ANSWER KEY. Final answers are in bold.

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6.3 Heat Transfer and Thermal Equilibrium

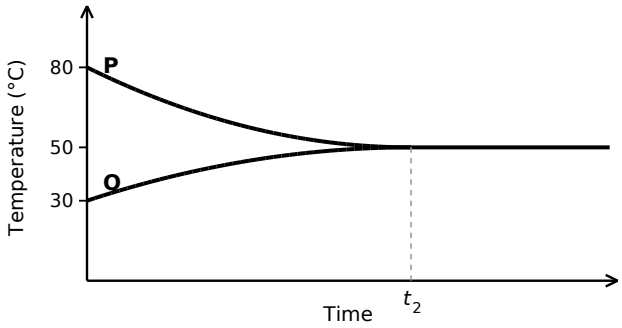
AP Chemistry | ANSWER KEY

Answer in complete sentences. Use particles, collisions, and kinetic energy in your explanations.

1. Explain the difference between heat and temperature. Use particles in your answer.

Temperature measures the average kinetic energy of the particles. Heat is energy transferred between objects because of a temperature difference, by collisions between particles. Objects do not contain heat.

2. Samples P and Q are placed in contact in an insulated container. The graph shows their temperatures over time.



(a) Which sample's particles had the greater average kinetic energy at the start?
(b) Describe the direction of energy transfer and how it happens.
(c) What is true about the particles of P and Q after time t_2?
(d) Is energy still being transferred after t_2? Explain.

(a) **Sample P** (higher temperature, 80°C compared with 30°C).

(b) **Energy moves from P to Q through collisions between particles at the boundary. P cools and Q warms.**

(c) **They have the same temperature (50°C) and the same average kinetic energy: thermal equilibrium.**

(d) **There is no net transfer. Particles still collide, but energy moves equally in both directions.**

3. In problem 2, P cooled by 30°C and Q warmed by 20°C. No energy escaped the container. How can the temperature changes be different when the energy lost by P equals the energy gained by Q?

The samples must differ in mass, in material, or both. A larger mass needs more energy to change by one degree, and different materials need different amounts of energy per gram per degree (specific heat, Topic 6.4). So the same amount of energy changes P and Q by different numbers of degrees. Accept mass or material as the reason.

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4. Container 1 holds $N_2(g)$ at 400 K and container 2 holds $CO_2(g)$ at 400 K.

(a) Which gas has the greater average kinetic energy?

(b) Which gas has particles with the greater average speed? Justify your answers.

(a) **Neither. Both have the same average kinetic energy because they are at the same temperature.**

(b) **N_2. $KE = \frac{1}{2}mv^2$ is the same for both, and N_2 particles have the smaller mass, so they must move faster on average.**

5. 100.0 g of water at 20.0°C is mixed with 100.0 g of water at 60.0°C in an insulated cup. Predict the final temperature and explain your reasoning using energy transfer.

40.0°C. The masses and the substance are the same, so the energy lost by the warm water equals the energy gained by the cool water when both change by the same number of degrees. The final temperature is halfway between 20.0°C and 60.0°C.

6. Each statement is false. Rewrite it so that it is true.

(a) “Cold flows from the ice into your hand.”

(b) “At thermal equilibrium, the particles stop colliding.”

(c) “A hot pan contains more heat than a cold pan.”

(d) “Two objects at thermal equilibrium have the same total energy.”

(a) **Energy flows from your hand (hotter) into the ice (colder).**

(b) **Particles keep colliding, but there is no net energy transfer.**

(c) **A hot pan has particles with greater average kinetic energy. Heat is energy being transferred, not something an object contains.**

(d) **They have the same temperature and the same average kinetic energy. Total energy also depends on how much substance there is.**

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