

AP Physics 2 - Chapter 10 Test

Indicate the answer choice that best completes the statement or answers the question.

- ___ 1. Suppose the pressure of 20 g of an ideal monatomic gas is tripled while its volume is halved. What happens to the internal energy of the gas?
- It stays the same, as the described changes do not involve internal energy.
 - It increases.
 - It decreases.
 - This depends on the molecular weight of the gas involved, thus this is indeterminate.
- ___ 2. A brass cube, 14 cm on a side, is raised in temperature by 243°C. The coefficient of volume expansion of brass is $57 \times 10^{-6}/\text{C}^\circ$. By what percentage does volume increase?
- 3.8%
 - 1.8%
 - 1.4%
 - 4.8%
 - 2.7%
- ___ 3. The zeroth law of thermodynamics pertains to what relational condition that may exist between two systems?
- zero net forces
 - zero velocities
 - zero temperature
 - thermal equilibrium
- ___ 4. Two one-liter containers each contain 10 moles of a gas. The temperature is the same in both containers. Container A holds helium (molecular mass = 4 u), and Container B holds oxygen (molecular mass = 16 u). Which container has the higher pressure and by what factor?
- Container A has 4 times the pressure of Container B.
 - Container A has 2 times the pressure of Container B.
 - Both containers have the same pressure.
 - More information is needed to answer this question.
- ___ 5. A helium-filled weather balloon has a 1.3 m radius at liftoff where air pressure is 2 atm and the temperature is 282 K. When airborne, the temperature is 224 K, and its radius expands to 3 m. What is the pressure at the airborne location?
- 0.205 atm
 - 0.69 atm
 - 0.129 atm
 - 0.032 atm
 - 19.5 atm

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- ___ 6. What is the root-mean-square speed of chlorine gas molecules at a temperature of 360 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. $1.1 \times 10^2 \text{ m/s}$
 - b. $3.6 \times 10^2 \text{ m/s}$
 - c. $8.4 \times 10^4 \text{ m/s}$
 - d. $1.3 \times 10^5 \text{ m/s}$
 - e. $3.5 \times 10^4 \text{ m/s}$
- ___ 7. A temperature change from 20°C to 40°C corresponds to what incremental change in $^\circ\text{F}$?
- a. 20
 - b. 68
 - c. 36
 - d. 104
 - e. 68
- ___ 8. Boltzmann's constant, k_B , may be derived as a function of R , the universal gas constant, and N_A , Avogadro's number. Which expresses the value of k_B ?
- a. $N_A R^2$
 - b. $N_A R$
 - c. R/N_A
 - d. N_A/R
- ___ 9. 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.
- ___ 10. 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.

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- ___ 11. 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 $1.01 \times 10^6 \text{ N/m}^2$, what is the volume? ($R = 8.31 \text{ J/mol} \cdot \text{K}$)
- a. $2.45 \times 10^{-3} \text{ m}^3$
 - b. $4.9 \times 10^{-3} \text{ m}^3$
 - c. $6.13 \times 10^{-3} \text{ m}^3$
 - d. $9.81 \times 10^{-3} \text{ m}^3$
 - e. $3.68 \times 10^{-3} \text{ m}^3$
- ___ 12. Why do vapor bubbles get larger in boiling water as they approach the surface?
- a. They only appear to get larger, this being a magnification effect due to looking through the water.
 - b. The bubbles' pressure increases as they rise.
 - c. The pressure in the water decreases as the bubble moves toward the surface.
 - d. Bubbles always get bigger after they form.
- ___ 13. 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
- ___ 14. 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
- ___ 15. Two ideal gases, X and Y, are thoroughly mixed and at thermal equilibrium in a single container. The molecular mass of X is 25 times that of Y. What is the ratio of root-mean-square velocities of the two gases, $v_{X, \text{rms}} / v_{Y, \text{rms}}$?
- a. 25/1
 - b. 5/1
 - c. 1/5
 - d. 1/25
 - e. 1/10

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- ___ 16. What is the internal energy of 40 moles of Neon gas (molecular mass = 20 u) at 20°C? ($R = 8.31 \text{ J/mol} \cdot \text{K}$)
- $1.5 \times 10^5 \text{ J}$
 - $6.5 \times 10^5 \text{ J}$
 - $1.7 \times 10^3 \text{ J}$
 - $1 \times 10^4 \text{ J}$
 - It depends on the container size, which is not given.
- ___ 17. A quantity of a monatomic ideal gas expands to twice the volume while maintaining the same pressure. If the internal energy of the gas were U_0 before the expansion, what is it after the expansion?
- U_0
 - $2 U_0$
 - $4 U_0$
 - The change in temperature must also be known to answer this question.
- ___ 18. Which best describes a system made up of ice, water and steam existing together?
- absolute zero
 - triple point
 - ice point
 - steam point
- ___ 19. The internal energy of a monatomic ideal gas is equal to which of the following?
- $(3/2)PV$
 - $(3/2)nT/V$
 - $3 T/P$
 - none of the above
- ___ 20. The temperature of a quantity of ideal gas in a sealed container is increased from 0°C to 273°C. What happens to the rms speed of the molecules of the gas as a result of this temperature increase?
- It does not change since rms speed is independent of temperature.
 - It increases but it less than doubles.
 - It doubles.
 - It quadruples.
- ___ 21. For an ideal gas of a given mass, if the pressure remains the same and the volume increases:
- the average kinetic energy of the molecules decreases.
 - the average kinetic energy of the molecules stays the same.
 - the average kinetic energy of the molecules increases.
 - Nothing can be determined about the molecular kinetic energy.

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- ___ 22. A spherical air bubble originating from a scuba diver at a depth of 15 m has a diameter of 0.8 cm. What will the bubble's diameter be when it reaches the surface? (Assume constant temperature.)
- a. 2 cm
 - b. 1.2 cm
 - c. 1.1 cm
 - d. 0.9 cm
 - e. 1.7 cm
- ___ 23. Metal lids on glass jars can often be loosened by running them under hot water. Why is this?
- a. The hot water is a lubricant.
 - b. The metal and glass expand due to the heating, and the glass being of smaller radius expands less than the metal.
 - c. The metal has a higher coefficient of thermal expansion than glass so the metal expands more than the glass thus loosening the connection.
 - d. This is just folklore.
- ___ 24. The noble gases, listed by increasing molecular weight, are He, Ne, Ar, Kr, Xe, and Rn. If samples of 1 mole each of these gases are placed in separate containers and heated to 300 K, which gas has the greatest internal energy and the molecules of which gas have the highest rms speed?
- a. The He has the greatest internal energy, and the Rn has the greatest rms speed.
 - b. The Rn has the greatest internal energy, and the He has the greatest rms speed.
 - c. All the gases have the same internal energy, and the Rn has the greatest rms speed.
 - d. All the gases have the same internal energy, and the He has the greatest rms speed.
- ___ 25. One way to heat a gas is to compress it. A gas at 1 atm at 35°C is compressed to three tenths of its original volume, and it reaches 43 atm pressure. What is its new temperature?
- a. 725 K
 - b. 452°C
 - c. 3,973°C
 - d. 3,700°C
 - e. 1,850 K
- ___ 26. At what temperature is the same numerical value obtained in Celsius and Fahrenheit?
- a. -40°
 - b. 0°
 - c. 40°
 - d. -72°

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- ___ 27. The mass of a hot-air balloon and its cargo (not including the air inside) is 252 kg. The air outside is at a temperature of 10°C and a pressure of $1\text{ atm} = 10^5\text{ N/m}^2$. The volume of the balloon is 500 m^3 . 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/m^3 .)
- a. 4°C
 - b. 9°C
 - c. 407°C
 - d. 124°C
 - e. 345°C
- ___ 28. 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.
- ___ 29. 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.
- ___ 30. Estimate the volume of a helium-filled balloon at STP if it is to lift a payload of 400 kg. The density of air is 1.29 kg/m^3 and helium has a density of 0.178 kg/m^3 .
- a. $2,247\text{ m}^3$
 - b. 272 m^3
 - c. 360 m^3
 - d. 310 m^3
 - e. 445 m^3

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Answer Key

1. b
2. c
3. d
4. c
5. c
6. b
7. c
8. c
9. b
10. b
11. b
12. c
13. a
14. a
15. c
16. a
17. b
18. b
19. a
20. b
21. c
22. c
23. c
24. d
25. d
26. a

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27. d

28. c

29. b

30. c