CHAPTER 10

- 1. If it is given that 546 K equals 273°C, then it follows that 400 K equals:
 - a. 127°C b. 150°C c. 473°C d. 1 200°C
- 2. A steel wire, 150 m long at 10°C, has a coefficient of linear expansion of $11 \times 10^{-6}/C^{\circ}$. Give its change in length as the temperature changes from 10°C to 45°C.
 - a. 0.65 cm b. 1.8 cm c. 5.8 cm d. 12 cm
- 3. A rectangular steel plate with dimensions of 30 cm \times 25 cm is heated from 20°C to 220°C. What is its change in area? (Coefficient of linear expansion for steel is 11×10^{-6} /C°.)
 - a. 0.82 cm^2 b. 1.65 cm^2 c. 3.3 cm^2 d. 6.6 cm^2
- 4. What happens to a given mass of water as it is cooled from 4°C to zero?
 - a. expands
 - b. contracts
 - c. vaporizes
 - d. neither expands, contracts, nor vaporizes
- 5. An ideal gas is confined to a container with adjustable volume. The pressure and mole number are constant. By what factor will volume change if absolute temperature triples?
 - a. 1/9 b. 1/3 c. 3.0 d. 9.0

- 6. An ideal gas is confined to a container with constant volume. The number of moles is constant. By what factor will the pressure change if the absolute temperature triples?
 - a. 1/9 b. 1/3 c. 3.0 d. 9.0
- 7. An ideal gas is confined to a container with adjustable volume. The number of moles and temperature are constant. By what factor will the volume change if pressure triples?
 - a. 1/9 b. 1/3 c. 3.0 d. 9.0
- 8. A 2.00-L container holds half a mole of an ideal gas at a pressure of 12.5 atm. What is the gas temperature? (R = 0.082 1 L·atm/mol·K)
 - A. 1 980 K b. 1 190 K c. 965 K d. 609 K
- 9. Two ideal gases, X and Y, are thoroughly mixed and at thermal equilibrium in a single container. The molecular mass of X is 9 times that of Y. What is the ratio of root-mean-square velocities of the two gases, $v_{X, rms}/v_{Y, rms}$?
 - a. 9/1 b. 3/1 c. 1/3
 - d. 1/9
- 10. The observation that materials expand in size with an increase in temperature can be applied to what approximate proportion of existing substances?
 - a. 100%
 - b. most
 - c. few
 - d. none
- 11. Which best describes the relationship between two systems in thermal equilibrium?
 - a. no net energy is exchanged
 - b. volumes are equal
 - c. masses are equal
 - d. zero velocity

- 12. What is the temperature of a system in thermal equilibrium with another system made up of water and steam at one atmosphere of pressure?
 - a. 0°F b. 273 K c. 0 K d. 100°C
- 13. What is the temperature of a system in thermal equilibrium with another system made up of ice and water at one atmosphere of pressure?
 - a. 0°F b. 273 K c. 0 K d. 100°C
- 14. Which best describes a system made up of ice, water and steam existing together?
 - a. absolute zerob. triple pointc. ice pointd. steam point
- 15. The absolute temperature of an ideal gas is directly proportional to which of the following properties, when taken as an average, of the molecules of that gas?
 - a. speed
 - b. momentum
 - c. mass
 - d. kinetic energy
- 16. The zeroth law of thermodynamics pertains to what relational condition that may exist between two systems?
 - a. zero net forces
 - b. zero velocities
 - c. zero temperature
 - d. thermal equilibrium
- 17. Which best expresses the value for the coefficient of volume expansion, β , for given material as a function of its corresponding coefficient of linear expansion, α ?
 - a. $\beta = \alpha^{3}$ b. $\beta = 3\alpha$ c. $\beta = \alpha^{2}$ d. $\beta = 2\alpha$

- 18. A steel plate has a hole drilled through it. The plate is put into a furnace and heated. What happens to the size of the inside diameter of a hole as its temperature increases?
 - a. increases
 - b. decreases
 - c. remains constant
 - d. becomes elliptical
- 19. With volume and molar quantity held constant, by what factor does the absolute temperature change for an ideal gas when the pressure is five times bigger?
 - a. 0.2 b. 1.0 c. 5.0 d. 25.0
- 20. With molar quantity and temperature held constant, by what factor does the pressure of an ideal gas change when the volume is five times bigger?
 - a. 0.2 b. 1.0 c. 5.0 d. 25.0
- 21. A temperature change from 15°C to 35°C corresponds to what incremental change in °F?
 - a. 20 b. 40 c. 36 d. 313
- 22. A substance is heated from 15°C to 35°C. What would the same incremental change be when registered in kelvins?
 - a. 20b. 40c. 36d. 313
- 23. 88°F is how many degrees Celsius?
 - a. 31b. 49c. 56d. 158

- 24. A brass cube, 10 cm on a side, is raised in temperature by 200°C. The coefficient of volume expansion of brass is 57×10^{-6} /C°. By what percentage does volume increase?
 - a. 12% b. 2.8% c. 1.1% d. 0.86%
- 25. A brass cube, 10 cm on a side, is raised in temperature by 200°C. The coefficient of volume expansion of brass is $57 \times 10^{-6}/C^{\circ}$. By what percentage is any one of the 10-cm edges increased in length?
 - a. 4% b. 2.8% c. 0.38% d. 0.29%
- 26. An automobile gas tank is filled to its capacity of 15.00 gallons with the gasoline at an initial temperature of 10°C. The automobile is parked in the sun causing the gasoline's temperature to rise to 60°C. If the coefficient of volume expansion for gasoline is 9.6×10^{-4} /C°, what volume runs out the overflow tube?
 - a. 1.74 gallonsb. 1.18 gallonsc. 0.72 gallonsd. 0.30 gallons
- 27. What happens to a given volume of water when heated from 0° C to 4° C?
 - a. density increases
 - b. density decreases
 - c. density remains constant
 - d. vaporizes
- 28. What happens to a volume of water when its temperature is reduced from 8°C to 4°C?
 - a. density increasesb. density decreasesc. density remains constantd. vaporizes
- 29. Two moles of nitrogen gas are contained in an enclosed cylinder with a movable piston. If the molecular mass of nitrogen is 28, how many grams of nitrogen are present?
 - a. 0.14 b. 56 c. 42 d. 112

30. Two moles of nitrogen gas are contained in an enclosed cylinder with a movable piston. If the gas temperature is 298 K, and the pressure is 1.01×10^6 N/m², what is the volume? (R = 8.31 J/mol·K)

a. $9.80 \times 10^{-3} \text{ m}^3$ b. $4.90 \times 10^{-3} \text{ m}^3$ c. $17.3 \times 10^{-3} \text{ m}^3$ d. $8.31 \times 10^{-3} \text{ m}^3$

- 31. Boltzmann's constant, $k_{\rm B}$, may be derived as a function of R, the universal gas constant, and $N_{\rm A}$, Avogadro's number. Which expresses the value of $k_{\rm B}$?
 - a. $N_A R^2$ b. $N_A R$ c. R/N_A d. N_A/R
- 32. How many atoms are present in a sample of pure iron with a mass of 300 g? (The atomic mass of iron = 56 and $N_A = 6.02 \times 10^{23}$)
 - a. 1.8×10^{19} b. 6.7×10^{22} c. 1.6×10^{28} d. 3.2×10^{24}
- 33. What is the root-mean-square speed of chlorine gas molecules at a temperature of 320 K? ($R = 8.31 \text{ J/mol}\cdot\text{K}$, $N_A = 6.02 \times 10^{23}$, and the molecular mass of $\text{Cl}_2 = 71$)
 - a. 1.7×10^2 m/s b. 3.4×10^2 m/s c. 0.8×10^4 m/s d. 1.1×10^5 m/s
- 34. Two moles of an ideal gas at 3.0 atm and 10°C are heated up to 150 °C. If the volume is held constant during this heating, what is the final pressure?
 - a. 4.5 atm b. 1.8 atm c. 0.14 atm d. 1.0 atm

- 35. One way to heat a gas is to compress it. A gas at 1.00 atm at 25.0°C is compressed to one tenth of its original volume, and it reaches 40.0 atm pressure. What is its new temperature?
 - a. 1 500 K b. 1 500°C c. 1 192°C d. 919°C
- 36. A pressure of 1.0×10^{-7} mm of Hg is achieved in a vacuum system. How many gas molecules are present per liter volume if the temperature is 293 K? (760 mm of Hg = 1 atm, R = 0.082 1 L·atm/mol·K and $N_A = 6.02 \times 10^{23}$)
 - a. 16×10^{18} b. 4.7×10^{16} c. 3.3×10^{12} d. 3.4×10^{9}
- 37. A helium-filled weather balloon has a 0.90 m radius at liftoff where air pressure is 1.0 atm and the temperature is 298 K. When airborne, the temperature is 210 K, and its radius expands to 3.0 m. What is the pressure at the airborne location?
 - a. 0.50 atm b. 0.013 atm c. 0.019 atm d. 0.38 atm
- 38. If the temperature of an ideal gas contained in a box is increased:
 - a. the average velocity of the molecules in the box will be increased.
 - b. the average speed of the molecules in the box will be increased.
 - c. the distance between molecules in the box will be increased.
 - d. all of the above.
- 39. At what temperature is the same numerical value obtained in Celsius and Fahrenheit?
 - a. -40° b. 0° c. 40° d. -72°
- 40. Normal body temperature for humans is 37°C. What is this temperature in kelvins?
 - a. 296
 b. 310
 c. 393
 d. 273

- 41. The thermal expansion of a solid is caused by:
 - a. the breaking of bonds between atoms.
 - b. increasing the amplitude of the atoms vibration.
 - c. increasing the distance between equilibrium positions for the vibrating atoms.
 - d. all of the above.
- 42. A steel sphere sits on top of an aluminum ring. The steel sphere ($\alpha = 1.10 \times 10^{-5}/C^{\circ}$) has a diameter of 4.0000 cm at 0°C. The aluminum ring ($\alpha = 2.40 \times 10^{-5}/C^{\circ}$) has an inside diameter of 3.9940 cm at 0°C. Closest to which temperature given will the sphere just fall through the ring?
 - a. 462°C b. 208°C c. 116°C d. 57.7°C
- 43. Between 0° and 4°C, the volume coefficient of expansion for water:
 - a. is positive.
 - b. is zero.
 - c. is becoming less dense.
 - d. is negative.
- 44. For an ideal gas of a given mass, if the pressure remains the same and the volume increases:
 - a. the average kinetic energy of the molecules decreases.
 - b. the average kinetic energy of the molecules stays the same.
 - c. the average kinetic energy of the molecules increases.
 - d. Nothing can be determined about the molecular kinetic energy.
- 45. John rapidly pulls a plunger out of a cylinder. As the plunger moves away, the gas molecules bouncing elastically off the plunger are:
 - a. rebounding at a higher speed than they would have if the plunger weren't removed.
 - b. rebounding at a lower speed than they would have if the plunger weren't removed.
 - c. rebounding at the same speed as they would have if the plunger weren't removed.
 - d. Whether they speed up or slow down depends on how fast the plunger is removed.
- 46. Consider two containers with the same volume and temperature. Container One holds "dry" air—a mixture of nitrogen and oxygen. Container Two holds "moist" air. The "moist" air has the same ratio of nitrogen to oxygen molecules, but also contains water vapor. According to the ideal gas law, if the pressures are equal, the weight of the gas in Container One will be:
 - a. lighter than the gas inside the second container.
 - b. equal to the weight of the gas in the second container.
 - c. heavier than the gas inside the second container.
 - d. all the above are incorrect because the pressures cannot be equal.

- 47. Evaporation cools the liquid that is left behind because the molecules that leave the liquid during evaporation:
 - a. have kinetic energy.
 - b. have greater than average speed.
 - c. have broken the bonds that held them in the liquid.
 - d. create vapor pressure.
- 48. One mole of an ideal gas at 1.00 atm and 0.00°C occupies 22.4 L. How many molecules of an ideal gas are in one cm³ under these conditions?

a. 28.9 b. 22 400 c. 2.69 \times 10¹⁹ d. 6.02 \times 10²³

49. A long steel beam has a length of twenty-five meters on a cold day when the temperature is 0°C. What is the length of the beam on a hot day when $T = 40^{\circ}$ C? ($\alpha_{\text{steel}} = 1.1 \times 10^{-5}$ /C°)

a. 25.000 44 m b. 25.004 4 m c. 25.011 m d. 25.044 m

- 50. Suppose the ends of a 20-m-long steel beam are rigidly clamped at 0°C to prevent expansion. The rail has a cross-sectional area of 30 cm². What force does the beam exert when it is heated to 40°C? ($\alpha_{\text{steel}} = 1.1 \times 10^{-5}/\text{C}^{\circ}$, $Y_{\text{steel}} = 2.0 \times 10^{11} \text{ N/m}^2$).
 - a. 2.6×10^{5} N b. 5.6×10^{4} N c. 1.3×10^{3} N d. 6.5×10^{2} N
- 51. Carbon dioxide forms into a solid (dry ice) at approximately -157°F. What temperature in degrees Celsius does this correspond to?
 - a. -157°C b. -93°C c. -121°C d. -105°C

52. How many moles of air must escape from a $10\text{-m} \times 8.0\text{-m} \times 5.0\text{-m}$ room when the temperature is raised from 0°C to 20°C? Assume the pressure remains unchanged at one atmosphere while the room is heated.

a. 1.3×10^{3} moles b. 1.2×10^{3} moles c. 7.5×10^{2} moles d. 3.7×10^{2} moles

53. Estimate the volume of a helium-filled balloon at STP if it is to lift a payload of 500 kg. The density of air is 1.29 kg/m³ and helium has a density of 0.178 kg/m³.

a. 4 410 m³ b. 932 m³ c. 450 m³ d. 225 m³

- 54. Tricia puts 44 g of dry ice (solid CO₂) into a 2.0-L container and seals the top. The dry ice turns to gas at room temperature (20°C). Find the pressure increase in the 2.0-L container. (One mole of CO₂ has a mass of 44 g, R = 0.082 1 L·atm/mol·K.)
 - a. 6.0 atm b. 12 atm c. 18 atm d. 2.0 atm
- 55. The mass of a hot-air balloon and its cargo (not including the air inside) is 200 kg. The air outside is at a temperature of 10°C and a pressure of 1 atm = 10^5 N/m². The volume of the balloon is 400 m³. Which temperature below of the air in the balloon will allow the balloon to just lift off? (Air density at 10°C is 1.25 kg/m³).
 - a. 37°C b. 69°C c. 99°C d. 200°C
- 56. 9.0 g of water in a 2.0-L pressure vessel is heated to 500°C. What is the pressure inside the container? (R = 0.082 L·atm/mol·K, one mole of water has a mass of 18 grams)
 - a. 7.9 atm b. 16 atm c. 24 atm d. 32 atm

57. At 20°C an aluminum ring has an inner diameter of 5.000 cm, and a brass rod has a diameter of 5.050 cm. Keeping the brass rod at 20°C, which of the following temperatures of the ring will allow the ring to just slip over the brass rod? ($\alpha_{Al} = 2.4 \times 10^{-5} / C^{\circ}$, $\alpha_{brass} = 1.9 \times 10^{-5} / C^{\circ}$)

 $(\alpha_{Al} = 2.4 \times 10^{-7}/C^{\circ}, \alpha_{brass} = 1.9 \times 10^{-7}/C^{\circ}$

- a. 111°C b. 236°C c. 384°C d. 437°C
- 58. A spherical air bubble originating from a scuba diver at a depth of 18.0 m has a diameter of 1.0 cm. What will the bubble's diameter be when it reaches the surface? (Assume constant temperature.)
 - a. 0.7 cm b. 1.0 cm c. 1.4 cm d. 1.7 cm
- 59. As a copper wire is heated, its length increases by 0.100%. What is the change of the temperature of the wire? ($\alpha_{Cu} = 16.6 \times 10^{-6}/C^{\circ}$)
 - a. 120.4°C b. 60.2°C c. 30.1°C d. 6.0°C
- 60. A tank with a volume of 0.150 m³ contains 27.0°C helium gas at a pressure of 100 atm. How many balloons can be blown up if each filled balloon is a sphere 30.0 cm in diameter at 27.0°C and absolute pressure of 1.20 atm?
 - a. 963 balloonsb. 884 balloonsc. 776 balloonsd. 598 balloons
- 61. The ideal gas law treats gas as consisting of
 - a. atoms.
 - b. molecules.
 - c. chemicals
 - d. bubbles.

- 62. An interval of one Celsius degree is equivalent to an interval of
 - a. one Fahrenheit degree.
 - b. one kelvin.
 - c. 5/9 Fahrenheit degree.
 - d. 5/9 kelvin.
- 63. The coefficient of area expansion is
 - a. half the coefficient of volume expansion.
 - b. triple the coefficient of volume expansion.
 - c. double the coefficient of linear expansion.
 - d. triple the coefficient of linear expansion.
- - a. the same as
 - b. more than
 - c. less than
 - d. stronger than
- 65. The sulfur hexafluoride molecule consists of one sulfur atom and six fluorine atoms. The atomic masses of sulfur and fluorine are 32.0 u and 19.0 u respectively. One mole of this very heavy gas has what mass?
 - a. 32 g b. 51 g c. 146 g d. 608 g
- 66. A room has a volume of 60 m³ and is filled with air of an average molecular mass of 29 u. What is the mass of the air in the room at a pressure of 1.0×10^5 Pa and temperature of 22°C? R = 0.082 L·atm/mol·K
 - a. 2.4 kg b. 2 400 kg c. 71 kg d. 700 kg
- 67. Different units can be used for length: m and cm, of these two m being the larger. Different units can also be used for *R*: (1) J/mol·K, (2) L·atm/mol·K, and (3) (N/m²)·m³/mol·K. Which of these units for *R* is the largest? ($1L = 10^{-3} \text{ m}^3$, 1 atm = $1.01 \times 10^5 \text{ Pa}$)

a. 1b. 2c. 3d. They are all equal.

<u>#</u>	Ans	Difficulty	#	Ans	Difficulty
1.	А	1	35.	D	3
2.	С	2	36.	С	2
3.	С	2	37.	С	2
4.	А	2	38.	В	1
5.	С	1	39.	А	2
6.	С	1	40.	В	2
7.	В	1	41.	С	1
8.	D	2	42.	С	3
9.	С	2	43.	D	1
10.	В	1	44.	С	2
11.	А	1	45.	В	2
12.	D	1	46.	С	3
13.	В	1	47.	В	1
14.	В	1	48.	С	2
15.	D	1	49.	С	2
16.	D	1	50.	А	3
17.	В	1	51.	D	2
18.	А	1	52.	В	2
19.	С	1	53.	С	3
20.	А	1	54.	В	2
21.	С	1	55.	D	3
22.	А	1	56.	В	3
23.	А	1	57.	D	3
24.	С	2	58.	С	3
25.	С	2	59.	В	2
26.	С	2	60.	В	2
27.	А	1	61.	В	1
28.	А	1	62.	В	1
29.	В	1	63.	С	1
30.	В	2	64.	С	1
31.	С	2	65.	С	2
32.	D	2	66.	С	2
33.	В	2	67.	В	2
34	А	2			

CHAPTER 10 - ANSWERS