Name: ______________________ Class: _________________ Date: _________ ID: A

Cp physics web review practice test - Heat and Thermodynamics (ch 9-11)

Please do not write on my tests

Multiple Choice

Identify the choice that best completes the statement or answers the question.

____ 1. Which of the following is a direct cause of a substance's temperature increase?
a. Energy is removed from the particles of the substance.
b. Kinetic energy is added to the particles of the substance.
c. The number of atoms and molecules in a substance changes.
d. The volume of the substance decreases.

____ 2. What happens to the internal energy of an ideal gas when it is heated from 0°C to 4°C?
a. It increases.
b. It decreases.
c. It remains constant.
d. It is impossible to determine.

____ 3. Which of the following is a form of kinetic energy that occurs within a molecule when the bonds are stretched or bent?
a. translational
b. rotational
c. vibrational
d. internal

____ 4. Which of the following best describes the relationship between two systems in thermal equilibrium?
a. No net energy is exchanged.
b. The volumes are equal.
c. The masses are equal.
d. The velocity is zero.

____ 5. As the temperature of a substance increases, its volume tends to increase due to
a. thermal equilibrium.
b. thermal energy.
c. thermal expansion.
d. thermal contraction.

____ 6. What is the temperature of a system in thermal equilibrium with another system made up of water and steam at 1 atm of pressure?
a. 0°F
b. 273 K
c. 0 K
d. 100°C

____ 7. A substance registers a temperature change from 20°C to 40°C. To what incremental temperature change does this correspond?
a. 20 K
b. 40 K
c. 36 K
d. 313 K

____ 8. Energy transferred as heat occurs between two bodies in thermal contact when they differ in which of the following properties?
a. mass
b. specific heat
c. density
d. temperature

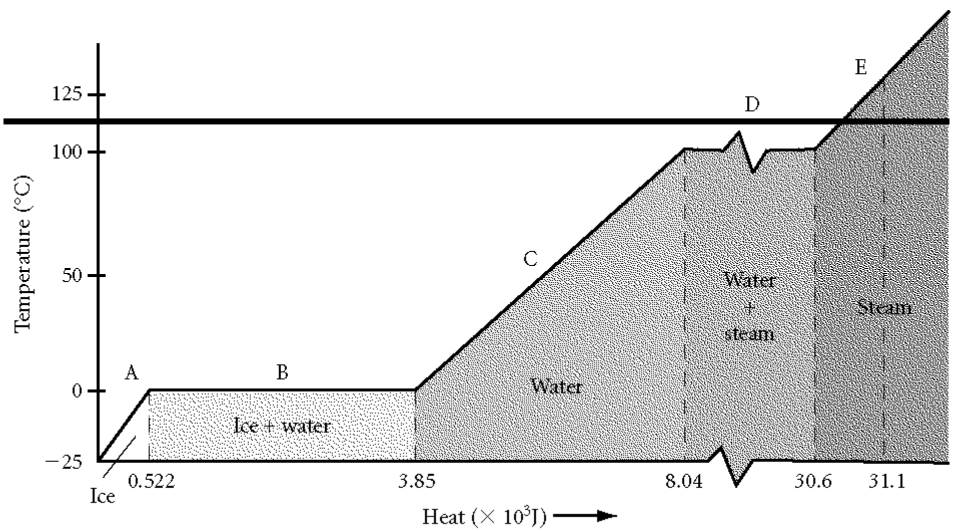
____ 9. Which of the following terms describes a transfer of energy?
a. heat
b. internal energy
c. temperature
d. kinetic energy

____ 10. How is energy transferred as heat always directed?
a. from an object at low temperature to an object at high temperature
b. from an object at high temperature to an object at low temperature
c. from an object at low kinetic energy to an object at high kinetic energy
d. from an object with higher mass to an object of lower mass

____ 11. If energy is transferred from a table to a block of ice moving across the table, which of the following statements is true?
a. The table and the ice are at thermal equilibrium.
b. The ice is cooler than the table.
c. The ice is no longer 0°C.
d. Energy is being transferred from the ice to the table.

____ 12. What three properties of a substance affect the amount of energy transferred as heat to or from the substance?
a. volume, temperature change, specific heat capacity
b. density, temperature change, specific heat capacity
c. mass, temperature change, specific heat capacity
d. mass, temperature change, latent heat

____ 13. Which of the following is true during a phase change?
a. Temperature increases.
b. Temperature remains constant.
c. Temperature decreases.
d. There is no transfer of energy as heat.



____ 14. The figure above shows how the temperature of 10.0 g of ice changes as energy is added. Which of the following statements is correct?
a. The water absorbed energy continuously, but the temperature increased only when all of the water was in one phase.
b. The water absorbed energy sporadically, and the temperature increased only when all of the water was in one phase.
c. The water absorbed energy continuously, and the temperature increased continuously.
d. The water did not absorb energy.

____ 15. At what point on the figure above does the substance undergo a phase change?
a. A
b. B
c. C
d. E

____ 16. Using the figure above, determine which value equals the latent heat required to change the liquid water into steam.

a. 8.04×10^3 J
b. 22.6×10^3 J
c. 30.6×10^3 J
d. 31.1×10^3 J

____ 17. At what point on the figure above is the amount of energy transferred as heat approximately 4.19×10^3 J?

a. A
b. B
c. C
d. D

____ 18. What accounts for an increase in the temperature of a gas that is kept at constant volume?

a. Energy has been removed as heat from the gas.
b. Energy has been added as heat to the gas.
c. Energy has been removed as work done by the gas.
d. Energy has been added as work done on the gas.

____ 19. When an ideal gas does positive work on its surroundings, which of the gas's quantities increases?

a. temperature
b. volume
c. pressure
d. internal energy

____ 20. An ideal gas system is maintained at a constant volume of 4 L. If the pressure is constant, how much work is done by the system?

a. 0 J
b. 5 J
c. 8 J
d. 30 J

____ 21. Air cools as it escapes from a diver's compressed air tank. What kind of process is this?

a. isovolumetric
b. isobaric
c. adiabatic
d. isothermal

____ 22. What thermodynamic process for an ideal gas system has an unchanging internal energy and a heat intake that corresponds to the value of the work done by the system?

a. isovolumetric
b. isobaric
c. adiabatic
d. isothermal

____ 23. Which thermodynamic process takes place when work is done on or by the system but no energy is transferred to or from the system as heat?

a. isovolumetric
b. isobaric
c. adiabatic
d. isothermal

____ 24. Which thermodynamic process takes place at a constant temperature so that the internal energy of a system remains unchanged?

a. isovolumetric
b. isobaric
c. adiabatic
d. isothermal

____ 25. Which thermodynamic process takes place at constant volume so that no work is done on or by the system?

a. isovolumetric
b. isobaric
c. adiabatic
d. isothermal

____ 26. In an isovolumetric process for an ideal gas, the system's change in the energy as heat is equivalent to a change in which of the following?

a. temperature
b. volume
c. pressure
d. internal energy

____ 27. During an isovolumetric process, which of the following does not change?
a. temperature
b. volume
c. pressure
d. internal energy

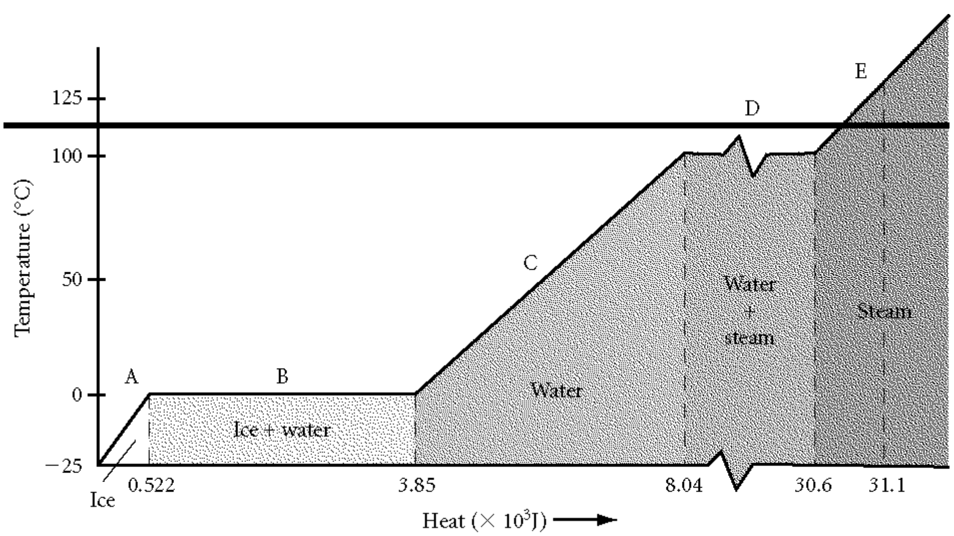
____ 28. How is conservation of internal energy expressed for a system during an adiabatic process?
a. $Q = W = 0$, so $\Delta U = 0$ and $U_i = U_f$
b. $Q = 0$, so $\Delta U = -W$
c. $\Delta T = 0$, so $\Delta U = 0$; therefore, $\Delta U = Q - W = 0$, or $Q = W$
d. $\Delta V = 0$, so $P\Delta V = 0$ and $W = 0$; therefore, $\Delta U = Q$

____ 29. How is conservation of internal energy expressed for a system during an isovolumetric process?
a. $Q = W = 0$, so $\Delta U = 0$ and $U_i = U_f$
b. $Q = 0$, so $\Delta U = -W$
c. $\Delta T = 0$, so $\Delta U = 0$; therefore, $\Delta U = Q - W = 0$, or $Q = W$
d. $\Delta V = 0$, so $P\Delta V = 0$ and $W = 0$; therefore, $\Delta U = Q$

____ 30. How is conservation of internal energy expressed for a system during an isothermal process?
a. $Q = W = 0$, so $\Delta U = 0$ and $U_i = U_f$
b. $Q = 0$, so $\Delta U = -W$
c. $\Delta T = 0$, so $\Delta U = 0$; therefore, $\Delta U = Q - W = 0$, or $Q = W$
d. $\Delta V = 0$, so $P\Delta V = 0$ and $W = 0$; therefore, $\Delta U = Q$

____ 31. How is conservation of internal energy expressed for an isolated system?
a. $Q = W = 0$, so $\Delta U = 0$ and $U_i = U_f$
b. $Q = 0$, so $\Delta U = -W$
c. $\Delta T = 0$, so $\Delta U = 0$; therefore, $\Delta U = Q - W = 0$, or $Q = W$
d. $\Delta V = 0$, so $P\Delta V = 0$ and $W = 0$; therefore, $\Delta U = Q$

Short Answer



32. The figure above shows how the temperature of 10.0 g of ice changes as energy is added. What happens to the ice at 0°C?

33. The figure above shows how the temperature of 10.0 g of ice changes as energy is added. What happens to the ice at 100°C?

34. The figure above shows how the temperature of 10.0 g of ice changes as energy is added. What happens to the ice between 0°C and 100°C?

Problem

35. What temperature on the Celsius scale is the equivalent of 88.0°F?

36. Liquid oxygen has a temperature of –183°C. What is this temperature in kelvins?

37. A falling stone with a mass of 0.255 kg strikes the ground. Assuming that the stone is initially at rest when it begins falling, how high must the stone be above the ground for the internal energy of the stone and ground to increase by 2450 J? (g = 9.81 m/s^2)

38. What is the temperature increase of 4.0 kg of water when it is heated by an 8.0×10^2 W immersion heater for exactly 10.0 min? (c_p = 4186 J/kg•°C)

39. An electric drill bores through a 0.100 kg piece of copper in 30.0 s. Find the increase in the temperature of the copper if the drill operates at 40.0 W. Assume that the drill does not increase in temperature. (c_p = 387 J/kg•°C)

40. Find the final equilibrium temperature when 10.0 g of milk at 10.0°C is added to 1.60×10^2 g of coffee with a temperature of 90.0°C. Assume the specific heats of coffee and milk are the same as for water ($c_{p,w}$ = 4.19 J/g•°C), and disregard the heat capacity of the container.

41. A container of gas is at a pressure of 3.7×10^5 Pa. How much work is done by the gas if its volume expands by 1.6 m^3?

42. A container of gas is at a pressure of 1.3×10^5 Pa and a volume of 6.0 m^3. How much work is done by the gas if it expands at constant pressure to twice its initial volume?

43. A cylinder has a radius of 0.080 m. How much work is done by a gas in the cylinder if the gas exerts a constant pressure of 7.8×10^5 Pa on the piston, moving it a distance of 0.060 m?

44. A total of 165 J of work is done on a gaseous refrigerant as it undergoes compression. If the internal energy of the gas increases by 123 J during the process, what is the total amount of energy transferred as heat?

45. The internal energy of a system is initially 63 J. A total of 71 J of energy is added to the system as heat while the system does 59 J of work. What is the system's final internal energy?

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Answer Section

MULTIPLE CHOICE

1. B
2. A
3. C
4. A
5. C
6. D
7. A
8. D
9. A
10. B
11. B
12. C
13. B
14. A
15. B
16. B
17. C
18. B
19. B
20. A
21. C
22. D
23. C
24. D
25. A
26. D
27. B
28. B
29. D
30. C
31. A

SHORT ANSWER

32. The ice begins to melt and change into water.
33. The temperature stops rising, and the water turns into steam.
34. The temperature of the melted ice (water) increases steadily until the water begins to vaporize at 100°C.

PROBLEM

35. 31.1°C

Given
$T_F = 88.0°F$

Solution
$T_F = \frac{9}{5}T_C + 32.0$

$T_C = \frac{5}{9}(T_F - 32.0) = \frac{5}{9}(88.0 - 32.0)°C = \frac{5}{9}(56.0)°C = 31.1°C$

36. 9.0×10^1 K

Given
$T_C = -183°C$

Solution
$T = T_C + 273.15$

$T = (-183 + 273.15)\text{ K} = 9.0 \times 10^1\text{ K}$

37. 979 m

Given
$m = 0.255$ kg
$\Delta U = 2450$ J
$g = 9.81\text{ m/s}^2$

Solution
$\Delta PE + \Delta KE + \Delta U = 0$

The kinetic energy increases with the decrease in potential energy, and then decreases with the increase in the internal energy of the water. Thus, the net change in kinetic energy is zero.

$\Delta PE + \Delta U = 0$

Assuming final potential energy has a value of zero, the change in the internal energy equals:

$0 - PE_i + \Delta U = 0$

$\Delta U = PE_i = mgh$

$$h = \frac{\Delta U}{mg} = \frac{2450\text{ J}}{(0.255\text{ kg})(9.81\text{ m/s}^2)} = 979\text{ m}$$

38. 29°C

Given
$m = 4.0$ kg
$P = 8.0 \times 10^2$ W
$\Delta t = 10.0$ min
$c_p = 4186$ J/kg°C

Solution
Heat equals the power delivered multiplied by the time interval.

$$Q = P\Delta t$$

$$Q = c_p m \Delta T$$

$$\Delta T = \frac{P\Delta t}{c_p m} = \frac{(8.0 \times 10^2 \text{ W})(10.0 \text{ min})}{(4186 \text{ J/kg°C})(4.0 \text{ kg})} \times \left(\frac{60 \text{ s}}{1 \text{ min}} \right) = 29°\text{C}$$

39. 31.0°C

Given
$m = 0.100$ kg
$\Delta t = 30.0$ s
$P = 40.0$ W
$c_p = 387$ J/kg•°C

Solution
Heat equals the power delivered multiplied by the time interval.

$$Q = P\Delta t$$

$$Q = c_p m \Delta T$$

$$\Delta T = \frac{P\Delta t}{c_p m} = \frac{(40.0 \text{ W})(30.0 \text{ s})}{(387 \text{ J/kg°C})(0.100 \text{ kg})} = 31.0°\text{C}$$

40. 85.3°C

Given

$m_m = 10.0\ \text{g}$

$T_m = 10.0°\text{C}$

$m_c = 1.60 \times 10^2\ \text{g}$

$T_c = 90.0°\text{C}$

$c_{p,w} = 4.19\ \text{J/g}\bullet°\text{C}$

Solution

From conservation of energy, the energy absorbed as heat by the milk equals the energy given up as heat by the coffee.

$$Q_m = -Q_c$$

$$c_{p,w} m_m \Delta T_m = -c_{p,w} m_c \Delta T_c$$

$$c_{p,w} m_m (T_f - T_m) = -c_{p,w} m_c (T_f - T_c) = c_{p,w} m_c (T_c - T_f)$$

$$m_m T_f + m_c T_f = m_c T_c + m_m T_m$$

$$T_f = \frac{m_c T_c + m_m T_m}{m_m + m_c}$$

$$T_f = \frac{(1.60 \times 10^2\ \text{g})(90.0°\text{C}) + (10.0\ \text{g})(10.0°\text{C})}{1.60 \times 10^2\ \text{g} + 10.0\ \text{g}}$$

$$T_f = \frac{1.44 \times 10^4\ \text{g°C} + 1.00 \times 10^2\ \text{g°C}}{1.70 \times 10^2\ \text{g}}$$

$$T_f = \frac{1.45 \times 10^4\ \text{g°C}}{1.70 \times 10^2\ \text{g}} = 85.3°\text{C}$$

41. 5.9×10^5 J

Given

$P = 3.7 \times 10^5\ \text{Pa}$

$\Delta V = 1.6\ \text{m}^3$

Solution

$$W = P\Delta V = (3.7 \times 10^5\ \text{Pa})(1.6\ \text{m}^3) = 5.9 \times 10^5\ \text{J}$$

42. 7.8×10^5 J

Given

$P = 1.3 \times 10^5$ Pa

$V_i = 6.0\ \text{m}^3$

$V_f = 2V_i$

Solution

$W = P\Delta V$

$\Delta V = V_f - V_i = 2V_i - V_i = V_i$

$W = (1.3 \times 10^5\ \text{Pa})(6.0\ \text{m}^3) = 7.8 \times 10^5\ \text{J}$

43. 9.4×10^2 J

Given

$r = 0.080$ m

$P = 7.8 \times 10^5$ Pa

$d = 0.060$ m

Solution

Work is done by the gas, so W is positive.

$W = P\Delta V = PAd$

$A = \pi r^2$

$W = PAd = P\pi r^2 d = (7.8 \times 10^5\ \text{Pa})(\pi)(0.080\ \text{m})^2(0.060\ \text{m})$

$P = 9.4 \times 10^2\ \text{J}$

44. –42 J, or 42 J transferred from the system as heat

Given

$W = -165$ J

$\Delta U = 123$ J

Solution

Work is done on the system, so W is negative.

$\Delta U = Q - W$

$Q = \Delta U + W = 123\ \text{J} + (-165\ \text{J}) = -42\ \text{J}$, or 42 J transferred from the system as heat

45. 75 J

Given
$U_i = 63$ J
$Q = 71$ J
$W = 59$ J

Solution
Work is done by the system, so W is positive. Energy is added as heat to the system, so Q is positive.
$\Delta U = U_f - U_i = Q - W$

$U_f = U_i + Q - W = 63\text{ J} + 71\text{ J} - 59\text{ J} = 75\text{ J}$