25.0 atm at standard temperature. If the temperature remains unchanged and the piston compresses the gas to 220 mL, what is the pressure inside the cylinder?

21. A sample of air occupies a volume of 35.75 L at 25.0˚C and 101.3 kPa. What pressure is needed to reduce the volume of air to 9.85 L at 25.0˚C?

22. Hydrogen gas occupies a volume of 500 at 125˚C. If the pressure remains constant, what volume will the hydrogen occupy at 25.0˚C?

23. A sample of natural gas occupies a volume of 350 L at 20.0˚C. The pressure remains unchanged, and the temperature is increased until the volume of natural gas becomes 385 L. What is the final temperature (in ˚C) of the gas?

24. A sample of gas is collected at 25˚C. If the temperature of the gas is tripled and the pressure on the gas is doubled, what portion of the original volume of gas will remain?

25. For each blank cell in the table below, calculate the missing quantity.

Initial temperature (˚C)	Final temperature (˚C)	Initial pressure (kPa)	Final pressure (kPa)	Initial volume (L)	Final volume (L)
100	100	101.3	110.0	5.0	
0	0	1.5×10^3		25.0	10.0
35	150	101.3	101.3	750	
65.0		125.0	125.0	35.5	25.5
27.0	45.5	102.5	66.7	1.00	
	65	99.5	66.7	450	500

26. A student collects 55.0 mL of hydrogen gas over water at 23.0˚C and 750 torr. What volume will the dry hydrogen occupy at 40˚C and 775 torr?

27. A mixture of gases in a cylinder contains 0.85 mol of methane (), 0.55 mol of oxygen, 1.25 mol of nitrogen, and 0.27 mol of propane (). The pressure on the cylinder gauge reads 2573 kPa. What pressure does each gas exert in the cylinder?

28. What volume will a weather balloon occupy if it contains 10 mol of air at 75.5 kPa and −45˚C?

29. A 180 mL light bulb contains approximately mol of argon in a 20˚C room. What is the pressure of the argon inside the light bulb?

30. A 13.65 L vessel contains 0.750 mol of chlorine at 135 kPa. What is the temperature of the chlorine gas (in ˚C)?

31. Nitrogen gas is used to produce ammonia fertilizer. A sample of gas occupies a 2500 L tank at 5.5 atm and 27.5˚C. What is the mass of nitrogen in the tank?

32. Ethanol vapour burns in air according to the following equation:

If 2.5 L of ethanol burns at STP, what volume of oxygen is required? What volume of carbon dioxide will be produced?

33. The head of a match contains approximately 0.75 g of diphosphorus trisulfide. When the match is struck on a rough surface, it explodes into flame producing diphosphorus pentaoxide and sulfur dioxide (this is a slightly different reaction from that in question 18). What volume of sulfur dioxide will be produced if the temperature is 26.5˚C and the pressure is 102.8 kPa?

34. Nitrogen monoxide, NO, is one of the gases that is responsible for smog. It is produced in various ways, one of which is during the combustion of ammonia.

If 25.0 L of ammonia reacts with 27.5 L of oxygen at STP, what mass of nitrogen monoxide will be produced?

35. When baking a tray of blueberry muffins, you need to use baking soda (sodium hydrogen carbonate). The baking soda acts as a leavening agent, causing the muffin dough to rise as it bakes. One of the reactions that occurs during baking is:

Suppose your recipe calls for 5 mL (approximately 3.0 g) of baking soda. What volume of carbon dioxide will be generated at 195˚C and 100 kPa to make the dough rise?

36. An anesthetic used in hospitals after World War II was made up of 64.8% carbon, 13.67% hydrogen, and 21.59% oxygen. It was found that a 5.0 L sample of this anesthetic had a mass of 16.7 g at STP. What is the molecular formula of this gas?

37. When you peel an orange, you usually smell a pleasant, tangy odour. This odour is due to the presence of a chemical compound called an ester. The ester in orange peel is made up of

69.8% carbon, 18.6% oxygen, and 11.6% hydrogen. When 5.3 g of this compound is vapourized at 125˚C and 102 kPa, it is found to occupy a volume of 1.0 L. What is the molecular formula of this compound?

38. Each time you inhale, you take in about 0.50 L of air. How many molecules of each of the following gases do you inhale in one breath at 22˚C and 101.3 kPa?
- **(a)** nitrogen
- **(b)** oxygen
- **(c)** argon
- **(d)** carbon dioxide

39. The space shuttle orbits Earth at an altitude of approximately 300 km. Canadian astronauts worked outside the shuttle using the Canadarm to repair a satellite. They were working in what is commonly referred to as a vacuum. However, accurate measurements show that the atmospheric pressure at this altitude is kPa. Facing the sun, the average temperature is 223˚C. How many molecules of gas are there in one litre of this so-called "vacuum" in outer space?

Communication

40. Define each of the following:
- **(a)** Charles' law
- **(b)** standard temperature
- **(c)** standard pressure
- **(d)** ideal gas
- **(e)** Gay-Lussac's law

41. Convert each of the following temperatures as indicated:
- **(a)** 250.1˚C to kelvins
- **(b)** 373 K to degrees Celcius
- **(c)** absolute zero to degrees Celcius

42. Convert each of the following pressure values as indicated:
- **(a)** 725 torr to kPa
- **(b)** 105.1 kPa to torr
- **(c)** kPa to atm
- **(d)** 320 torr to atm

43. Prepare a concept map to explain the depletion of ozone in the atmosphere. Include details on the different chemicals responsible. Also, make sure you include information on how this depletion occurs.

Making Connections

44. Nitrogen monoxide is used to produce nitric acid, a widely used industrial compound. Unfortunately, this same gas is also partly responsible for the production of smog and acid rain. Research the amount of nitrogen monoxide produced by an average automobile per hour.
- **(a)** Estimate the number of cars in your community (assume two cars per family). Calculate the number of grams of nitrous oxide released into the air in your area per hour at rush hour.
- **(b)** Approximately how many grams of nitrogen monoxide are produced per day in a large city such as Toronto, Montreal, or Vancouver?

45. During World War II, Allied pilots carried lithium hydride tablets taped inside their life belts. Research why this was done. Hint: Look for chemical reactions involving lithium hydride that might be useful for these pilots.

46. The Montreal Protocol is an agreement between industrialized nations to reduce the amount of ozone-depleting chemicals released into the atmosphere. Do research to discover answers to these questions:
- **(a)** What amount of ozone-depleting chemicals was released in a typical year before the Montreal Protocol was signed?
- **(b)** What amount of ozone-depleting chemicals was released this year (or in the most recent year you can find)?
- **(c)** Compare the two values. Have there been any measurable decreases? By how much?
- **(d)** How does Canada compare to the other countries in the agreement?