GAS MEASUREMENT

Unit 1 - Fundamentals of Gas Measurement

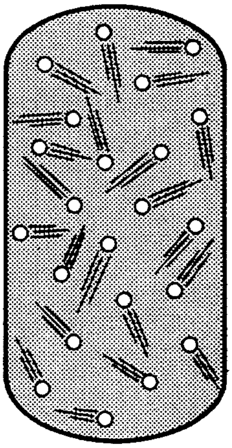
TEMPERATURE AND PRESSURE

1. Anything that moves has kinetic energy.

   Since gas molecules move constantly, they (possess/do not possess) kinetic energy.

2. The faster a molecule moves, the (more/less) kinetic energy it has.

3. This drawing shows a gas in a rigid, closed container.



   Because they are always moving, the molecules are constantly bumping into other ______________ and into the ______________ of the container.

4. The more molecules there are in the container, the (more/fewer) collisions will occur.

5. Also, the faster the molecules move, the (more/fewer) collisions there will be.

6. The temperature of a gas is determined by the average ______________ energy of its molecules.

7. So, an increased temperature in the container can mean that either:

   the molecules are moving ______________; or,

   that more ______________ have been added to those already there.

8. When molecules strike the container walls, they (do/do not) exert force.

9. Suppose the molecules are striking the container walls with a total *force* of 1000 pounds.

   The 1000-pound force is exerted (at one point/over the whole area).

10. Suppose the whole *area* is 10 square inches.

    1000 pounds spread over 10 square inches equals ____________ *pounds* for each *square inch.*

11. The *pressure* exerted is 100 ____________ per ____________ ____________, or 100 PSI.

12. Pressure is amount of ____________ exerted on a certain ____________.

13. Pressure can be increased either by (increasing/decreasing) the amount of force or by ____________ the size of the area.

14. The amount of force a molecule can exert depends on how much energy it possesses.

    The more energy a molecule has, the (more/less) force it can exert.

15. The faster a molecule moves, the (more/less) energy it has.

16. If two molecules of *different* weights are moving at the same speed, the (lighter/heavier) molecule has more energy.

17. So, the energy a single molecule has and the amount of force it can exert depend on two things:

    how ____________ the molecule is moving; and

    how much the molecule ____________.

18. The *total* force that gas molecules can exert on a rigid container also depends on how many ____________ are in the container.

19. In a rigid container of gas, with all the molecules the same weight, an increase in pressure can be caused by:

    adding more ____________ to the container; or by

    making the molecules move ____________.

Review

20. Both the pressure and temperature of a gas are related to the behavior of the gas molecules.

    In a rigid container, when molecules move faster, both pressure and temperature (increase/decrease).

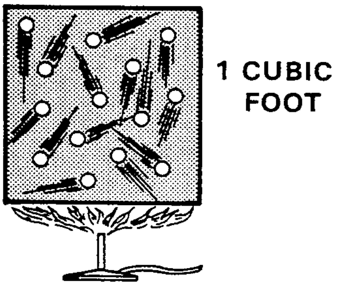
21. Packing more molecules into a rigid container also increases both ____________ and ____________.

22. In a rigid container, an increase in either pressure or temperature (causes/does not cause) an increase in the other.

23. Both pressure and temperature are indicators of the amount of ____________ possessed by gas molecules.

VOLUME

24. Suppose the volume of this rigid container is one cubic foot.

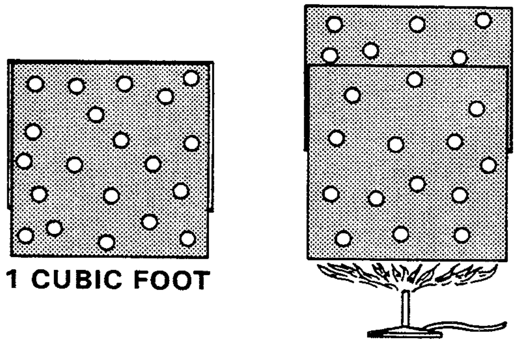


    If the container is heated, the gas molecules move ____________.

25. As the molecules move faster, both ____________ and ____________ increase.

26. The container is rigid, so unless the container explodes, gas volume (changes/stays the same).

27. Suppose the volume of this expandable container is one cubic foot.



    If the container is heated, the faster moving molecules cause the container to (expand/contract).

28. When the gas expands, its volume and the volume of the container (increase/decrease).

29. When the gas is heated, the total force of the molecules increases, but the number of square inches over which the force is spread also (increases/decreases).

30. Pressure is amount of *force* per unit of *area.*

Pressure increases if there is *either*:

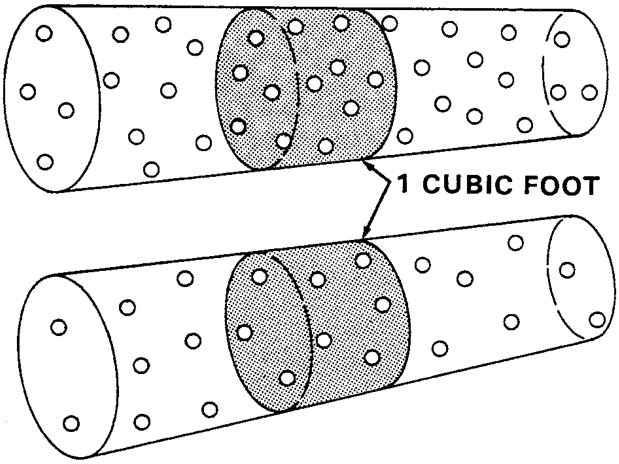
more (force/area) ; *or*

less (force/area).

31. If both force and area increase together at the same rate, pressure (does/does not) increase.

32. In an expandable container, an increase in temperature causes an increase in the ____________ that the gas occupies, but does not increase the ____________ that the gas exerts.

33. This drawing shows a section of a pipeline with the shaded portion representing one cubic foot.



If the temperature increases, the gas expands and the molecules are much farther apart.

When the gas expands, the number of molecules in a one cubic foot space is (greater/smaller).

34. This means that the *amount* of gas in one cubic foot is (more/less).

35. Suppose the pressure in the pipeline increases.

Under higher pressure, the molecules are closer together and the number of molecules squeezed into a one cubic foot space is (greater/smaller).

36. When pressure increases, the amount of gas squeezed into a one cubic foot space is (more/less).

37. One cubic foot of gas (is/is not) always a fixed amount of gas.

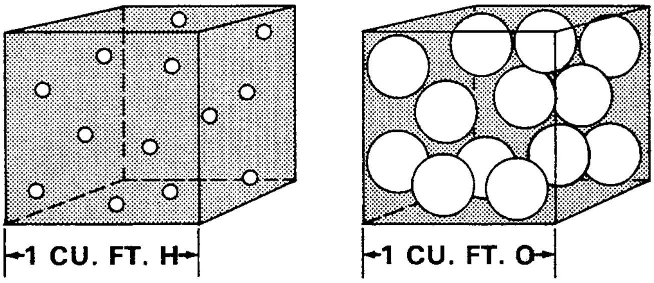
38. The amount of gas in one cubic foot depends on ____________ and ____________.

39. If you wanted to get the greatest *amount* of gas in each cubic foot, you would buy cubic feet of gas—

    at (high/low) temperature; and

    (high/low) pressure.

40. This drawing shows two containers, each holding one cubic foot of a different gas.



The container on the left holds a certain number of small, light-weight molecules, while the container on the right holds the same number of ____________ molecules.

41. The energy possessed by both groups of molecules is related to the ____________ and ____________ in the container.

42. If the pressure and temperature in both containers are the same, then the ______________ possessed by both gases is the same.

43. The molecules are not the same, so if the energy is the same, the light molecules are moving (faster/slower) than the heavy molecules.

44. No matter what the size of the molecules, equal volumes of all gases at the same pressure and temperature have (the same/a different) number of molecules.

45. So that both buyer and seller know exactly how much gas is involved in a transaction, a *standard* is established.

    Standardization means that every cubic foot of gas that meets the standard contains (the same/a different) number of molecules.

46. Amount of gas can be set by using a standard that specifies a certain ____________ of gas at a certain ____________ and ____________.

47. The American Gas Association standard of measurement is one cubic foot at a pressure of 14.73 PSIA (pounds per square inch absolute) and a temperature of 60° Fahrenheit.

Every cubic foot of gas at these conditions contains the ____________ number of molecules.

GAGE AND ABSOLUTE PRESSURE

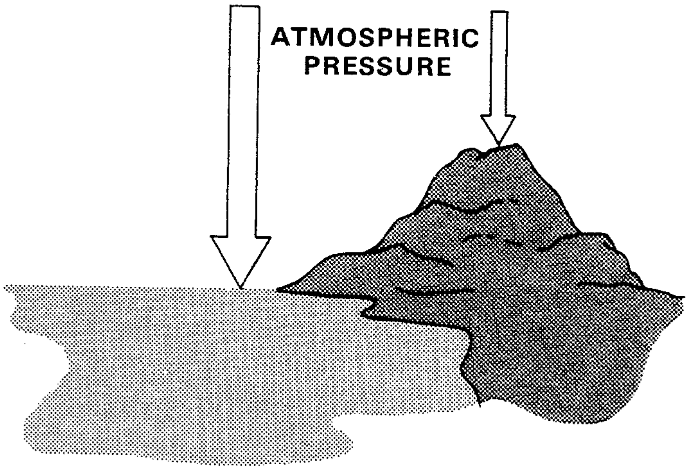
48. Pressure is amount of ____________ per unit area.

49. When force is expressed in pounds per square inch, it is called the ____________ the gas exerts.

50. The weight of the atmosphere exerts force, too.

At sea level, it exerts a force of about 15 ____________ on each square inch.

51. The atmosphere is thinner at the top of a mountain than it is at sea level.



As altitude increases, atmospheric pressure (increases/decreases).

52. The closer the altitude is to sea level, the (higher/lower) atmospheric pressure is likely to be.

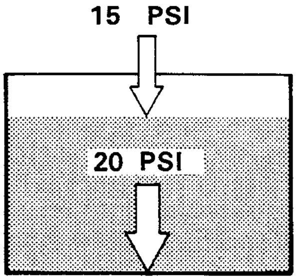
53. High-pressure weather conditions are accompanied by an (increase/decrease) in atmospheric pressure.

Low-pressure weather conditions are accompanied by a decrease in ____________ ____________.

54. So, atmospheric pressure varies with the weather and with the ____________ above sea level.

55. Normally, the pressure of the atmosphere is about ____________ PSI.

56. This drawing shows a tank of water open to the atmosphere.



The pressure of the atmosphere on the water is about ____________ PSI.

57. Suppose the pressure of the water on the bottom of the tank is 20 PSI.

The total, or *absolute*, pressure at the bottom of the tank is:

the pressure of the ____________ in the tank; plus,

the pressure of the ____________ on the water.

58. The total, or *absolute*, pressure at the bottom of the tank is 15 PSI plus 20 PSI, or ____________ PSIA.

59. Most gages are calibrated to measure only the pressure *within* a system.

Most gages (include/do not include) atmospheric pressure.

60. A pressure reading that does not include atmospheric pressure is called *gage* pressure.

Gage pressure is expressed as pounds per square inch *gage*, abbreviated (PSIG/PSIA).

61. Absolute pressure is total pressure including both:

the pressure within the system, or ____________ pressure; and

the pressure of the ____________.

62. Absolute pressure is expressed as pounds per square inch *absolute*, abbreviated ____________.

63. Gage pressure, PSIG, (includes/does not include) atmospheric pressure.

64. Absolute pressure, PSIA, is ____________ pressure plus ____________ pressure.

65. Since the pressure of the atmosphere affects gas molecules, the standard pressure for gas measurement is usually expressed as pounds per square inch (gage/absolute).

66. The A.G.A. defines a standard cubic foot as being at 60° Fahrenheit and 14.73 (PSIG/PSIA).

TEMPERATURE MEASUREMENT

67. There is more than one kind of temperature scale.

    Most thermometers in the U.S. read in degrees (Fahrenheit/Celsius).

68. Calculations in English units based on temperature are correct only if the *Rankine* scale is used.

    When calculations are required, degrees Fahrenheit (should/should not) be converted to degrees Rankine.

69. Conversion from Fahrenheit to Rankine is made by adding 460 to the Fahrenheit reading.

    A reading of 0°F is equal to ____________ °R.

70. A reading of 40°F is equal to ____________ °R.

71. The A.G.A. standard temperature is 60°F.

    This standard temperature on the Rankine scale is ____________ °R.

72. The Rankine scale is an *absolute* scale.

    Whenever *absolute temperature* is called for, a Fahrenheit reading is converted to an absolute reading by adding ____________.

73. A gas at 100°F has an absolute temperature of ____________ °R.

Review

74. Absolute pressure is total pressure.

    Absolute pressure is ____________ pressure plus ____________ pressure.

75. Gage pressure is abbreviated ____________, and absolute pressure is abbreviated ____________.

76. Depending on weather conditions and altitude, atmospheric pressure (may vary/is always the same).

77. Since atmospheric pressure can change, absolute pressure (can/cannot) change.

78. Standard pressure is a pressure established for the purpose of standardizing gas measurement.

Once a standard pressure is agreed on, it (does/does not) change.

79. For convenience in calculations, temperature is expressed in degrees absolute.

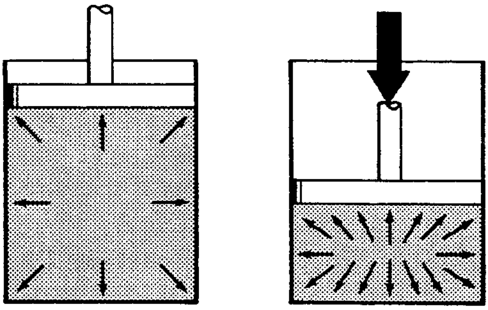
The Fahrenheit scale (is/is not) an absolute scale.

80. To convert Fahrenheit degrees to absolute degrees, add ____________.

81. The absolute scale used with Fahrenheit readings is called the ____________ scale.

BOYLE'S LAW

82. Suppose the volume of this gas is halved and that its temperature stays the same.



A B

The number of molecules in container A are forced into half the volume in container B. The pressure they exert in B is (half/double) the pressure they exert in A.

83. In B, pressure is (half/double) the pressure in A.

84. In other words, if the temperature stays the same, when volume decreases, pressure ____________.

85. When volume increases, pressure ____________.

86. This pressure-volume relationship is *inverse.*

That is, when one changes, the other changes in (the same/an opposite) direction.

87. This pressure-volume relationship, when expressed as a scientific law, is called *Boyle's law.*

Boyle's law says that at constant temperature, the volume of a gas changes (directly/inversely) with changes in (gravity/absolute pressure).

88. Boyle's law expresses a (pressure-volume/temperature-volume) relationship.

89. If half a cubic foot of gas at 60°F and 30 PSIA is expanded to a volume of *one* cubic foot at 60°F it will have a pressure of ____________ PSIA.

90. Two cubic feet of a gas at 60°F and 7.5 PSIA is equal to one cubic foot of the same gas at 60°F and ____________ PSIA.

91. At 60°F, both a half cubic foot at 30 PSIA and two cubic feet at 7.5 PSIA are equal to one cubic foot at ________ PSIA.

92. Using Boyle's law, quantities of gas at 60°F, *not* at standard pressure, (can/cannot) be converted to standard cubic feet.

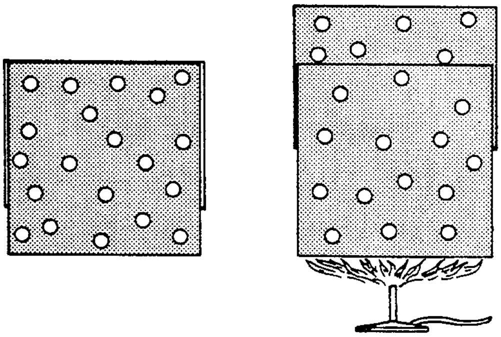
93. Boyle's law assumes a constant temperature.

If the temperature changes, Boyle's law (holds true/does not hold true).

94. The temperature specified for a standard cubic foot is 60°F.

If the temperature is constant, but not 60 ° F, Boyle's law alone (can/cannot) convert to standard cubic feet.

95. Suppose the gas in this expandable container is heated.



The pressure stays the same, but the gas (expands/contracts).

96. The *volume* of the gas (increases/decreases).

97. If pressure stays the same, as temperature increases, volume also ______.

98. This temperature-volume relationship is *direct*, rather than inverse.

That is, as temperature changes, volume changes in (the same/an opposite) direction.

99. This temperature-volume relationship expressed as a scientific law is called *Charles' law*.

Charles' law states that at constant pressure, the volume of a gas changes (directly/inversely) with changes in absolute (temperature/pressure).

100. Charles' law expresses a (pressure-volume/temperature-volume) relationship.

101. The absolute temperature of a standard cubic foot of gas is 520°R.

At a constant pressure of 15 PSIA, if the temperature of one cubic foot of gas is increased to 1040° R, the gas expands and becomes ______ cubic feet.

102. At the same constant pressure, if the temperature of a cubic foot of gas is reduced from 520°R to 260°R, the volume becomes ______ a cubic foot.

103. At a constant pressure of 15 PSIA, two cubic feet at 1040°R and half a cubic foot at 260°R are both equal to one cubic foot at ______ °R.

104. Using Charles' law, quantities of gas at standard pressure, but not at standard temperature, (can/cannot) be converted to standard cubic feet.

105. Charles' law assumes a constant pressure.

If the pressure changes, Charles' law (does/does not) hold true.

106. The pressure specified for a standard cubic foot is 14.73 PSIA.

If pressure is constant, but not 14.73 PSIA, Charles' law alone (can/cannot) convert to standard cubic feet.

Review

107. Boyle's law says that at constant temperature, the volume of a gas varies (directly/inversely) with changes in (gravity/absolute pressure).

108. In order to use Boyle's law to convert to standard cubic feet, the temperature must be a constant __________ °F.

109. Charles' law says that at constant pressure the volume of a gas changes (directly/inversely) with changes in absolute (pressure/temperature).

110. In order to convert to standard cubic feet using Charles' law, the pressure must be a constant __________ PSIA.

THE GENERAL GAS LAW

111. The cubic foot is the most common measure of volume in gas measurement.

In order to know how much gas a cubic foot contains, the __________ and temperature must be specified.

112. Every cubic foot of gas at the same specified pressure and temperature contains (the same/a different) amount of gas.

113. Once the amount of gas per cubic foot is known, both buyer and seller can agree on a __________ to be paid for each cubic foot.

114. If a different set of pressure and temperature conditions are specified, the price per cubic foot would be (the same/different).

Now turn the page, turn the book over, and go on.

115. Setting a price per cubic foot of gas is made easier when everyone specifies (the same/different) pressure and temperature conditions.

116. The gas industry standard unit of measure is the A.G.A. (American Gas Association) standard cubic foot which specifies a pressure of ____________ PSIA and a temperature of ____________ °F.

117. The pressure and temperature of gas actually being measured in the field is (usually/almost never) at these standard conditions.

118. For the purpose of buying and selling, cubic feet at measured conditions must be converted to cubic feet at ____________ conditions.

119. If this conversion is not made accurately, (it doesn't matter/someone loses money).

120. If the temperature is standard, the standard volume of gas at non-standard pressure can be found by using (Boyle's/Charles') law.

121. If the pressure is standard, the standard volume of gas at non-standard temperature can be found using ________ law.

122. By combining both Boyle's and Charles' law, standard volume can be calculated regardless of ____________ and ____________.

123. The *general gas law* for calculating standard volume is a combination of both ____________ and ____________ laws.

124. With reference to the volume of a gas, this law states that:

    gas volume changes in *direct* ratio to changes in absolute ____________; and

    gas volume changes in *inverse* ratio to changes in absolute ____________.

125. Expressed as a mathematical equation, the general gas law for calculating standard volume is this:

$$V_2 = \frac{P_1 \times V_1 \times T_2}{P_2 \times T_1}$$

The letters *P*, *V*, and *T*, stand for __________, __________, and ____________.

126. Using this equation allows starting out with any number of cubic feet, V_1, and any measured ____________ and ____________, P_1 and T_1;

and converting to cubic feet, V_2, at (measured/standard) pressure and temperature, P_2 and T_2.

127. The number that solving the equation gives, V_2, is the volume in (standard/measured) cubic feet.

128. V_1 is the number of (standard/measured) cubic feet.

129. The measured pressure and temperature are represented by (P_1 and T_1/P_2 and T_2).

130. Standard pressure and temperature are represented by ____________ and ____________.

131. The only unknown in the equation is V_2, or ____________ volume.

132. Standard temperature, T_2, is always ____________ °F and A.G.A. standard pressure, P_2, is always ____________ PSIA.

133. Depending on the situation, the measured parts of the equation, V_1, P_1, and T_1, (change/stay the same).

134. Pressure and temperature *must* be expressed in absolute terms.

Degrees Fahrenheit are converted to degrees absolute by adding ____________ to the Fahrenheit reading.

135. Standard temperature, T_2, for use in this equation is always ____________ ° Rankine.

136. Measured temperature, T_1, is degrees Fahrenheit plus ____________.

137. Absolute pressure is gage pressure plus ____________ pressure.

138. Assume an atmospheric pressure of 14 PSIA.

A gage pressure of 266 PSIG is an absolute pressure of ____________ PSIA.

139. Assume an oxygen bottle with an actual measured volume of 2.0 cubic feet, a pressure of 266 PSIG, and a temperature of 40°F. How many standard cubic feet (SCF) of oxygen does the bottle contain?

P_1 = measured pressure

T_1 = measured temperature

V_1 = measured volume

P_2 = standard pressure (14.73 PSIA)

T_2 = standard temperature (520°R)

V_2 = standard volume

If atmospheric pressure is 14.0 PSIA, P_1 in the equation is ____________ PSIA.

140. V_1 is ____________ cubic feet.

141. T_1 is ____________ °R.

142. P_2 is ____________ PSIA (standard).

143. T_2 is ____________ °R (standard).

144. V_2 is the number of ____________ cubic feet in the bottle.

145. $$V_2 = \frac{P_1 \times V_1 \times T_2}{P_2 \times T_1}$$

$$V_2 = \frac{280 \times 2.0 \times 520}{14.73 \times 500}$$

$V_2 =$ ____________ SCF.

Review

146. The cubic foot is the most common measure of volume in gas measurement.

The *standard* cubic foot represents a certain (volume/quantity) of gas.

147. For the purpose of buying and selling, non-standard cubic feet are converted to ____________ cubic feet.

148. The A.G.A. standard measure is one cubic foot at ____________ PSIA and ____________ °F.

149. The general gas law is a combination of ____________ and ____________ laws.

150. The general gas law says that:

gas volume changes in inverse ratio to changes in absolute ____________ ; and

gas volume changes in direct ratio to changes in absolute ____________.

151. For converting non-standard volumes to standard volumes, the ____________ gas law is used.

152. Written mathematically, the general gas law is this:

$$V_2 = \frac{P_1 \times V_1 \times T_2}{P_2 \times T_1}$$

P_1 is the non-standard measured ______________ (in PSIA).

153. V_1 is the non-standard measured ______________.

154. T_1 is the non-standard measured ______________ in °R.

155. P_2 and T_2 are ______________ pressure and temperature.

156. V_2 is the number of ______________ ______________ ______________.

157. Degrees Fahrenheit are converted to absolute degrees by (adding/subtracting) 460 to the Fahrenheit reading.

158. Absolute pressure is ______________ pressure plus ______________ pressure.

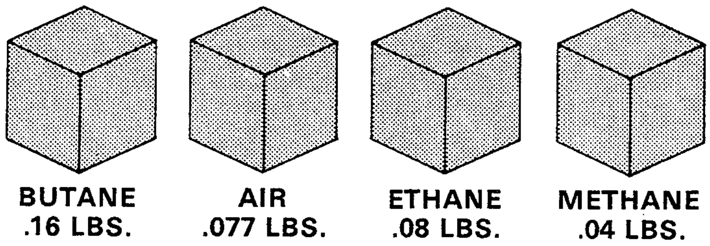
159. In order for the general gas law equation to work, all pressure and temperature values must be expressed in ______________ terms.

SPECIFIC GRAVITY AND DENSITY

160. *Density* is weight per unit of volume.

A cubic foot of lead weighs more than a cubic foot of water because lead is (more/less) dense than water.

161. This drawing shows the weight of four cubic foot containers of gases at standard temperature and pressure.



The density of air is ______________ pounds per cubic foot.

162. The density of ethane is ______________ pounds per cubic foot.

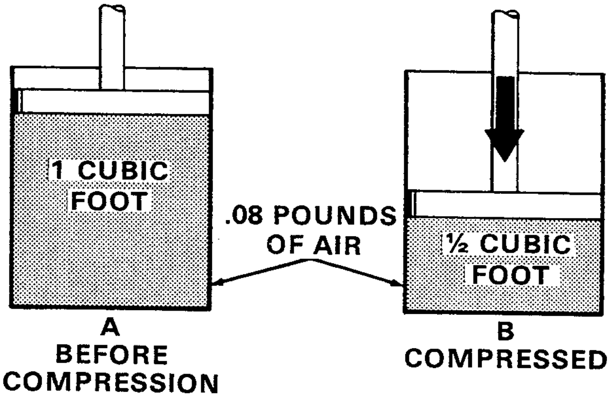
163. Ethane and air have (about the same/very different) densities.

164. The density of butane is 0.16 pounds per cubic foot.

Butane is approximately (twice/half) as heavy as air.

165. Methane, at 0.04 pounds per cubic foot, is __________ as heavy as air.

166. The drawing represents .08 pounds of air before and after compression.



Uncompressed, the air occupies a volume of __________ cubic foot.

167. In B, the same weight of gas occupies __________ the volume.

168. The density of the air in A is __________ pounds per cubic foot.

169. In B, .08 pounds occupies 1/2 foot.

A half cubic foot that weighs .08 pounds has the same density as one cubic foot that weighs (.16/.04) pounds.

170. The air at B is (twice/half) as dense as the air at A.

171. If the volume in A were allowed to expand to 2 cubic feet, the density would then be .08 pounds per 2 cubic feet or __________ pounds per one cubic foot.

172. The more a gas is compressed, the (higher/lower) its density.

173. Therefore, an increase in pressure causes an increase in __________.

174. If a gas is in a flexible container, increasing the temperature causes the gas to (expand/contract).

175. When a gas expands, there is more space between molecules and the density of the gas is (greater/less).

176. So, if pressure stays the same, an increase in temperature causes (an increase/a decrease) in density.

177. The density of a certain volume of gas depends both on its ____________ and ____________.

178. Changes in pressure and temperature (cause/do not cause) changes in density.

179. Both wood and oil float on water.

Water is (more/less) dense than wood and oil.

180. A helium-filled balloon floats up through air.

The density of helium is (higher/lower) than the density of air.

181. The *specific gravity* of a gas is its density in relation to the density of air, both at the same temperature and pressure.

To find the specific gravity of a gas, divide its density by the density of ____________.

182. If the density of methane is .04 pounds per cubic foot and the density of air is .08 pounds per cubic foot, the specific gravity of methane is .04/.08, or ________.

183. The specific gravity of air is 1.000 and the specific gravity of helium is 0.1368.

Helium is (more/less) dense than air.

184. Any gas with a density less than the density of air floats on air and has a specific gravity (greater/less) than 1.000.

185. When a piece of dry ice left on a table evaporates at room temperature, the white carbon dioxide "smoke" flows over the edge of the table and clings to the floor.

Carbon dioxide is (more dense/less dense) than air.

186. The specific gravity of carbon dioxide is 1.53.

If a gas is more dense than air, its specific gravity is (more/less) than 1.000.

And if the gas is less dense than air, its specific gravity is (more/less) than 1.000.

187. Ethane has a specific gravity of 1.049, and is slightly (more/less) dense than air.

188. Ethane (floats/sinks) in air.

189. Methane has a specific gravity of 0.554, and is (more/less) dense than air.

190. Methane (floats/sinks) in air.

191. Assume the gas from a certain well contains about 80% methane and 20% ethane.

Its specific gravity is around 0.65.

This gas is (more/less) dense than air.

192. The *makeup* of the gas as it comes from the well affects its specific gravity.

A higher proportion of a gas with a *low* specific gravity would (raise/lower) the specific gravity of the well gas.

193. A makeup with a higher proportion of a gas with a *high* specific gravity would (raise/lower) the specific gravity of the well gas.

194. So, the density of a gas depends partly on what mix of gases it contains, or its ______________.

195. Specific gravity is the density of a gas compared to the density of air *at the same* ___________ and ___________.

196. Since specific gravity is always the density of a gas divided by the density of air, both at the same pressure and temperature, the specific gravity of a particular gas (is always the same/sometimes changes).

REAL AND IDEAL GASES

197. Real gas molecules are attracted to one another.

This attraction between molecules is greater when molecules are (close together/far apart).

198. At very high pressures, gas molecules are relatively (close together/far apart).

199. At high pressures, then, attraction between gas molecules is (increased/decreased).

200. The general gas law is based on a theoretically perfect, or *ideal*, gas that has *no* attractions between molecules.

Ideal gases and real gases behave (exactly alike/differently).

201. Calculations based on the general gas law (only approximate/equal) the behavior of real gases.

202. The *greater* the attraction between molecules, the *more* real gas behavior differs from ideal gas behavior.

At high pressures, the deviation from the gas laws is (greater than / less than) the deviation at low pressures.

203. At low pressures, fairly accurate calculations can be made without applying a correction for molecular attraction.

At high pressures, the general gas law (requires/does not require) a correction factor.

204. At low pressures, the general gas law accounts for the compressibility of gas.

At high pressures, the compressibility of gas changes because of the ______________ between molecules.

205. This change in the behavior of gas at high pressures is called *compressibility.*

The factor that corrects the general gas law for high pressures is called the ______________ factor.

206. In equations, the compressibility factor is represented by the letter *Z*.

The compressibility factor is also referred to as the ______________ factor.

> When equations are written the letter Z might be confused with the number 2.
>
> For this reason, in mathematics, the letter Z is always written with a line through it, like this—Ƶ.

207. The general gas law written to include the Ƶ factor is this:

$$V_2 = \frac{P_1 V_1 T_2 Ƶ_2}{P_2 T_1 Ƶ_1}.$$

The Ƶ factor corrects the general gas law for the compressibility of gas at high ______________.

208. For convenience in making accurate field calculations, the Ƶ factor can (be ignored/be found in published tables).

REVIEW AND SUMMARY

209. Absolute pressure is ______________ pressure plus ______________ pressure.

210. Atmospheric pressure is usually about 15 PSIA, but can change with changes in local ______________ conditions.

211. Atmospheric pressure is also affected by the ______________ above or below sea level.

212. Standard pressure, as specified by the A.G.A., is ____________ PSIA.

213. A standard pressure, once decided on, (can fluctuate/ is always the same).

214. Absolute temperature, °R, is the Fahrenheit reading plus ____________.

215. Standard temperature, as specified by the A.G.A., is ____________ °F, or ____________ °R.

216. In regard to volume, the general gas law states that:

gas volume changes in *inverse* ratio to changes in absolute ____________; and

gas volume changes in *direct* ratio to changes in absolute ____________.

217. Equal volumes of any gas at the same pressure and temperature contain (the same/a different) number of molecules.

218. A cubic foot of gas can contain any amount of gas depending on ____________ and ____________.

219. To determine the amount of gas in a cubic foot at *measured* pressure and temperature, a conversion is made to cubic feet at (measured/standard) pressure and temperature.

220. To account for the change in the compressibility of gas at high pressures, the general gas law is corrected by the ____________ factor.

221. The general gas law is a combination of ____________ law and ____________ law.

THE END