

9.9: Exercises

9.3: Gas Pressure

1. Why are sharp knives more effective than dull knives (Hint: think about the definition of pressure)?

Answer

The cutting edge of a knife that has been sharpened has a smaller surface area than a dull knife. Since pressure is force per unit area, a sharp knife will exert a higher pressure with the same amount of force and cut through material more effectively.

2. Why do some small bridges have weight limits that depend on how many wheels or axles the crossing vehicle has?

Answer

More axles or wheels will increase the surface area of the vehicle with the bridge, decreasing the pressure.

3. Why should you roll or belly-crawl rather than walk across a thinly-frozen pond?

Answer

Lying down distributes your weight over a larger surface area, exerting less pressure on the ice compared to standing up. If you exert less pressure, you are less likely to break through thin ice.

4. A typical barometric pressure in Redding, California, is about 750 mm Hg. Calculate this pressure in atm and kPa.

Answer

0.99 atm; 1.0×10^2 kPa

5. A typical barometric pressure in Denver, Colorado, is 615 mm Hg. What is this pressure in atmospheres and kilopascals?

Answer

0.809 atm; 82.0 kPa

6. A typical barometric pressure in Kansas City is 740 torr. What is this pressure in atmospheres, in millimeters of mercury, and in kilopascals?

Answer

0.97 atm; 740 mm Hg; 99 kPa

7. Canadian tire pressure gauges are marked in units of kilopascals. What reading on such a gauge corresponds to 32 psi?

Answer

2.2×10^2 kPa

8. During the Viking landings on Mars, the atmospheric pressure was determined to be on the average about 6.50 millibars. What is that pressure in torr and kPa?

Answer

4.88 torr; 0.650 kPa

9. The pressure of the atmosphere on the surface of the planet Venus is about 88.8 atm. Compare that pressure in psi to the normal pressure on earth at sea level in psi.

Answer

Earth: 14.7 psi; Venus: 1.31×10^3 psi

10. A medical laboratory catalog describes the pressure in a cylinder of a gas as 14.82 MPa. What is the pressure of this gas in atmospheres and torr?

Answer

146.3 atm; 1.112×10^5 torr

11. Consider this scenario and answer the following questions: On a mid-August day in the northeastern United States, the following information appeared in the local newspaper: atmospheric pressure at sea level 29.97 in. Hg (1015 mbar).
- What was the pressure in kPa?
 - The pressure near the seacoast in the northeastern United States is usually reported near 30.0 in. Hg. During a hurricane, the pressure may fall to near 28.0 in. Hg. Calculate the drop in pressure in torr.

Answer

- 101.5 kPa
- 51 torr drop

9.4: Pressure and Volume

12. If the volume of a fixed amount of a gas is tripled at constant temperature, what happens to the pressure?

Answer

The pressure decreases by a factor of 3.

13. A 2.0 mL sample of air in a syringe has a pressure of 743 mm Hg. What is the pressure of the air when the volume is increased to 16.0 mL at constant temperature?

Answer

93 mm Hg

14. A container of nitrogen gas has a volume of 34.1 L at a pressure of 0.643 atm and 298 K. What will be the volume of the nitrogen if the pressure is increased to 0.917 atm at 298 K?

Answer

23.9 L

15. A sealed bag of chips contains air with a pressure of 755 mm Hg and a volume of 1.00 L. What will be the volume of the air in the bag when the chips are shipped over mountains where the pressure is 635 mm Hg?

Answer

1.19 L

16. One mol of N_2 gas has a volume of 6.318 L at a pressure of 1.000 atm at -196°C . What pressure is needed to compress the N_2 gas to 34.65 mL at the same temperature?

Answer

182.3 atm

17. A large scuba tank with a volume of 18 L is rated for a pressure of 220 bar. The tank is filled at 20°C and contains enough air to supply 1860 L of air to a diver at a pressure of 2.37 atm (a depth of 45 feet). Was the tank filled to capacity at 20°C ?

Answer

Yes. The pressure of the 18 L of air in the scuba tank would be 240 atm or 240 bar.

9.5: Volume and Temperature

18. Sometimes leaving a bicycle in the sun on a hot day will cause a blowout. Why?

Answer

The temperature of the air in the bicycle tire will increase, increasing the volume of the air. If the volume of the air exceeds the capacity of the tire, it will cause a blowout.

19. What is the temperature of an 11.2 L sample of carbon monoxide, CO , at 744 torr if it occupies 13.3 L at 55°C and 744 torr?

Answer

276 K or 3°C

20. A 3.00 L sample of air at 25°C is cooled to -196°C using liquid nitrogen at constant pressure. What is the new volume of the air?

Answer

0.78 L

21. What temperature is required to cause a 1.15 L balloon at 35°C and 1.1 atm to occupy a volume of 2.55 L at 1.1 atm?

Answer

693 K or 420°C

22. A 2.50 L volume of hydrogen measured at -100°C is warmed to 100°C . Calculate the volume of the gas at the higher temperature, assuming no change in pressure.

Answer

5.39 L

9.6: Pressure and Temperature

23. If the temperature of a fixed amount of a gas is doubled at constant volume, what happens to the pressure?

Answer

The pressure is also doubled.

24. A 2.00 L steel container holding 456 torr of oxygen gas at 25°C is heated. What will be the temperature of the gas when the pressure is 775 torr?

Answer

506 K or 233°C

25. What will be the pressure of a gas that is cooled to –75°C from a starting temperature and pressure of 35°C and 784 mm Hg? Assume that the volume remains constant.

Answer

504 mm Hg

26. A pressure of a sample of neon gas initially at 35°C and 1.24 atm drops to 0.872 atm. Assuming that the volume does not change, what is the new temperature of the gas?

Answer

217 K or –56°C

27. A spray can is used until it is empty except for the propellant gas, which has a pressure of 1344 torr at 23°C. If the can is thrown into a fire ($T = 475^\circ\text{C}$), what will be the pressure in the hot can?

Answer

3.40×10^3 torr

9.7: The Combined Gas Law

28. What is the final temperature of a gas whose initial conditions are 667 mL, 822 torr, and 67°C and whose final volume and pressure are 1.334 L and 2.98 atm, respectively? Assume the amount remains constant.

Answer

1870 K or 1.60×10^3 °C

29. What is the final pressure of a gas whose initial conditions are 1.407 L, 2.06 atm, and –67°C and whose final volume and temperature are 608 mL and 449 K, respectively? Assume the amount remains constant.

Answer

$$6.32 \times 10^3 \text{ atm}$$

30. At an altitude of 40 km above the earth's surface, the atmospheric pressure is 5.00 torr, and the surrounding temperature is -20°C . If a weather balloon filled with He at 760. torr and 22°C has a volume of 24.2 L, what is its final volume when it reaches 40 km in altitude? (Assume the pressure of the gas equals the surrounding pressure.)

Answer

$$3.15 \times 10^3 \text{ L}$$

31. If a balloon is filled with He at 760. torr and 22°C has a volume of 24.2 L, what is its final volume if it descends to the bottom of the Mariana Trench, where the surrounding temperature is 1.4°C and the pressure is 1,060 atm?

Answer

$$0.0213 \text{ L}$$

32. A high altitude balloon is filled with $1.41 \times 10^4 \text{ L}$ of hydrogen at a temperature of 21°C and a pressure of 745 torr. What is the volume of the balloon at a height of 20 km, where the temperature is -48°C and the pressure is 63.1 torr?

Answer

$$1.29 \times 10^5 \text{ L}$$

33. A cylinder of medical oxygen has a volume of 35.4 L, and contains O_2 at a pressure of 151 atm and a temperature of 25°C . What volume of O_2 does this correspond to at normal body conditions, that is, 1 atm and 37°C ?

Answer

$$5.56 \times 10^3 \text{ L}$$

34. A balloon that is 100.21 L at 21°C and 0.981 atm is released and just barely clears the top of Mount Crumpet in British Columbia. If the final volume of the balloon is 144.53 L at a temperature of 5.24°C , what is the pressure experienced by the balloon as it clears Mount Crumpet?

Answer

$$0.644 \text{ atm}$$

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