Worksheet 19 Solutions

1. Rationalize the following observations:
   a. Aerosol cans will explode if heated

   Heating the can will increase the pressure of the gas inside the can, P α T, V and n constant. As the pressure increases, it may be enough to rupture the can.

   b. You can drink through a soda straw

   As you draw a vacuum in your mouth, atmospheric pressure pushing on the surface of the liquid forces the liquid up the straw.

   c. A thin-walled can will collapse when the air inside is removed by a vacuum pump

   The external atmospheric pressure pushes on the can. Since there is no opposing pressure from the air inside, the can collapses.

   d. Manufacturers produce different types of tennis balls for high and low elevations.

   How "hard" the tennis ball is depends on the difference between the pressure of the air inside the tennis ball and atmospheric pressure. A "sealevel" ball will be much "harder" at high altitude since the external pressure is lower at high altitude. A "high altitude" ball will be "soft" at sea level.

2. The pressure needed to make synthetic diamonds from graphite is 8.0×10^4 atm. Express this pressure in

   a. kPa b. torr c. psi

   a. 8.1×10^6 kPa b. 6.1×10^7 torr c. 1.2×10^6 psi

3. Explain why the height of mercury is independent of the diameter of the mercury column.

   The height of the mercury column in a barometer is a measure of atmospheric pressure. The Hg column is steady when the pressure exerted by the atmosphere is equal to the downward pressure due to the mass of the Hg column. Pressure is defined as force per unit area. Thus, the larger the diameter of the Hg column, the greater the mass of Hg column and greater the total force exerted by the Hg column. However, this force is distributed over a larger cross-sectional area, so the ratio of force/area, the pressure, is the same as that of a smaller diameter column. The same length Hg column is required to balance atmospheric pressure, regardless of the diameter of the column.

   Mathematically:

   $P = F/A$; $F = ma$; $m = d\,V$ $V = A\,h$

   Substituting, $P = d\,h\,a$

   The "A" term cancels, and pressureis independent of cross sectional area.

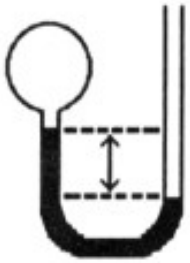
4. How high in meters must a column of water be to exert a pressure equal to that of a 760 mm column of mercury?

   10.3 m

5. Mineral oil can be used in place of mercury in manometers when small pressure changes are to be measured. What is the pressure of an oxygen sample in mm of mineral oil if its pressure is 28.5 mm Hg? (*density* of mineral oil = 0.88 g/mL; *density* of Hg = 13.5 g/mL)

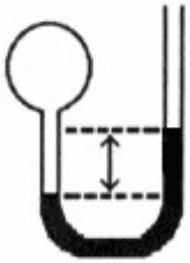
   440 mm mineral oil

6. If the atmospheric pressure is 0.975 atm, what is the pressure of the enclosed gas in each of the following cases:



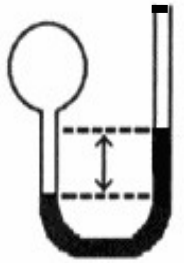
h = 52 cm

i. 0.29 atm



h = 67 mm

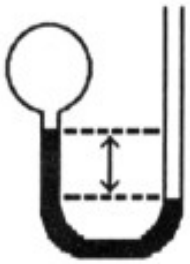
ii. 1.1 atm



h = 10.3 cm

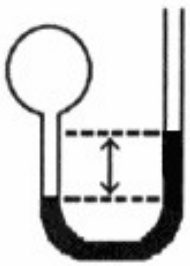
iii. 1.11 atm

7. What is the pressure (in kPa) of the gas in the flask below, if the barometer reads 765.2 mm Hg?



h = 1.30 cm ***100.3 kPa***

8. What is the pressure (in atm) of the gas in the flask, if the barometer reads 738.5 torr?



h = 2.35 cm ***1.00 atm***

9. What is the effect of the following on the volume of 1 mol of an ideal gas?
   a. The pressure is tripled (at constant T)
      Volume decreases to one third the original volume
   b. The absolute temperature is increased by a factor of 3 (at constant P)
      Volume increases by a factor of 3

c. 3 more moles of gas are added (at constant T and P)
Volume increases by a factor of 4

d. Half the gas escapes (at constant T and P)
Volume decreases by a factor of 2

e. Both the pressure and temperature decreases to one-fourth of their initial values.
No change in volume

10. Complete the following table for an ideal gas

P	***V***	***n(mol)***	***T***
7.74 x 10^3Pa	12.2 mL	***3.81 x 10^{-5}***	25°C
179 atm	43.0 mL	0.421 mol	223 K
455 torr	***3.6 L***	4.4 x 10^{-2} mol	331°C
745 mm Hg	11.2 L	0.401 mol	***61°C***

11. What volume is occupied by 19.6 g of methane (CH_4) at 27°C and 1.59 atm?
18.9 L

12. A container is filled with an ideal gas to a pressure of 40.0 atm at 0°C.
a. What will be the pressure in the container if it is heated to 45°C? ***46.6 atm***
b. At what temperature would the pressure be 1.50 x 10^2 atm? ***1.02 x 10^3 K***
c. At what temperature would the pressure be 25.0 atm? ***171 K***

13. A chemist prepares a sample of hydrogen gas and finds that it occupies 250. mL at 65°C and 500 torr. What volume would it occupy at 0°C at the same pressure?
202 mL

14. A balloon is filled to a volume of 7.00 x 10^2 mL at a temperature of 20.0°C. The balloon is then cooled at constant pressure to a temperature of 1.00 x 10^2 K. What is the final volume of the balloon?
239 mL

15. A 250. mL aerosol can at 25°C and 1.10 atm was thrown into an incinerator. When the temperature in the can reached 625°C, it exploded. What is the pressure in the can just before it exploded, assuming it reached the maximum pressure possible at that temperature?
3.31 atm

16. A person accidentally swallows a drop of liquid oxygen, O_2*(l),* which has a density of 1.149 g/mL. Assuming the drop has a volume of 0.050 mL, what volume of gas will be produced in the person's stomach at body temperature (37°C) and a pressure of 1.0 atm?
46 mL

17. Hot-air balloons gain their lift from the reduction in the density of air that occurs when the air in the envelope is heated. To what temperature should you heat a sample of air, initially at 340 K, to increase its volume by 14%?

    388 K

18. A bicycle tire is filled with air to a pressure of 100.psi at a temperature of 19°C. Riding the bike on asphalt on a hot day increases the temperature of the tire to 58°C. The volume of the tire increases by 4.0%. What is the new pressure in the bicycle tire?

    109 psi

19. The volume of a weather balloon is 200.0 L and its internal pressure is 1.17 atm when it is launched at 20.0°C. The balloon rises to an altitude in the stratosphere where its internal pressure is 63 mm Hg and the temperature is 210 K. What is the volume of the balloon then?

    2.02×10^{3} L

20. A 0.850-mole sample of nitrous oxide, a gas used as an anesthetic by dentists, has a volume of 20.46 L at 123°C and 1.35 atm. What would be its volume at 468°C and 1.35 atm?

    38.3 L

21. Calculate the pressure of a helium sample at -207.3°C and 768 mL, if it exerts a pressure of 175 kPa at 25.0°C and 925 mL.

    46.5 kPa

22. A compressed gas cylinder contains 1.00×10^{3} g of argon gas. The pressure inside the cylinder is 2050. psi (pounds per square inch) at a temperature of 18°C. How much gas remains in the cylinder if the pressure is decreased to 650.psi at a temperature of 26°C?

    309Ar remains

    Nitrogen dioxide is a red-brown gas that is responsible for the color of photochemical smog. A sample of nitrogen dioxide has a volume of 28.6 L at 45.3°C and 89.9 kPa. What is its volume at STP?

    21.7 L

23. A sample of nitrogen gas has a volume of 1.75 L at STP. How many moles of N_2 are present?

    0.0781 moles

24. A sample of oxygen gas contains 2.42×10^{18} molecules at STP. What volume does oxygen gas occupy?

    9.00×10^{-5} L

25. What is the density of carbon tetrachloride (CCl_4) vapor at 714 torr and 125°C?

    4.43g/L