SMART EXAM RESOURCES

IGCSE PHYSICS

THERMAL PHYSICS-IMPORTANT CHANGES [26-28 EXAMS]

2.2.3.1 Describe melting/solidifying and boiling/condensing in terms of energy input/output without a change in temperature

[old syllabus: Describe melting and boiling in terms of energy input without a change in temperature]

[New syllabus requires use of new terms such as solidifying and condensing, in addition to include energy output]

Melting/solidifying and boiling/condensing are phase transitions where a substance changes between its solid, liquid, and gas phases. These transitions involve energy input or output without a change in temperature. Here's how these processes work in terms of energy:

Melting/Solidifying:

- Melting (Endothermic): When a solid substance absorbs heat energy, it gains enough energy for its particles to overcome the forces holding them in a fixed position. This results in the solid turning into a liquid without a change in temperature. The energy input breaks the bonds between the particles, allowing them to move more freely.
- Solidifying (Exothermic): Conversely, when a liquid loses heat energy, its particles lose enough energy for the forces between them to cause them to become fixed in position, forming a solid. This release of energy occurs without a change in temperature and is known as solidification or freezing.

Boiling/Condensing:

- Boiling (Endothermic): When a liquid absorbs heat energy, it gains enough energy for its particles to overcome the intermolecular forces holding them together. This results in the liquid turning into a gas without a change in temperature. The energy input allows the particles to move freely enough to escape the liquid's surface.
- Condensing (Exothermic): Conversely, when a gas loses heat energy, its particles lose enough energy for the intermolecular forces to bring them closer together, forming a liquid. This release of energy occurs without a change in temperature and is known as condensation.

In both cases, the energy input or output is used to break or form intermolecular bonds rather than increasing or decreasing the kinetic energy (temperature) of the substance. This phenomenon is governed by the principle of latent heat, which is the energy absorbed or released during a phase transition at constant temperature. It's crucial to note that during these phase transitions, the temperature remains constant until all the substance has completed the transition, at which point further heating or cooling resumes.

2.3.3.3 Describe the effect of surface colour (black or white/silver) and texture (dull or shiny) on the emission, absorption and reflection of infrared radiation

[old syllabus: Describe the effect of surface colour (black or white) and texture (dull or shiny) on the emission, absorption and reflection of infrared radiation]

[New syllabus requires the use of the term silver while providing explanation of the related process]

The surface colour (black or white/silver) and texture (dull or shiny) play significant roles in the emission, absorption, and reflection of infrared radiation. Here's how they affect these processes:

Surface Colour:

- Black Surface: Black surfaces absorb more infrared radiation than white or silver surfaces. This is because black surfaces are better at absorbing a wide range of wavelengths, including those in the infrared spectrum. When infrared radiation falls on a black surface, it is absorbed rather than reflected, leading to an increase in the surface's temperature.
- White/Silver Surface: Conversely, white or silver surfaces reflect more infrared radiation than black surfaces. These surfaces have higher albedo, meaning they reflect a larger portion of incident radiation. As a result, less infrared radiation is absorbed by white or silver surfaces, leading to lower surface temperatures compared to black surfaces.

Surface Texture:

- Dull Texture: Dull or rough surfaces tend to absorb more infrared radiation than shiny or smooth surfaces. This is because rough surfaces have more irregularities and imperfections, which increase the surface area available for absorption. As a result, infrared radiation is more likely to be absorbed by the surface rather than being reflected.
- Shiny Texture: Shiny or smooth surfaces reflect more infrared radiation compared to dull surfaces. The smoothness of the surface reduces the number of irregularities, leading to less absorption and more reflection of infrared radiation. As a result, shiny surfaces tend to have lower absorption and higher reflection of infrared radiation.

In summary, black surfaces with a dull texture are the most efficient at absorbing infrared radiation, while white or silver surfaces with a shiny texture are the least efficient. The absorption, reflection, and emission of infrared radiation are crucial factors in understanding the thermal properties of materials and surfaces, which have implications in various fields such as building insulation, solar energy systems, and thermal imaging technologies.

2.3.4.1 Explain some of the basic everyday applications and consequences of conduction, convection and radiation, including:

(a) heating objects such as kitchen pans and their contents

(b) heating a room by convection

Explain some of the basic everyday applications and consequences of conduction, convection and radiation, including:

(a) heating objects such as kitchen pans

(b) heating a room by convection

[New syllabus: Requires to include the contents of the pan in the explanation of the heat-transfer process]

Conduction:

- When you place a kitchen pan on a stove, heat is transferred from the stove to the pan through conduction. The molecules at the bottom of the pan gain energy from the stove's heat source, causing them to vibrate faster and collide with neighboring molecules. This energy is then transferred throughout the pan by molecular collisions.
- As the pan heats up, it conducts heat to the contents inside, such as water or food. The molecules in the food gain energy through conduction, leading to an increase in temperature.

Radiation:

- In addition to conduction, the stove emits infrared radiation, which directly heats the surface of the pan. This radiation penetrates the pan's material and transfers energy to its molecules, contributing to the heating process.
- Similarly, when you place food inside a microwave oven, electromagnetic radiation (microwaves) is emitted, which penetrates the food and heats it from the inside out through radiation.

(b) Heating a room by convection:

Convection:

- Convection plays a significant role in heating rooms. When a room is heated, the air near the heat source, such as a radiator or a fireplace, becomes warmer and less dense. As a result, it rises upwards, creating a convection current.
- As the warm air rises, it displaces cooler air near the ceiling, which then moves towards the heat source to be heated again. This circulation of air forms a convection current that continuously distributes heat throughout the room.

Radiation:

- In addition to convection, radiation also contributes to heating a room. For example, when sunlight enters a room through windows, it warms surfaces such as walls, floors, and furniture. These surfaces then re-radiate heat into the room, contributing to overall room temperature.

Conduction, convection, and radiation are essential mechanisms for heat transfer in everyday life, playing crucial roles in various heating processes, from cooking food to heating rooms. Understanding these mechanisms helps in optimizing heating systems for efficiency and comfort.