Physics Lo.10

Qena Student Club

Temperature

It is the average kinetic energy of the moving molecules (particles) in an object. Temperature is one of the seven SI base quantities. Physicists measure temperature on the Kelvin scale, which is marked in units called kelvins.

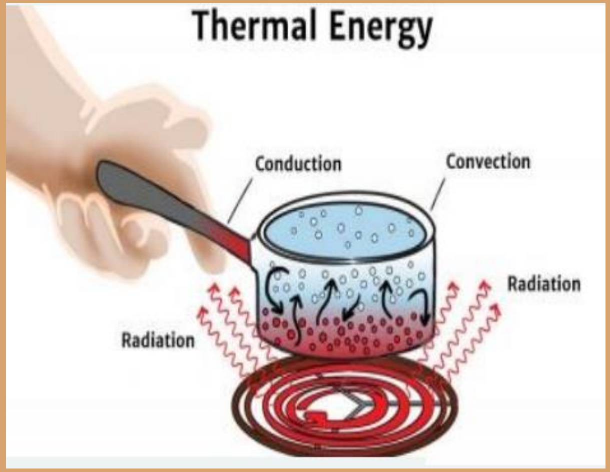
The properties of many bodies change as we change their temperature:

1. **The volume of liquid increases by increasing temperature.**
2. **A metal rod grows a little longer by increasing the temperature.**
3. **3. The electric resistance of a wire increases.**
4. **pressure exerted by a confined gas increase.**

Thermal energy

As we know, Energy cannot be created or destroyed, meaning that the total amount of energy in the universe has always been and will always be constant.
However, this does not mean that energy is immutable; it can change form and even transfer between objects.

- The si unit of thermal energy is joule (J).
- The thermal energy formula is given by: $Q=mc\Delta T$ Q = thermal energy,” the absolute quantity of heat” m = mass of the given substance, c = specific heat, ΔT = temperature difference.



Definitions

Thermal energy : Energy is produced by the movement of particles within a substance
Internal energy : Total kinetic and potential energy of a system in a state of thermal equilibrium.
Heat : Transfer of thermal energy from one object to another due to a temperature difference.

Radiation : is the transference of heat in the form of light. Heat transfer by way of light can be both visible and nonvisible. Radiative heat can pass through a vacuum, gas, or liquid, any of which can reflect or move the radiation.

There are 3 types of thermal energy:

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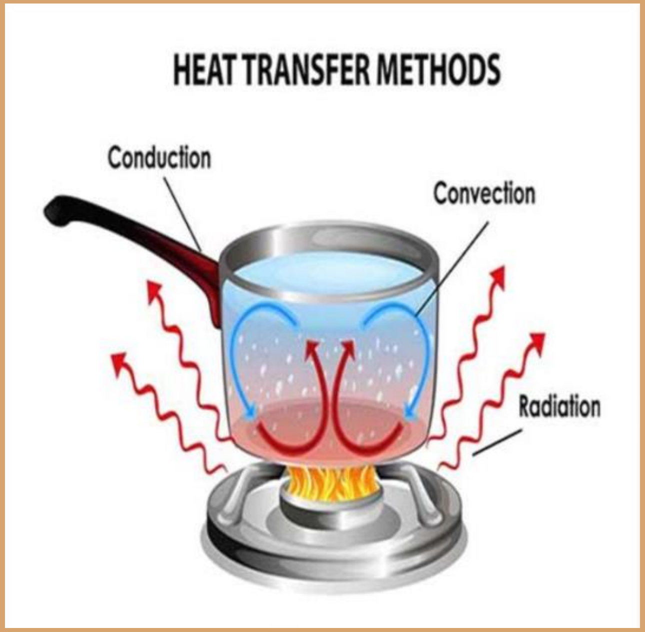
- **Conduction :is when heat passes through solid material to increase the temperature of whatever is beyond it. A good example of this is when the sun and outdoor temperature heats the body of a car, and then, in turn, the temperature inside the vehicle rises.**
- **Convection : happens when heat is transferred by fluid movement, also known as the mass motion of a fluid substance. Convection will only be initiated if the temperatures of the surface of an object and the fluid, solid or gas are different. An example of this is cold water that rises in temperature to become hot water.**
- **Radiation : is the transference of heat in the form of light. Heat transfer by way of light can be both visible and nonvisible. Radiative heat can pass through a vacuum, gas, or liquid, any of which can reflect or move the radiation**



Thermodynamics

- It is the science of the relationship between heat, work, temperature, and energy.
- Thermodynamics deals with the transfer of energy from one place to another and from one form to another.

Laws of thermodynamics:-

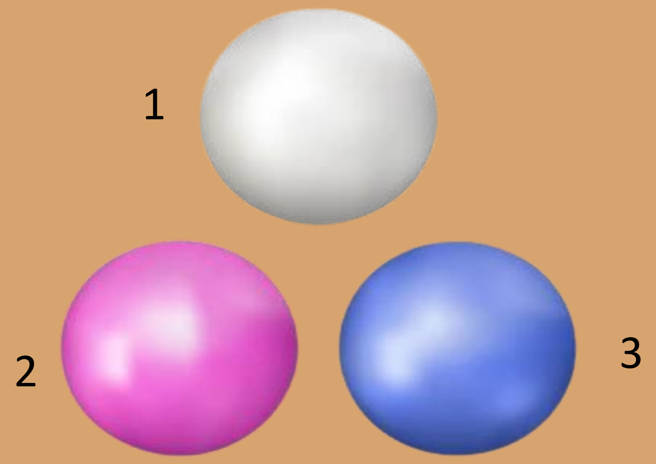
- **Zeroth law of thermodynamics:**

'When two systems are each in thermal equilibrium with a third system, the first two systems are in thermal equilibrium with each other.'

Example:

When T1 = T2 , T2=T3

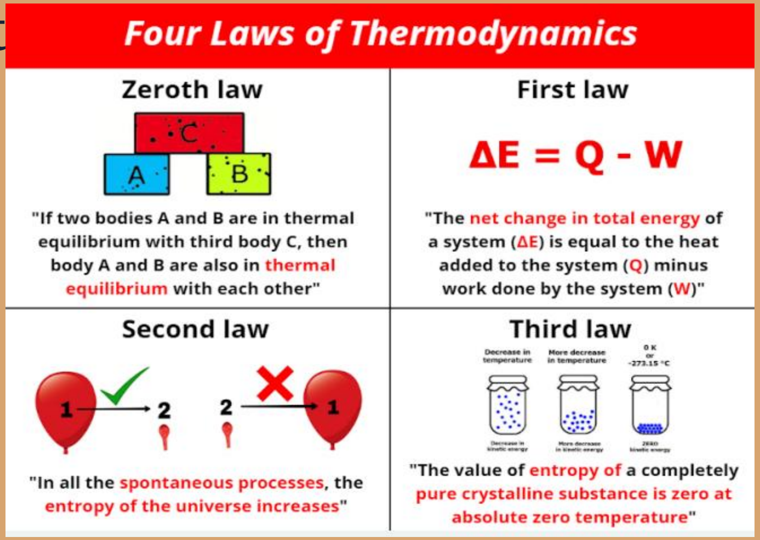
Then T1=T3



First law of thermodynamics : **The first law of thermodynamics (the law of conservation of energy).**
The change in a system’s internal energy is equal to the difference between heat added to the system from its surroundings and work done by the system on its surroundings. The amount of energy in the world remains constant.

Second law of thermodynamics : **The law states that in any closed system, the total entropy (a measure of disorder or randomness) will always increase over time, unless external energy is added to the system.**

Third law of thermodynamics :The third law implies that there is a limit to how close a system can approach absolute zero, and t always be some residual entropy present in the system even at very low temperatures.



Difference between heat , temperature and thermal energy

Temperature	Thermal Energy	Heat
A measure of the average kinetic energy of the particles in a substance	The total internal energy of molecules	The transfer of energy between objects that are at different temperatures
Degrees Fahrenheit, degrees Celsius, or Kelvins	Joules	Joules
Does NOT vary with mass	Varies with mass and temp.	Varies with mass, specific heat capacity, and temp. change

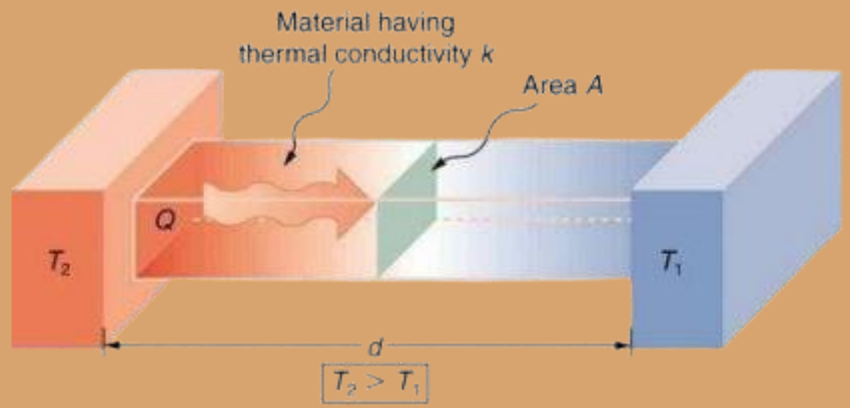
Types of elements according to ability to conduct heat:-

Thermal insulator : a material that does not allow thermal energy to be easily by conduction. The ability to conduct heat depends on the structure of the materials than the materials itself. Thermal conductivity describes how the metal conducts well. it happens in solids or liquids by transferring heat through bonds between atoms. It is a material that conducts heat poorly. They are bad conductors of heat, but they are good thermal insulators. Examples: Nonmetals such as plastic and air. Liquids and gases.

Thermal conductors : They are good conductors of heat. This means they can conduct heat very fast.

Notes : All metals are good conductors of heat.

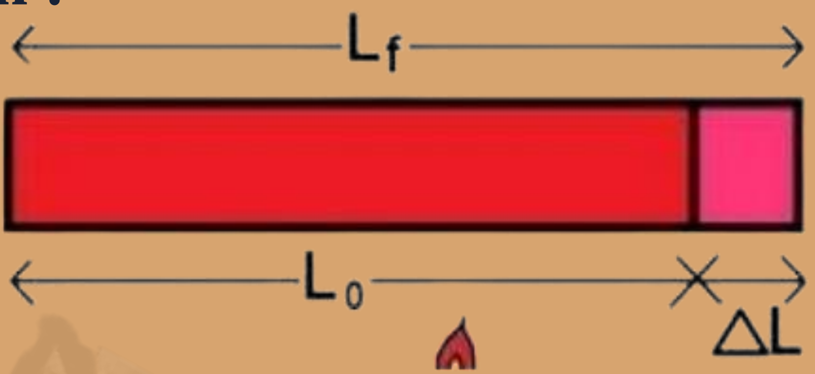
Rate of heat transfer :
$Q/t \propto A$
$Q/t \propto 1/L$
Q/t ∝ A Δt / L
Q/t ∝ k A Δt / L
K = thermal conductivity



Measuring temperature

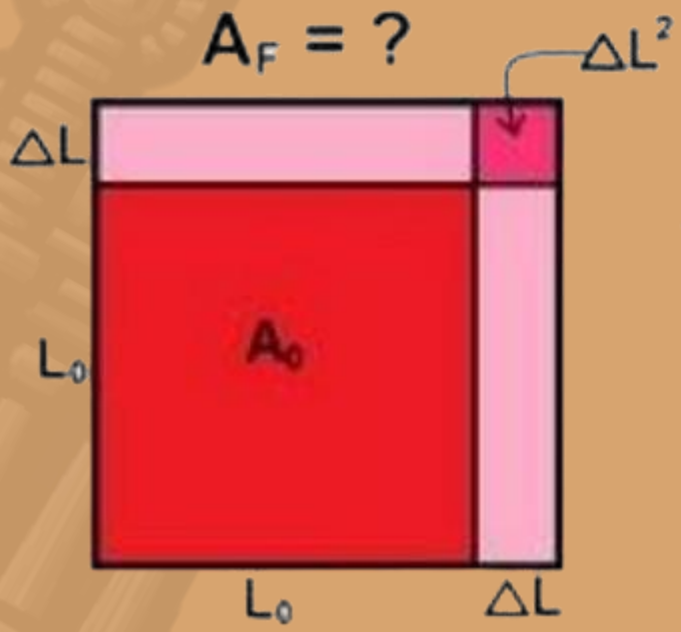
- **Linear expansion : It is the rate of change of unit length per unit degree change in temperature.**
- **Area expansion : it is the rate of square unit length per unit degree change in temperature.**
- **Volume expansion : it is the rate of change of the volume of an object or a liquid per unit degree change in temperature.**

Linear expansion :



$$L_f = L_0 + \Delta L$$
$$= L_0 + \alpha L_0 \Delta T$$
$$= L_0(1+\alpha \Delta T)$$

Area expansion :



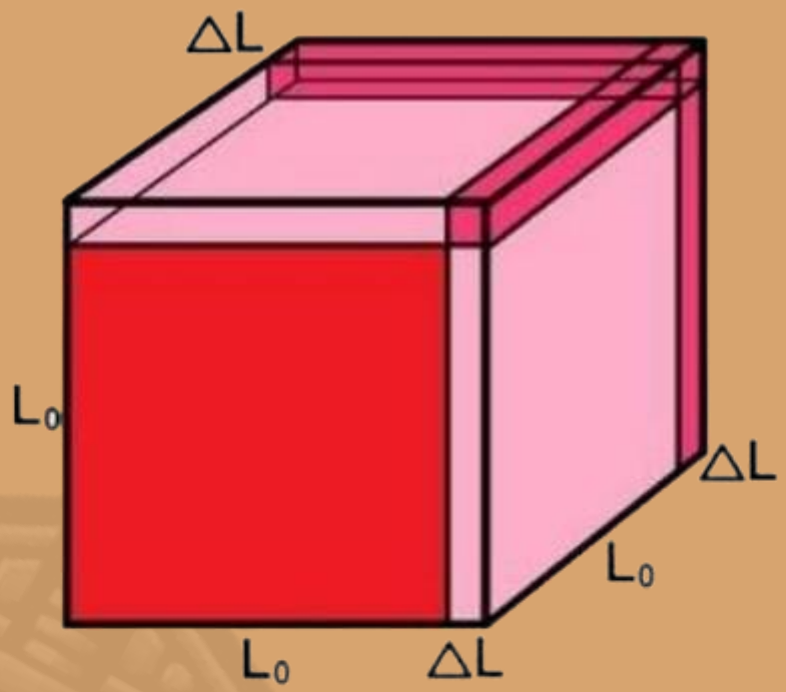
$$A_F = (L_0 + \Delta L)^2$$
$$= L^2 + 2L_0\Delta L + \Delta L^2 \quad (\approx 0)$$

$$\Delta L = \alpha L_0 \Delta T$$

$$A_F = A_0(1 + 2\alpha \Delta T)$$

Coefficient of area expansion constant

Volume expansion :



$$V_0 = L_0^3$$

$$V_F = (L_0 + \Delta L)^3$$

$$= V_0 + 3L_0^2 \Delta L$$

$$\Delta L = \alpha L_0 \Delta T$$

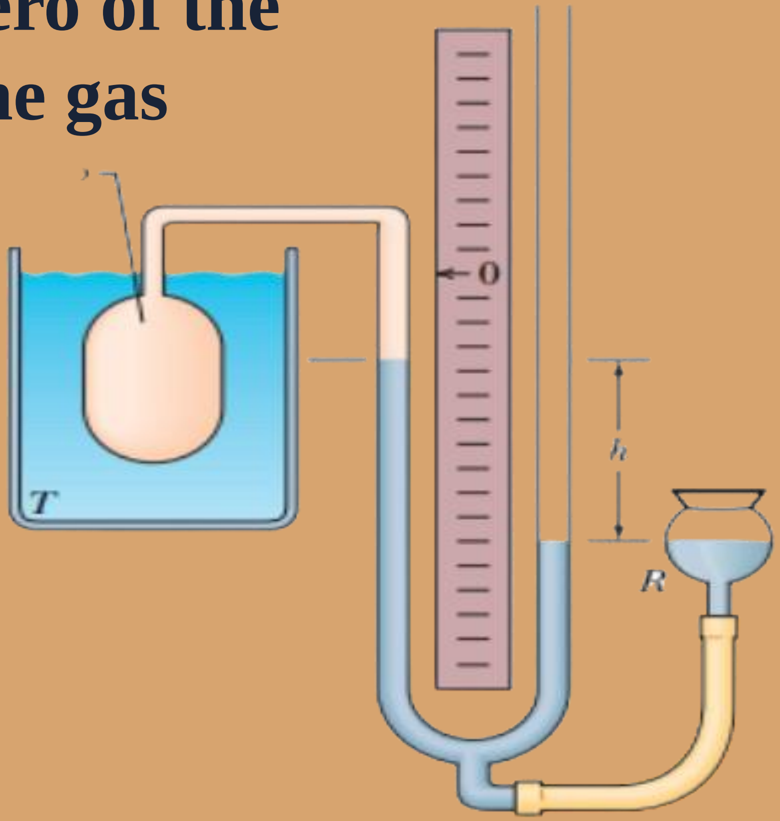
$$V_F = V_0 (1 + 3\alpha \Delta T)$$

$$= V_0 (1 + \beta \Delta T)$$

The constant volume gas of thermometer:

The standard thermometer is based on the pressure of a gas in a fixed volume. the constant volume gas thermometer consists of a gas-filled bulb connected by a tube to a mercury manometer.

By raising and lowering reservoir R, the mercury level in the left arm of the U-tube can always be brought to the zero of the scale to keep the gas volume constant (variations in the gas volume can affect temperature measurements).



	LIQUID GLASS THERMOMETER	CONSTANT VOLUME GAS THERMOMETER	SOLID (PLATINUM)
Thermometer substance	Mercury of alcohol	Trapped gas	Wire from platinum
Property changed with temperature	Volume or length of liquid column (L)	The pressure of the trapped gas (P)	The electric resistance of the platinum wire (R)
law	$Tc° = ((Lt - Lo) / (L100 - Lo))x100$	$Tc° = ((Pt - Po) / (P100 - Po))x100$	$Tc° = ((Rt - Ro) / (R100 - Ro))x100$

- **The temperature of any object in thermal contact with the bulb (such as the liquid surrounding the bulb) is then defined to be: $T = Cp$**
- **Where P is the pressure exerted by the gas and C is constant.**

Temperature scale

- **Celsius** : Kelvin scale is used in basic scientific work, while the Celsius scale is used in popular and commercial use and It is called the centigrade scale. Celsius temperatures are measured in degrees, where: °C = K – 273.15° or it is written (TC = T – 273.15°).
- **Fahrenheit** : The Fahrenheit scale, used in the United States, employs a smaller degree than the Celsius scale and a different zero of temperature. The relation between Fahrenheit and Celsius is: °F = 9/5 °C + 32° or it is written (TF = 9/5 TC +32°).

Temperature scales	Melting point	Boiling biont
Kelvin	273	373
Celsius	0	100
Fahrenheit	32	212

Heat Capacity

The heat capacity of a substance can be defined as the amount of heat required to change its temperature by one degree.Thermodynamics in its totality is concerned about heat. The meaning of heat today is energy in transit. Before the development of thermodynamic laws, the heat was considered as the measure of an invisible fluid, caloric, present in any matter. The capability of a substance to hold this fluid was then referred to as the heat capacity of that substance. The development in thermodynamics and dependence of heat transfer on temperature changed the definition of heat.Modern thermodynamics defines heat as the measure of the total internal energy of a system. In order to quantify the heat energy associated with matter and its dependence on temperature, two properties were defined. These properties were named as specific heat capacity and heat capacity of the system.

Heat Capacity Formula:

- Heat energy is the measure of the total internal energy of a system. This includes the total kinetic energy of the system and the potential energy of the molecules.
- It has been seen that the internal energy of a system can be changed by either supplying heat energy to it, or doing work on it.
- The internal energy of a system is found to increase with the increase in temperature. This increase in internal energy depends on the temperature difference, the amount of matter, etc.
- Heat capacity is defined as the amount of heat energy required to raise the temperature of a given quantity of matter by one degree Celsius.
- Heat capacity for a given matter depends on its size or quantity and hence it is an extensive property. The unit of heat capacity is joule per Kelvin or joule per degree Celsius.

Mathematically,

$$Q = C\Delta T$$

Where Q is the heat energy required to bring about a temperature change of ΔT and C is the heat capacity of the system under study.

Specific Heat Capacity

Scientists needed a quantity that has no dependence on the quantity or size of matter under consideration for thermodynamic studies this made them define specific heat capacity. It is an intensive property as it is independent of the quantity or size of the matter. Specific heat capacity for any substance or matter can be defined as the amount of heat energy required to raise the temperature of a unit mass of that substance by one degree Celsius. Mathematically it is given as:

$$Q = m\ c\ \Delta T$$

Here Q is the amount of heat energy required to change the temperature of m (kg) of a substance by ΔT, s is the specific heat capacity of the system.

Thermodynamics continues to play a vital role in our lives directly or indirectly. Scientists and engineers use the laws of thermodynamics to design new processes for reactions that would have high efficiency and product yield. Chemical and mechanical engineers apply the concepts of thermodynamics for designing heat engines with high efficiency and better outputs.

What is Specific Heat?

Specific heat, CSP, is the amount of heat required to change the heat content of exactly 1 gram of a material by exactly 1°C. Specific heat values can be determined in the following way: When two materials, each initially at a different temperature, are placed in contact with one another, heat always flows from the warmer material into the colder material until both materials attain the same temperature. From the law of conservation of energy, the heat gained by the initially colder material must equal the heat lost by the initially warmer material.
We know that when heat energy is absorbed by a substance, its temperature increases. If the same quantity of heat is given to equal masses of different substances, it is observed that the rise in temperature for each substance is different. This is due to the fact that different substances have different heat capacities. So heat capacity of a substance is the quantity of the heat required to raise the temperature of the whole substance by one degree. If the mass of the substance is unity then the heat capacity is called Specific heat capacity or the specific heat

Specific Heat Capacity Formula

$Q = C\ m\ \Delta t$

WhereQ = quantity of heat absorbed by a body

m = mass of the body

Δt = Rise in temperature

C = Specific heat capacity of a substance depends on the nature of the material of the substance.

S.I unit of specific heat is J kg-1 K-1.Specific Heat Capacity UnitHeat capacity = Specific heat x massIts S.I unit is J K-1.Specific Heat of WaterFor liquid at room temperature and pressure, the value of specific heat capacity (Cp) is approximately 4.2 J/g°C. This implies that it takes 4.2 joules of energy to raise 1 gram of water by 1 degree Celsius. This value for Cp is actually quite large. This (1 cal/g.deg) is the specific heat of the water as a liquid or specific heat capacity of liquid water .One calorie= 4.184 joules; 1 joule= 1 kg(m)2(s)-2 = 0.239005736 calorie

The specific heat capacity of water vapour at room temperature is also higher than most other materials.

For water vapour at room temperature and pressure, the value of specific heat capacity (Cp) is approximately 1.9 J/g°C.As with most liquids, the temperature of water increases as it absorbs heat and decreases as it releases heat. However, the temperature of liquid waterfalls & rises more slowly than most other liquids. We can say that water absorbs heat without an immediate rise in temperature. It also retains its temperature much longer than other substances.We use this property of water in our body to maintain constant body temperature. If water had a lower Csp value, then there would a lot of cases of overheating and underheating

Specific heat efficiency is measured by the amount of heat energy required to raise one gram of one degree Celsius of a product. Water's specific heat power is 4.2 joules per gram per Celsius degree or 1 calory per gram per Celsius degree.

Blackbody radiation

blackbody is an object that absorbs all electromagnetic radiation (light) incident on it. An object that absorbs all visible light appears black, which is how blackbodies get their name.

Blackbodies also emit radiation, depending on their temperature.

We know that any object that absorbs energy will heat up; it will increase in temperature. The object then has an opportunity to radiate some of that absorbed energy away. Blackbodies not only absorb energy, but they also radiate it, and they do this in a very specific way.

Consider the electric heating element shown

This heating coil is emitting radiation. We see that part of the coil is literally "red-hot." Other parts of the coil are not quite so hot and appear dull red in color. As the coil heats, the wavelength (and therefore the energy) of the light emitted changes.

This heating coil is a good approximation of a blackbody. Blackbodies also emit light depending on their temperature.

Keeping in mind that many wavelengths of light are invisible to our eyes, consider a graph showing how light is emitted by blackbodies at different temperatures.

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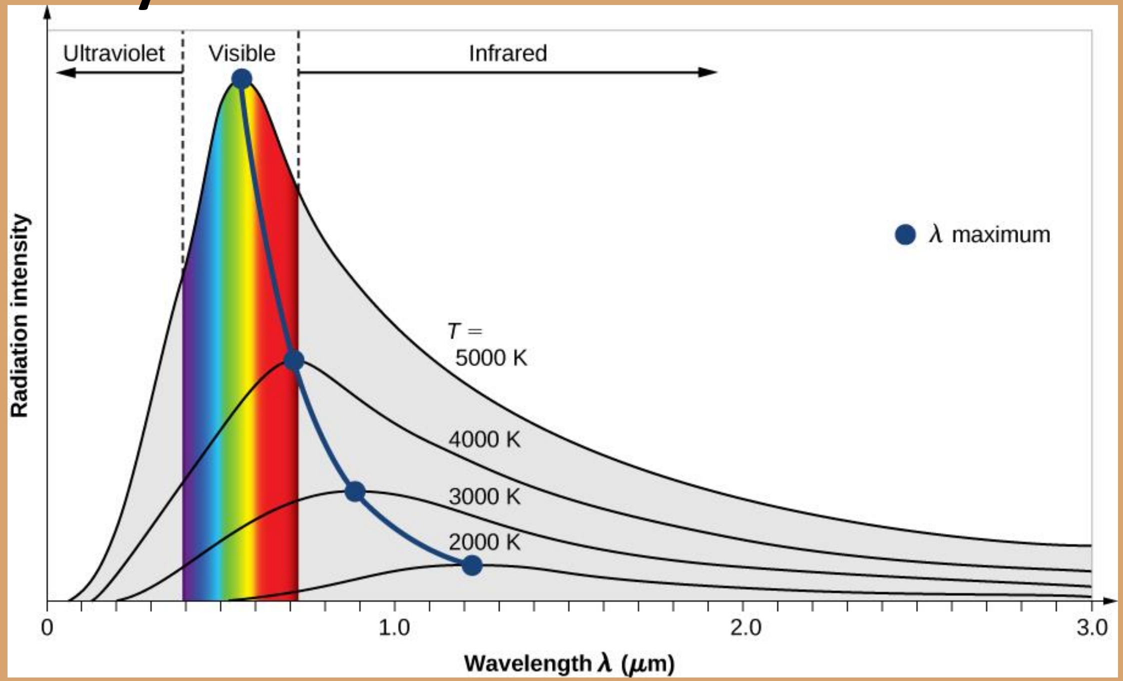


This graph shows light intensity on the vertical axis and wavelength on the horizontal axis. The four curves plotted are for blackbodies heated to temperatures of 3 000,4 000,5 000,and 6 000 kelvins respectively. 6 000 K is the approximate temperature of the surface of the Sun.

Regarding how these blackbodies would appear to us, note that up to a temperature of roughly 5 000 K,the peak wavelength of visible light emitted by a blackbody looks red. At higher temperatures, the perceived color of the blackbody will change.

Regardless of the step on which the object rests, its energy will be some integer multiple of mgh,the object's gravitational potential energy when it is on the first step. The object cannot have, for example, an energy of $12\times mgh$,$113\times mgh$,or any other noninteger multiple of this value.

When a system's energy can only take on certain discrete amounts, we say that it is "quantized."

A physicist named Max Planck studied blackbody systems. He compared how blackbodies would radiate if their energies were not quantized to how they would radiate if they were. A graph of these two models is shown below.

Formula: Energy, Frequency, and Number of Quanta Emitted by a Blackbody

$En=nhf$,where n is the number of light quanta in the system possessing a frequency f and h is a constant called Planck’s constant with an approximate value of $6.626\times10^{34}\ m^2\cdot kg/s$.

Note that for light waves, wave speed is the speed of light in vacuum c.Since wave speed in general equals the frequency of the wave times its wavelength $c=f\lambda$, we can write $En=nh(c/\lambda)$

This equation helps us understand why the assumption of energy quantization creates a blackbody radiation curve that goes to zero as wavelength gets smaller and smaller.

In a cavity blackbody system, even though the number of resonant modes increases as wavelength decreases, the amount of energy needed to actually produce a quantum of light at such short wavelengths is very large—so large that it is unlikely for the system to do so.

At the other end of the spectrum, when wavelengths become large, there are fewer and fewer modes that meet the boundary conditions of a given cavity. Therefore, fewer light quanta are emitted, explaining why the emission curve tails off as it does.

calorimetry

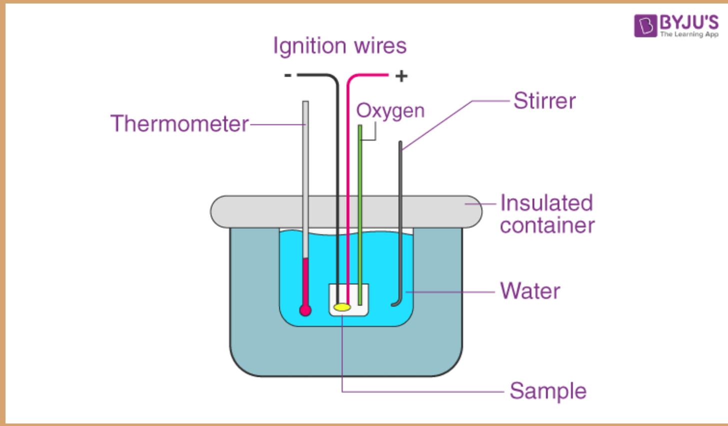
• It is the science of determining the change in energy of a system by measuring the heat exchange of
the system with the surroundings.
• It is used to measure the volume and heat produced during a certain time interval

When two bodies of different temperatures (preferably a solid and a liquid) are placed in physical contact with each other, the heat is transferred from the body with a higher temperature to the body with a lower temperature until thermal equilibrium is attained between them.
The body at a higher temperature releases heat while the body at a lower temperature absorbs heat.
The principle of calorimetry indicates the law of conservation energy in which the total heat lost by the hot body is equal to the total heat gained by the cold body.
Heat Lost = Heat Gained

It is a technique for measuring the specific heat of a solid or liquid is to
raise the temperature of the substance to some value, place it into a vessel containing cold water of known mass and temperature, and measure the temperature of the combination after equilibrium is reached.

If the vessel is assumed to be a good insulator, so that energy doesn't leave the system, then we can assume the system is isolated.

Vessels having this property are called calorimeters, and analysis performed using such vessels is called calorimetry.



The principle of conservation of energy for this isolated system requires that the net result of all energy transfers is zero.

If one part of the system loses energy, another part has to gain the energy because the system is isolated and the energy has nowhere else to go.

When a warm object is placed in the cooler water of a calorimeter, the warm object becomes cooler while
the water becomes warmer. This principle can be written as:

$Q_{cold} = -Q_{hot}$

Q cold is positive because energy is flowing into cooler objects, and Q hot is negative because energy is leaving the hot object

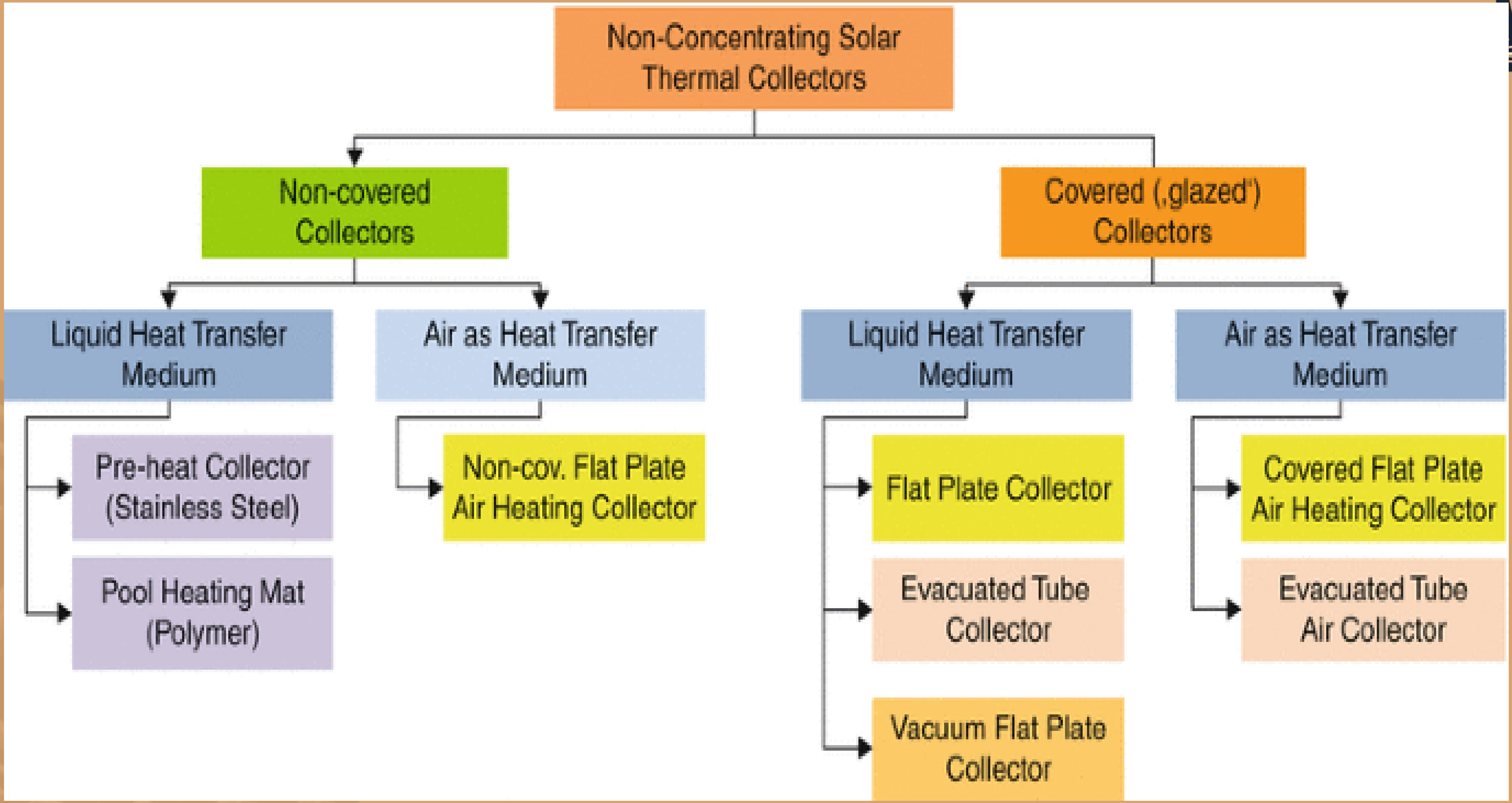
solar thermal collectors

They are devices that collect heat by absorbing light coming from the sun.

They are used for:

- heating like solar heaters and solar ovens.
- generating electricity, like solar towers, and parabolic troughs.

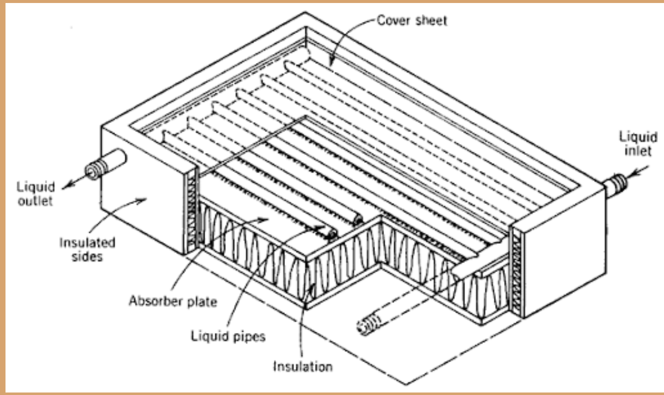
There are two types of solar collectors:



Non-concentrating collectors:

From the examples of popular non-concentrating collectors are:

The metal plate is painted a dark color to maximize the absorption of sunlight, where the energy is then collected by cooling the plate with a working fluid.



concentrating collectors:

Sometimes concentrating collectors are called active collectors because they often require solar tracking systems due to the movement of the sun during the day.

Note

o Non-concentrating collectors are typically used in residential, industrial, and commercial buildings for space heating.

o concentrating collectors in concentrated solar power plants generate electricity by heating a heat-transfer fluid to drive a turbine connected to an electrical generator.

Geothermal

- It is the heat energy from the Earth.
- It can be generated by various natural processes such as:

1) The heat from when the planet formed hasn't been lost yet.
2) Decay of radioactive elements.
3) Friction.

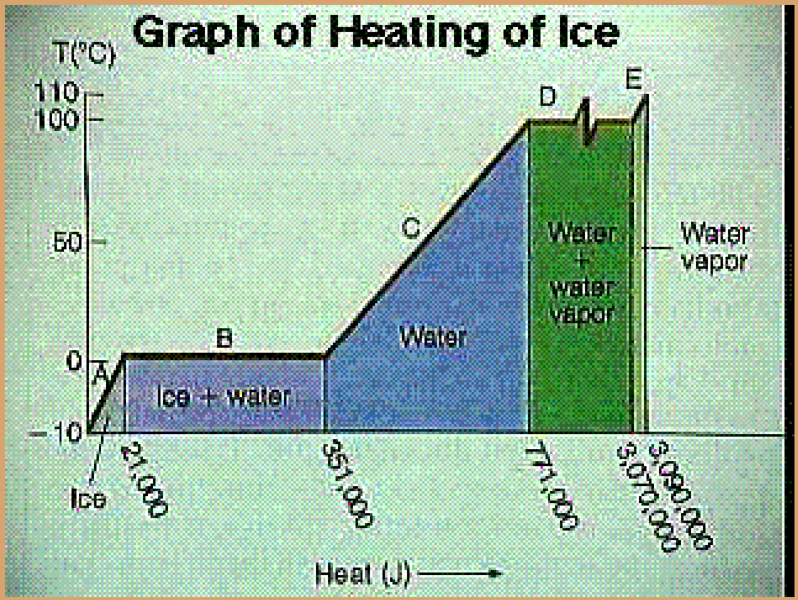
- Geothermal energy source lies 6500 Km under the Earth's surface, Core containing hot magma
- Heat flows outward from Earth's interior. The crust insulates us from the Earth's interior heat. The mantle is semi-molten, the outer core is liquid, and the inner core is solid.
- Geothermal energy is a type of renewable energy that is taken from the Earth's core.
- It comes from the heat generated during the original formation of the planet and the decay of radioactive elements.
- This thermal energy is stored in rocks and fluids in the center of the Earth.
- The energy is produced by the decay of radioactive particles of rocks, creating magma.
- Geothermal heat is used by using hot springs or underground water to provide homes and buildings with heat energy

Latent heat

Latent heat (L) is the energy (Q) absorbed or released by one gram of a substance during a change in
its physical state (phase) that occurs without changing the temperature.

- The latent heat is expressed as the amount of heat per unit mass of the substance undergoing a phase change.
- We get the latent heat by the following law:
- $l = Q/m$
- The unit of the latent heat is:

1) Joule/gram (J/g)
2) Calory/mole (cal/mol)



- The energy Q needed to change the phase of a given pure substance is:

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$Q = \pm ml$

- Where L is the latent heat of the substance, and m is the mass of the substance.

- Note that: the positive sign in the equation is chosen when energy is absorbed by a substance, and the negative sign is chosen when the energy is removed from the substance, as when steam condenses to water.
- The latent heat of fusion **Lf** is used when a phase change occurs during melting or freezing.
- The latent heat of vaporization **Lv** is used when a phase change occurs during boiling or condensing.

For example, at atmospheric pressure, the latent heat of fusion for water is **3.33×105** J/kg and the latent heat of vaporization for water is 2.26 × 106 J/kg. The latent heats of different substances vary considerably.

• The latent heat of sublimation Ls is used when a phase change occurs when a solid phase changes into
a gaseous phase without changing into a liquid phase.

Part A: During this portion of the curve, the temperature of the ice changes from -30.0°C to 0.0°C. Because
the specific heat of ice is 2090 J/kg.°C, we can calculate the amount of energy added

Q = mcΔT = (1.00 × 10–3kg) (2090J/kg .°C) (30.0°C) = 62.7J

Part B: When the ice reaches 0°C, the ice–water mixture remains at that temperature even though energy
is being added until all the ice melts to become water at 0°C. Then the energy required to melt 1.00 g of ice
at 0°C is:

Q = mLf = (1.00 × 10–3kg)(3.33 × 105J/kg) = 333J

Part C: Between 0°C and 100°C, no phase change occurs. The energy added to the water is used to increase its temperature, as in part A. The amount of energy necessary to increase the temperature from 0°C to 100°C is:

$$Q = mc\ water\Delta T = (1.00 \times 10\text{^}{-3}kg)\ (4.19 \times 103 J/kg\ .°C\ )\ (1.00 \times 102°C) = 4.19 \times 102J$$

Part D: At 100°C, another phase change occurs as the water changes to steam at 100°C. As in Part B, the water–steam mixture remains at a constant temperature, this time at 100°C even though energy is being added until all the liquid has been converted to steam. The energy required to convert 1.00 g of water at 100°C to steam at 100°C is:

$$Q = mLv = (1.00 \times 10{-}3kg)(2.26 \times 106J/kg\ ) = 2.26 \times 103J$$

Part E: During this portion of the curve, as in parts A and C, no phase change occurs, so all the added energy goes into increasing the temperature of the steam. The energy that must be added to raise the temperature of the steam to 120.0°C is:

$$Q = mc\ steam\Delta T = (1.00 \times 10-3 kg)\ (2.01 \times 103 J/kg\ .°C\ )\ (20.0°C) = 40.2 J$$

Specific Latent heat:

Substance	Melting point / °C	Specific latent heat of fusion, / J kg^{-1}	Boiling point / °C	Specific latent heat of vaporisation, / J kg^{-1}
Water	0	3.36×10^5	100	2.26×10^6
Mercury	–39	1.14×10^4	357	2.96×10^5
Ethanol	–114	1.08×10^5	78	8.55×10^5
Gold	1063	6.28×10^4	2808	1.72×10^6
Copper	1083	2.07×10^5	2566	4.73×10^6
Lead	327	2.32×10^4	1750	8.59×10^5
Nitrogen	–210	2.57×10^4	–196	2.00×10^5
Oxygen	–219	1.39×10^4	–183	2.13×10^5

Part A: The energy added to change the temperature of ice from -30°C to 0°C is calculated using the specific heat of ice.

$Q = mc\Delta T = (1.00\times10^{-3}\ kg)(2090\ J/kg.°C)(30.0°C) = 62.7J$

Part B: The energy required to melt 1.00 g of ice at 0°C is calculated using the latent heat of fusion.

$Q = mL_f = (1.00\times10^{-3}\ kg)(3.33\times10^{5}\ J/kg) = 333J$

Part C: The energy necessary to increase the temperature of water from 0°C to 100°C is calculated using the specific heat of water.

$Q = mc_{water}\Delta T = (1.00\times10^{-3}\ kg)(4.19\times10^{3}\ J/kg.°C)(1.00\times10^{2}°C) = 4.19\times10^{2}\ J$

Part D: The energy required to convert 1.00 g of water at 100°C to steam at 100°C is calculated using the latent heat of vaporization.

$Q = mL_v = (1.00\times10^{-3}\ kg)(2.26\times10^{6}\ J/kg) = 2.26\times10^{3}\ J$

Part A: The energy added to change the temperature of ice from -30°C to 0°C is calculated using the specific heat of ice.

$Q = mc\Delta T = (1.00\times10^{-3}\ kg)(2090\ J/kg.°C)(30.0°C) = 62.7 J$

Part B: The energy required to melt 1.00 g of ice at 0°C is calculated using the latent heat of fusion.

$Q = mL_f = (1.00\times10^{-3}\ kg)(3.33\times10^{5}\ J/kg) = 333 J$

Part C: The energy necessary to increase the temperature of water from 0°C to 100°C is calculated using the specific heat of water.

$Q = mc_{water}\Delta T = (1.00\times10^{-3}\ kg)(4.19\times10^{3}\ J/kg.°C)(1.00\times10^{2}°C) = 4.19\times10^{2}\ J$

Part D: The energy required to convert 1.00 g of water at 100°C to steam at 100°C is calculated using the latent heat of vaporization.

$Q = mL_v = (1.00\times10^{-3}\ kg)(2.26\times10^{6}\ J/kg) = 2.26\times10^{3}\ J$

Part A: The energy added to change the temperature of ice from -30°C to 0°C is calculated using the specific heat of ice.

$$Q = mc\Delta T = (1.00\times10^{-3}\ \text{kg})(2090\ \text{J/kg.°C})(30.0\text{°C}) = 62.7\text{J}$$

Part B: The energy required to melt 1.00 g of ice at 0°C is calculated using the latent heat of fusion.

$$Q = mL_f = (1.00\times10^{-3}\ \text{kg})(3.33\times10^{5}\ \text{J/kg}) = 333\text{J}$$

Part C: The energy necessary to increase the temperature of water from 0°C to 100°C is calculated using the specific heat of water.

$$Q = mc_{water}\Delta T = (1.00\times10^{-3}\ \text{kg})(4.19\times10^{3}\ \text{J/kg.°C})(1.00\times10^{2}\text{°C}) = 4.19\times10^{2}\ \text{J}$$

Part D: The energy required to convert 1.00 g of water at 100°C to steam at 100°C is calculated using the latent heat of vaporization.

$$Q = mL_v = (1.00\times10^{-3}\ \text{kg})(2.26\times10^{6}\ \text{J/kg}) = 2.26\times10^{3}\ \text{J}$$

NOTES:

Part A: The energy added to change the temperature of ice from -30°C to 0°C is calculated using the specific heat of ice.

$Q=mc\Delta T=(1.00\times10^{-3}\ kg)(2090\ J/kg.°C)(30.0°C)=62.7J$

Part B: The energy required to melt 1.00 g of ice at 0°C is calculated using the latent heat of fusion.

$Q=mL_f=(1.00\times10^{-3}\ kg)(3.33\times10^{5}\ J/kg)=333J$

Part C: The energy necessary to increase the temperature of water from 0°C to 100°C is calculated using the specific heat of water.

$Q=mc_{water}\Delta T=(1.00\times10^{-3}\ kg)(4.19\times10^{3}\ J/kg.°C)(1.00\times10^{2}°C)=4.19\times10^{2}\ J$

Part D: The energy required to convert 1.00 g of water at 100°C to steam at 100°C is calculated using the latent heat of vaporization.

$Q=mL_v=(1.00\times10^{-3}\ kg)(2.26\times10^{6}\ J/kg)=2.26\times10^{3}\ J$

Part E: The energy necessary to increase the temperature of steam from 100°C to 120°C is calculated using the specific heat of steam.

$Q=mc_{steam}\Delta T=(1.00\times10^{-3}\ kg)(2.01\times10^{3}\ J/kg.°C)(20.0°C)=40.2J$