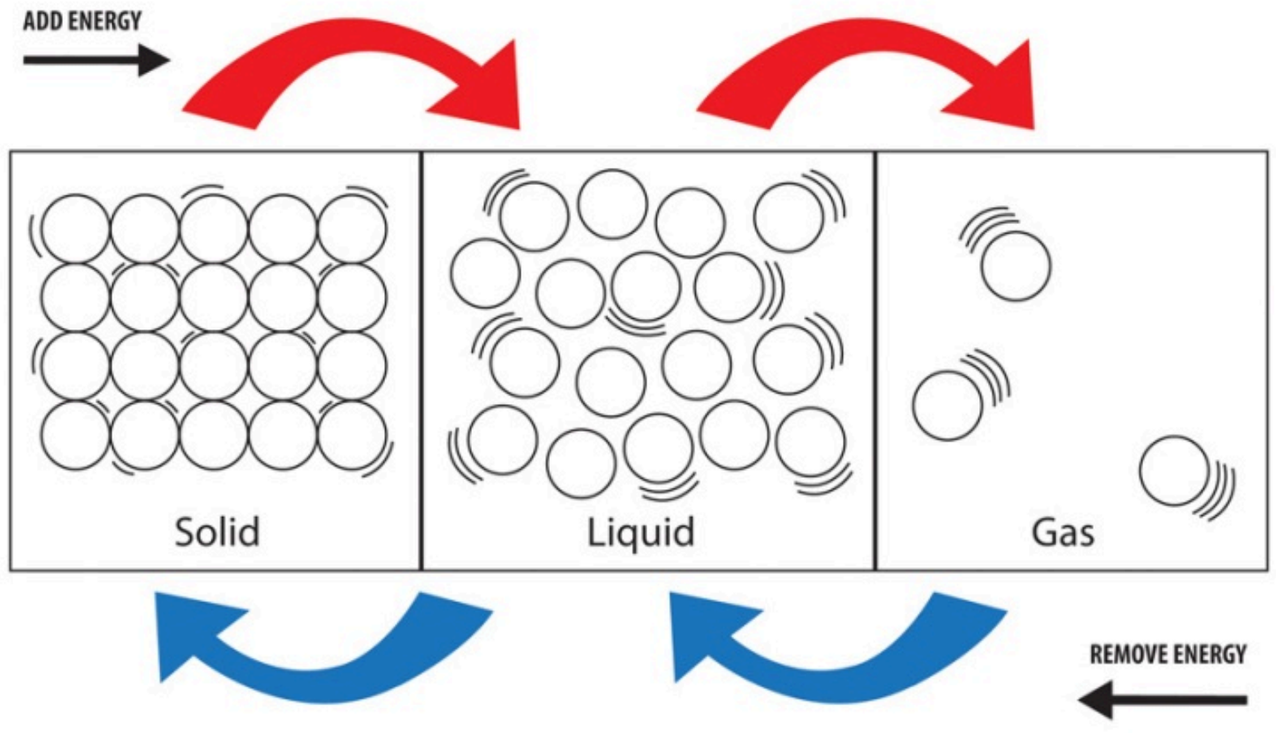
Chem ch#1 notes

Chapter 1: The Particulate Nature of Matter



1.1 Matter and Its States

Definition of Matter

- *Matter is anything that has mass and occupies space. It exists in thr ee physical states: solid, liquid, and gas.*
- *All matter is made up of extremely small particles (atoms, molecule s, or ions).*
- *These particles are constantly in motion and have forces of attractio n between them.*

1.2 The Kinetic Particle Theory (KPT)

The Kinetic Particle Theory explains
the properties of solids, liquids, and gases based on the arrangement, mo vement, and energy of particles.

Particle arrangement

1.Tightly packed in a fixed, regular lattice
2.Close but random arrangement
3.Far apart and random

Particle movement

1.Vibrate about fixed positions
2.Move freely but stay close
3.Move rapidly in all directions

Forces of attraction
1.Very strong
2.Moderate
3.Negligible

Shape
1.Fixed
2.No fixed shape
3.No fixed shape

Volume
1.Fixed
2.Fixed
3.Compressible

Energy level
1.Lowest
2.Moderate
3.Highest

> ***Exam Tip (P1/P2): Use phrases like***
“particles vibrate in fixed positions” or
“intermolecular forces are strong enough to hold particles in a regular ar rangement.”

1.3 Changes of State

Changes between states involve energy transfer (either heat gain or heat l oss):

Change	*Process Name*	*Energy Transferred*	*Particle Behavior*
Solid → Liquid	*Melting*	*Gain heat*	*Particles vibrate faster, overcome forces partially*

Liquid → Gas Boiling Gain heat
Particles completely overcome intermolecular forces

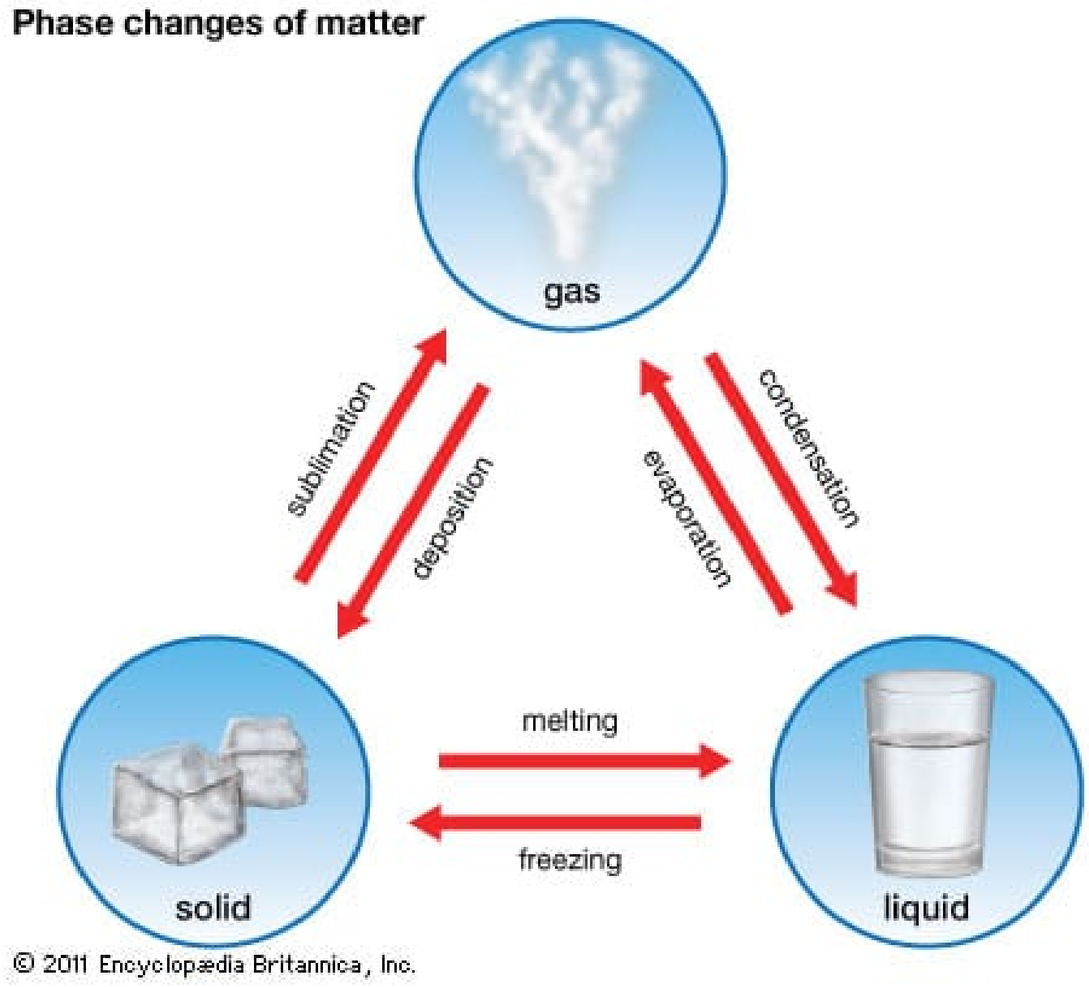
Gas → Liquid Condensation Lose heat Particles lose energy, move closer

Liquid → Solid Freezing Lose heat Particles settle into fixed positions

Solid → Gas Sublimation Gain heat Particles separate rapidly

Gas → Solid Deposition Lose heat
Particles come together without becoming liquid

These are physical changes, meaning no new substance is formed, and t he process is reversible:



*1. **Melting***
Solid → Liquid (by heating)

- *Particles gain energy, vibrate faster, and overcome some intermolec ular forces.*
- ***Melting point is the temperature at which this occurs.***
- *Example: Ice → Water at 0°C.*

2. ***Freezing***

Liquid → Solid (by cooling)

- *Particles lose energy, move slower, and become fixed in a regular st ructure.*
- ***Freezing point equals the melting point.***
- *Example: Water → Ice at 0°C.*

3. ***Boiling***

- *Liquid → Gas (throughout the liquid)*
- *Particles gain enough energy to completely overcome intermolecul ar forces.*
- ***Boiling point is the temperature at which this occurs.***
- *Example: Water → Steam at 100°C.*

4. ***Evaporation***

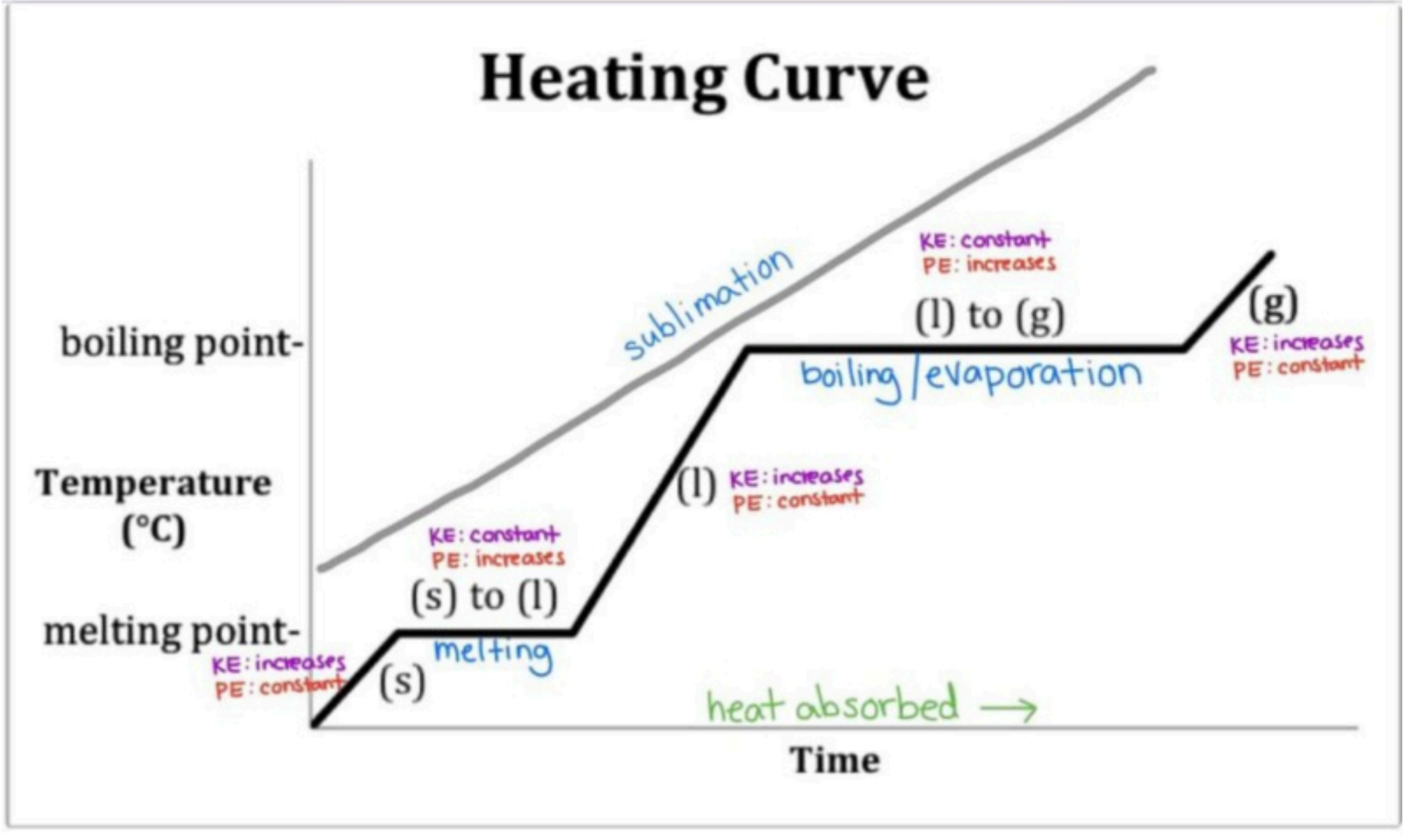
- *Liquid → Gas (only at the surface)*
- *Occurs below boiling point.*
- *Depends on surface area, temperature, and airflow.*

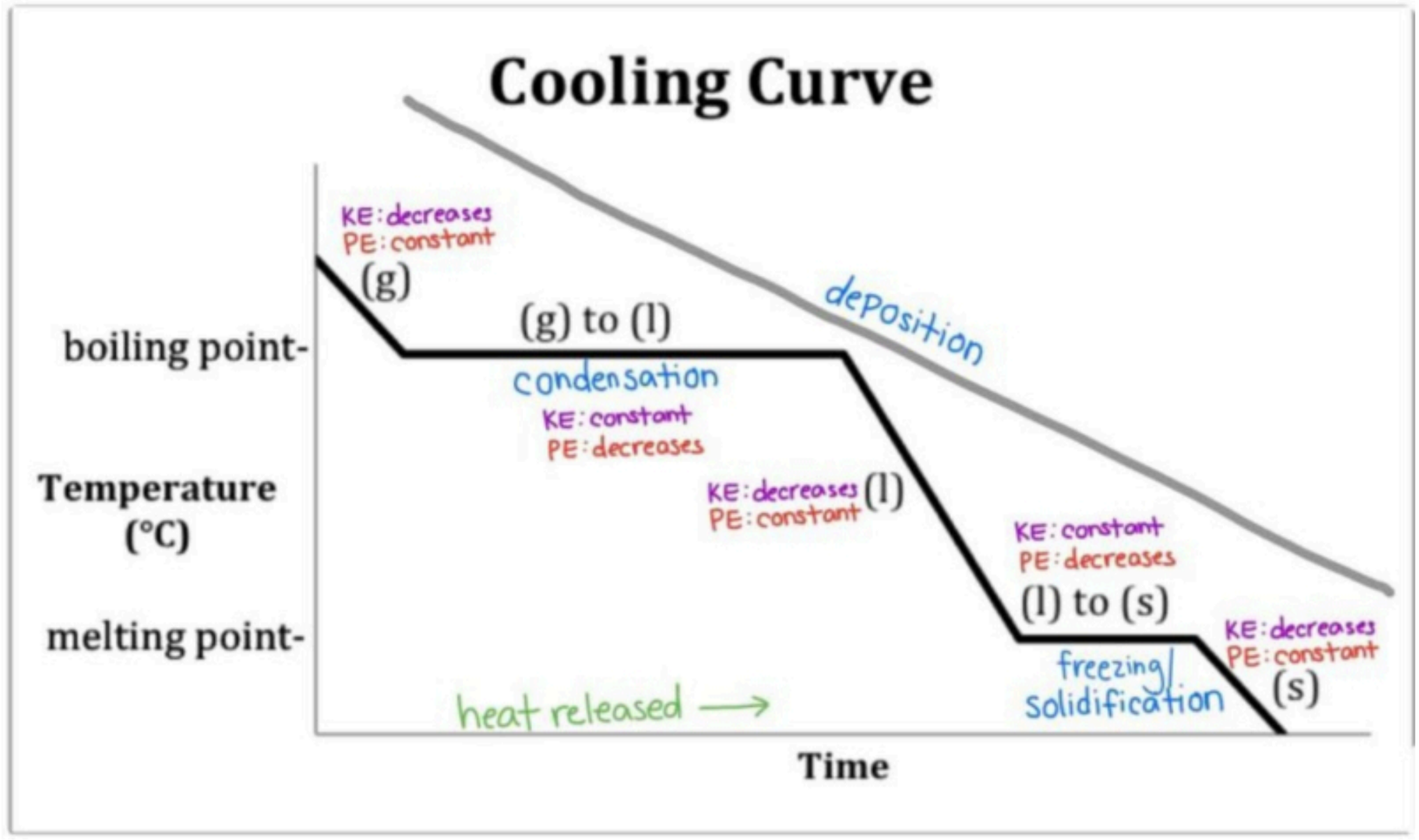
5. ***Condensation***

- *Gas → Liquid (by cooling)*
- *Particles lose kinetic energy and move closer, forming a liquid.*
- *Example: Steam → Water droplets.*

6. ***Sublimation***

- *.Solid → Gas (directly without becoming liquid)*
- *Reverse process is deposition.*
- *Example: Iodine crystals, Dry Ice (solid CO_2).*





> Past Paper Tip (P2): Always mention energy transfer and particle movement in change-of-state questions.

1.4 Diffusion and Evidence for Particles

Diffusion

*Diffusion is the **net movement** of particles from a region of **higher concent ration** to a region of **lower concentration**, due to random motion of particl es.*

Occurs faster in gases than liquids due to:
i)Greater interparticle spaces
ii)Higher kinetic energy of gas particles

Factors affecting diffusion in gases

1. **Temperature –**
   Higher temperature = faster diffusion (more kinetic energy).
2. **Molecular mass –**
   Lighter particles diffuse faster (e.g., ammonia diffuses faster than hydrogen chloride).

Experiments That Show Diffusion

1. Bromine Gas in Air

- *Brown bromine vapour diffuses from one jar to another.*
- *Demonstrates gases are made of tiny particles in motion.*

2. Ammonia and Hydrogen Chloride

- *NH_3 and HCl gases released at ends of a glass tube.*
- *White ring of ammonium chloride (NH_4Cl) forms closer to HCl end.*
- *Shows that lighter particles (NH_3) move faster than heavier ones (HC l).*

💡 **PPQ Example**:
“Why does ammonia gas reach the cotton wool before hydrogen chloride i n a glass tube?”
→ Because ammonia has a **lower molar mass**, so it diffuses faster

> ***Exam Tip (P4): Label diagrams clearly, mark diffusion front, and explain results in terms of relative molecular masses and kinetic energy***

1.6 Physical and Chemical Change

Property	*Physical Change*	*Chemical Change*
Reversibility	*Usually reversible*	*Usually irreversible*
New substances?	*No*	*Yes*
Energy involved?	*Often little energy*	*Usually involves large energy changes*
Examples	*Melting, boiling, dissolving*	*Rusting, combustion, neutralisation*

> ***Past Paper Tip (P2): Be specific about whether a new substance is formed and whether a chemical reaction has occurred.***

Physical Change	**Chemical Change**
Change in physical property	Change in physical and chemical property
Reversible process	Irreversible process
Energy is neither absorbed nor evolved	Energy is either absorbed or evolved
No new product formation	The new product is formed

Advanced Vocabulary: Use terms like:

- *“particles vibrate about fixed positions” (not just “they don’t move”),*
- *“intermolecular forces of attraction” (not “glued together”),*
- *“compressibility is negligible” instead of “can’t be compressed”.*
- *Fixed : Definite*
- *Moves freely : Undergoes translational motion.*
- *Random : Disordered*
- *Mixed : Heterogeneous*
- *Boiling : Vaporization*

🧩 Quick Concept Checks

- Particles in solids only vibrate, not move freely.

- In gases, intermolecular forces are negligible.
- Sublimation includes iodine and dry ice (CO_2).
- Pure substances have sharp boiling/melting points; mixtures don't.

□

Key Differences Between Boiling and Evaporation:

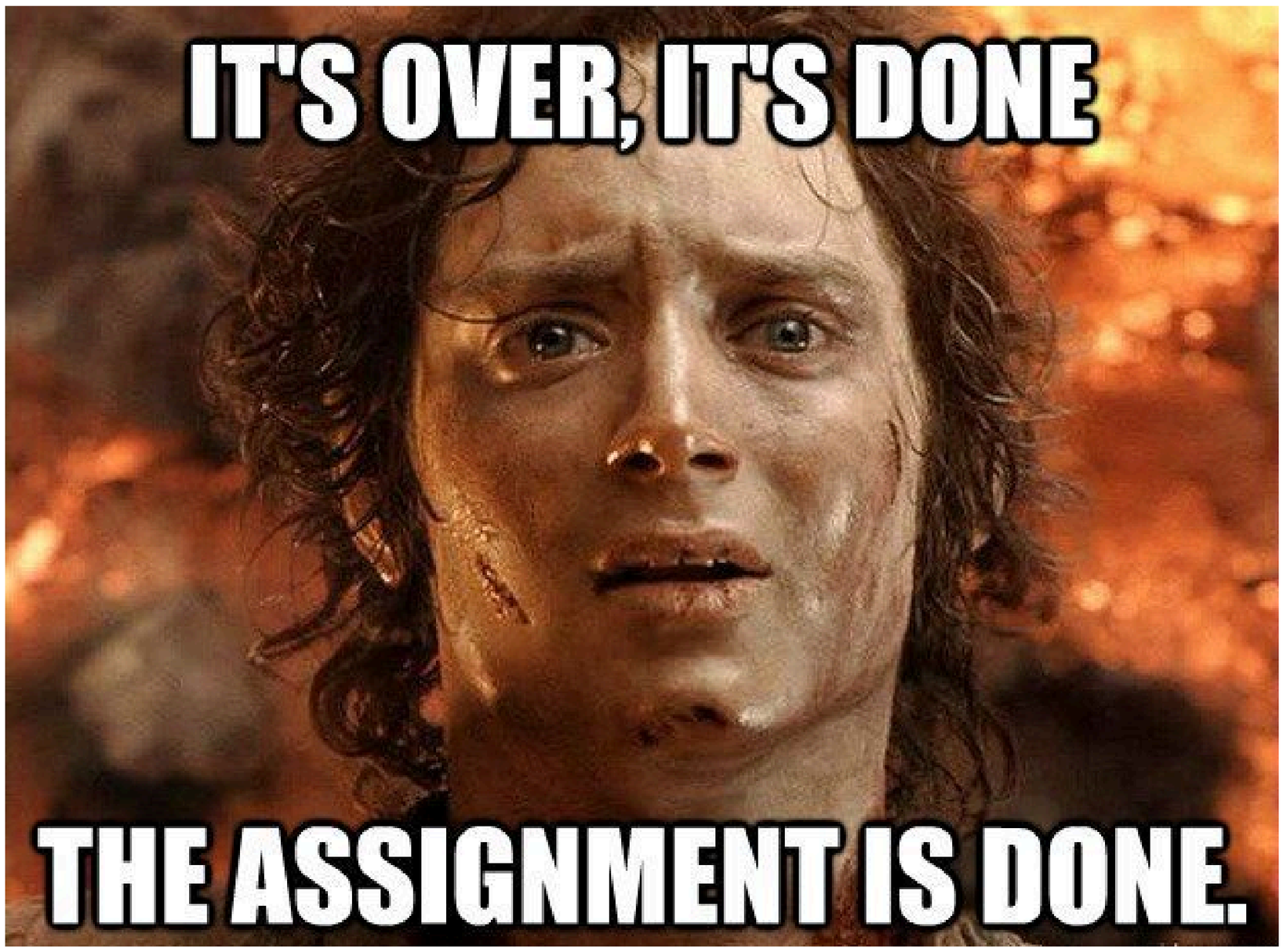
Boiling	Evaporation
Occurs at **boiling point**	Occurs at **any temperature**
Fast process	Slow process
Occurs **throughout** liquid	Occurs only at **surface**
Bubbles formed	No bubbles

Extra conceptual details:

Brownian Motion (O-Level Conceptual Detail)

- Brownian Motion refers to the random, zigzag movement of microsc opic particles suspended in a fluid (liquid or gas), caused by the cons tant and uneven collisions with the rapidly moving particles of the m edium.
- First observed by Robert Brown in 1827 while studying pollen grains in water.
- Provides direct evidence for the existence of tiny, constantly moving particles in matter (supporting the kinetic particle theory).
- The irregular motion becomes more vigorous at higher temperature s due to increased kinetic energy of the fluid's molecules.

> Example: Smoke particles viewed under a microscope moving erratica lly in still air due to collisions with invisible air molecules


IT'S OVER, IT'S DONE
THE ASSIGNMENT IS DONE.