1. In which state are the particles far apart, fast, and moving in random directions?

   ☐ they are the same in all states

   ☐ solid

   ☐ liquid

   ☐ gas

2. For the same rise in temperature, which expands the most?

   ☐ a gas

   ☐ a solid

   ☐ a liquid

   ☐ they all expand by the same amount

3. While ice is melting into water, what happens to the temperature?

   ☐ it rises, then falls

   ☐ it stays the same

   ☐ it falls steadily

   ☐ it rises steadily

4. Why are metals such good conductors of thermal energy?

   ☐ they have free electrons that carry energy quickly

   ☐ they contain trapped air between the atoms

   ☐ they are shiny, so they reflect heat inwards

   ☐ they are heavy, so energy sinks through them

5. Temperature is a measure of:

   ☐ the mass of the object

   ☐ the total number of particles

   ☐ the average kinetic energy of the particles

   ☐ the colour of the object

6. How much energy is needed to heat 2.0 kg of water by 10 °C? (Use $c = 4200$ J per kg per °C.)

   _____ J

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☐ True ☐ False

8. Convection can happen in a solid.

   ☐ True ☐ False

9. Convert 27 °C to kelvin.

   _____ K

10. Adding 8400 J raises the temperature of 0.50 kg of a metal by 40 °C. What is its specific heat capacity, in J per kg per °C?

    _____ J/(kg °C)

1. **gas**

   Gas particles are far apart and move quickly in random directions, filling the container. Solids only vibrate; liquids slide past each other.

2. **a gas**

   Gases expand the most, then liquids, then solids (whose particles are held most tightly).

3. **it stays the same**

   During a change of state the energy goes into breaking the forces between particles, so the temperature stays constant until the change is complete.

4. **they have free electrons that carry energy quickly**

   Metals have free (delocalised) electrons that move through the metal and carry energy rapidly from the hot end to the cold end.

5. **the average kinetic energy of the particles**

   Hotter means the particles move faster, so temperature measures their average kinetic energy.

6. **84000 J**

   $\Delta E = mc\,\Delta\theta = 2.0 \times 4200 \times 10 = 84\,000$ J.

7. **True**

   Evaporation happens at the surface at any temperature – the fastest surface particles escape. Boiling happens throughout the liquid at the boiling point.

8. **False**

   Convection needs particles to move from place to place, so it only happens in liquids and gases – not solids.

9. **300 K**

   $T = \theta + 273 = 27 + 273 = 300$ K.

10. **420 J/(kg °C)**

    $c = \dfrac{\Delta E}{m\,\Delta\theta} = \dfrac{8400}{0.50 \times 40} = \dfrac{8400}{20} = 420$ J per kg per °C.

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