Temperature

1. X°C= (X + 273)K
2. Good thermometer
    - Sensitive to small temperature changes
    - Able to measure the required range of temperatures
3. Thermometric properties vary uniformly and continuously with temperature
4. Types of thermometers

Property	Examples
Volume of fixed mass of liquid	Mercury-in-glass thermometer
	Alcohol-in-glass thermometer
Electrical Resistance	Resistance Thermometer
Electromotive Force	Thermocouple thermometer

5. Ice point (lower fixed point), pure melting water
   Steam point (upper fixed point), pure boiling water
   When mercury level in thermometer stem remains steady, make a mark L_0 and L_{100} respectively

Kinetic Model of Matter

(Shape, volume, density and compressibility)

6. States of matter

State	Arrangement / Motion	Property
Solid	Most closely packed in a regular pattern	Highest Density
		Incompressible
	Strongest intermolecular forces = particles vibrate about fixed positions	Fixed shape and volume
Liquid	Closely packed and randomly arranged	Higher density
		Incompressible
	Strong intermolecular forces = particles move about freely within the liquid	Fixed volume but takes the shape of container

Gas	Far apart from one another and randomly arranged	Lowest density
		Compressible
	Weakest intermolecular forces = particles move about randomly at high speeds	No fixed shape and volume

7. All matter is made up of molecules which are always in continuous random motion
8. Brownian motion: random, haphazard and constant motion of tiny particles suspended in a gas or liquid due to uneven bombardment on different sides by the molecules in action
9. Due to brownian motion, molecules will even spread out
10. Gas pressure due to collision of gas molecules with the walls of container (force is exerted when air molecule hits the wall)
11. PV/T is a constant
    - Pressure-Temperature (Volume is constant)
      By kinetic model of gases, a rise in the temperature of the gas causes an increase in the kinetic energy and hence the speed of gas molecules. The gas molecules will bombard the walls more vigorously and more frequently. The average force acting on the wall. Thus, pressure increases since P= F/A.
    - Volume-Temperature (Pressure is constant)
      Repeat P-T + However, in order for the pressure to remain constant, the gas will expand eventually.
    - Pressure-Volume (Temperature is constant)
      When the volume of container decreases, the number of gas molecules per unit volume increases. The gas molecules will bombard the walls more frequently. The average force acting on the wall increases. Thus, pressure increases since P= F/A.

<u>Transfer of Thermal Energy</u>

12. Net heat flow from hotter object to cooler object until thermal equilibrium is reached
13. Molecular Vibration:
    When one end of an object is heated, the particles at this end gain kinetic energy and vibrate faster and further apart. They collide with their less energetic neighbouring particles. Some of their energy is transferred to their neighbouring particles, which in turn gain kinetic energy. In this way, heat is passed along the

object by vibrating particles.

14. Free Electron Diffusion:
    In addition to that, free electron diffusion takes place in metals. When heated, free electrons gain energy and move faster. They will travel in the spaces between particles freely before colliding with other electrons and transferring some of their energy to them.
15. Heat conduction by free electron diffusion is much faster than that by vibration of molecules
16. Conduction cannot take place in a vacuum where there are no molecules to transfer heat
17. Convection:
    When the liquid at the bottom is heated, it expands and becomes less dense and rises. The colder and denser liquid sinks and replaces it. This in turn gets heated up. A convection current is set up.
18. Convection cannot take place in a vacuum where there are no particles to move by convection
19. Convection cannot take place in solids as particles are held in fixed positions and cannot be moved by convection currents
20. For ↑ in rate of infrared radiation,
    - Dull and black surfaces as compared to shiny and white surfaces
    - Higher temperature relative to surrounding temperature
    - Greater surface area
21. Radiation can pass through vacuum

<u>Thermal Properties of Matter</u>

22. E (J) = m (kg) x c (J/kg K) x $\Delta\theta$ (change in temperature in K)
    = heat capacity (J/K) x $\Delta\theta$
    = m x specific latent heat of fusion (J/kg)
    = m x specific latent heat of vaporisation (J/kg)
23. At higher temperatures, more heat is lost to the surrounding per unit time. By using a more powerful heater, more heat energy is supplied by the heater to the water per unit time, the water will boil within a shorter time and provide a more accurate result.
24. Rise in temperature:
    Heat energy absorbed is converted to:
    - Internal kinetic energy = vibrate/move faster
    - Internal potential energy = move further apart

    Vice versa for heat energy released
25. Constant temperature:
    Heat energy absorbed converted to:

- Internal potential energy to overcome intermolecular force to change the substance state from _ to _

Heat energy released to form intermolecular force to change the substance state from _ to _

26. Factors affecting melting and boiling point

	Melting Point	Boiling Point
↑ Pressure	Lowered	Raised
Impurities		

27. Cooling by evaporation

By the kinetic model of matter, particles of liquid are in constant, random motion. They move at different speeds. Evaporation occurs when the faster moving particles escape from the surface of the liquid, leaving behind slower moving particles. The average speed, and therefore the average kinetic energy decreases. As the average kinetic energy of particles is proportional to the temperature of the liquid, the temperature of liquid decreases.

28. Factors affecting evaporation
    - The higher the temperature, the greater the number of molecules energetic enough to escape from the surface, the faster the rate of evaporation
    - The greater the exposed surface area, the greater the number of molecules that can escape from the surface,the faster the rate of evaporation
    - The faster the motion of air, the more water vapour formed by evaporation it carries away, the faster the rate of evaporation
    - The lower the humidity, the faster the rate of evaporation
    - The lower the external pressure, the faster the rate of evaporation
    - The lower the boiling point, the faster the rate of evaporation