

Questions 1-2

A piece of metal with a mass of 1.50 kilograms, specific heat of $200 \text{ J/kg} \cdot \text{C}^\circ$, and initial temperature of 100°C is dropped into an insulated jar that contains liquid with a mass of 3.00 kilograms, specific heat of $1,000 \text{ J/kg} \cdot \text{C}^\circ$, and initial temperature of 0°C . The piece of metal is removed after 5 seconds, at which time its temperature is 20°C . Neglect any effects of heat transfer to the air or to the insulated jar.

1.) The temperature of the liquid after the metal is removed is

- (A) 0°C
- (B) 4°C
- (C) 8°C
- (D) 10°C
- (E) 20°C

2.) The average rate at which heat is transferred while the piece of metal is in the liquid is

- (A) 4,000 J/s
- (B) 4,800 J/s
- (C) 6,000 J/s
- (D) 9,600 J/s
- (E) 16,000 J/s

3.) If the gas in a container absorbs 275 joules of heat, has 125 joules of work done on it, and then does 50 joules of work, what is the increase in the internal energy of the gas?

- (A) 100 J
- (B) 200 J
- (C) 350 J
- (D) 400 J
- (E) 450 J

4.) An ice cube of mass m and specific heat c_i is initially at temperature T_1 , where $T_1 < 273 \text{ K}$. If L is the latent heat of fusion of water, and the specific heat of water is c_w , how much energy is required to convert the ice cube to water at temperature T_2 , where $273 \text{ K} < T_2 < 373 \text{ K}$?

- (A) $m[c_i(273 - T_1) + L + c_w(373 - T_2)]$
- (B) $m[c_i(273 - T_1) + L + c_w(T_2 - 273)]$
- (C) $c_i(273 - T_1) + c_w(T_2 - 273)$
- (D) $mL + c_w(T_2 - T_1)$
- (E) $mL + \left(\frac{c_w + c_i}{2}\right)(T_2 - T_1)$

A sample of an ideal gas is in a tank of constant volume. The sample absorbs heat energy so that its temperature changes from 300 K to 600 K.

5.) If v_1 is the average speed of the gas molecules before the absorption of heat and v_2 is their average speed after the absorption of heat, what is the ratio v_2/v_1 ?

- (A) $\frac{1}{2}$
- (B) 1
- (C) $\sqrt{2}$
- (D) 2
- (E) 4

6.) In a certain process, 400 J of heat is added to a system and the system simultaneously does 100 J of work. The change in internal energy of the system is

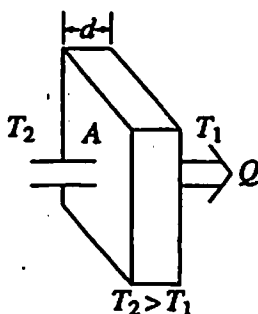
- (A) 500 J
- (B) 400 J
- (C) 300 J
- (D) -100 J
- (E) -300 J

7.) The absolute temperature of a sample of monatomic ideal gas is doubled at constant volume. What effect, if any, does this have on the pressure and density of the sample of gas?

- | <u>Pressure</u> | <u>Density</u> |
|------------------------------------|--------------------------------|
| (A) Remains the same | Remains the same |
| (B) Remains the same | Doubles |
| (C) Doubles | Remains the same |
| (D) Doubles | Is multiplied by a factor of 4 |
| (E) Is multiplied by a factor of 4 | Doubles |

8.) A gas with a fixed number of molecules does 32 J of work on its surroundings, and 16 J of heat are transferred from the gas to the surroundings. What happens to the internal energy of the gas?

- (A) It decreases by 48 J.
- (B) It decreases by 16 J.
- (C) It remains the same.
- (D) It increases by 16 J.
- (E) It increases by 48 J.



9.) In time t , an amount of heat Q flows through the solid door of area A and thickness d represented above. The temperatures on each side of the door are T_2 and T_1 , respectively.

Which of the following changes would be certain to decrease Q ?

- (A) Increasing A only
- (B) Decreasing d only
- (C) Increasing d and $T_2 - T_1$ only
- (D) Decreasing A and $T_2 - T_1$ only
- (E) Increasing d , A , and $T_2 - T_1$

10.) Which of the following will occur if the average speed of the gas molecules in a closed rigid container is increased?

- (A) The density of the gas will decrease.
- (B) The density of the gas will increase.
- (C) The pressure of the gas will increase.
- (D) The pressure of the gas will decrease.
- (E) The temperature of the gas will decrease.

11.) An ideal gas may be taken from one state to another state with a different pressure, volume, and temperature along several different paths. Quantities that will always be the same for this process, regardless of which path is taken, include which of the following?

- I. The change in internal energy of the gas
- II. The heat exchanged between the gas and its surroundings
- III. The work done by the gas

- (A) I only
- (B) II only
- (C) I and III only
- (D) II and III only
- (E) I, II, and III

12.) Two blocks of steel, the first of mass 1 kg and the second of mass 2 kg, are in thermal equilibrium with a third block of aluminum of mass 2 kg that has a temperature of 400 K. What are the respective temperatures of the first and second steel blocks?

- (A) 400 K and 200 K
- (B) 200 K and 400 K
- (C) 400 K and 400 K
- (D) 800 K and 400 K
- (E) None of the above

13.) Which of the following statements is NOT a correct assumption of the classical model of an ideal gas?

- (A) The molecules are in random motion.
- (B) The volume of the molecules is negligible compared with the volume occupied by the gas.
- (C) The molecules obey Newton's laws of motion.
- (D) The collisions between molecules are inelastic.
- (E) The only appreciable forces on the molecules are those that occur during collisions.