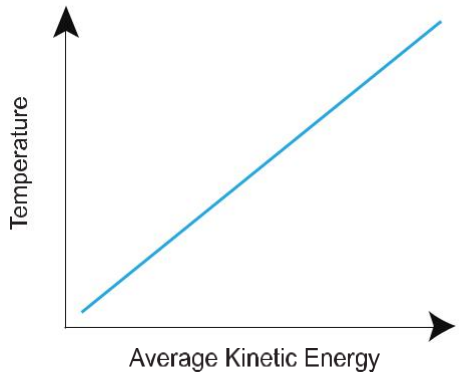
CHAPTER (4)

STATES OF MATTER

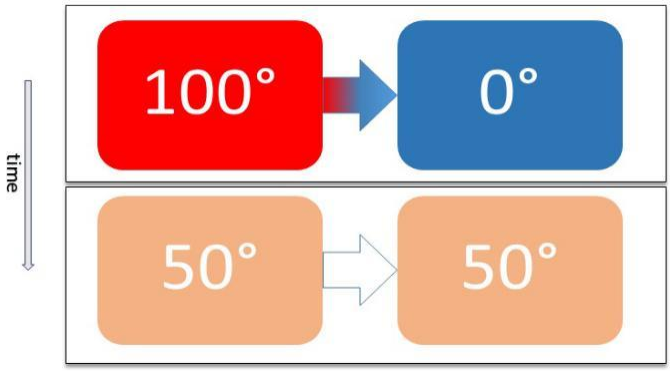
States of matter

Thermal energy:
is the total energy of molecules in the matter.

- Total energy is the sum of kinetic and potential energy of the molecules.
- Thermal energy is proportional to the number of molecules in the object.
- Temperature: is the average kinetic energy of molecules in the matter.
- Temperature depends only on the average kinetic energy of molecules and it does not depend on the number of molecules in the object



Thermal equilibrium: is a state at which two substances in physical contact have no difference in their body temperatures.



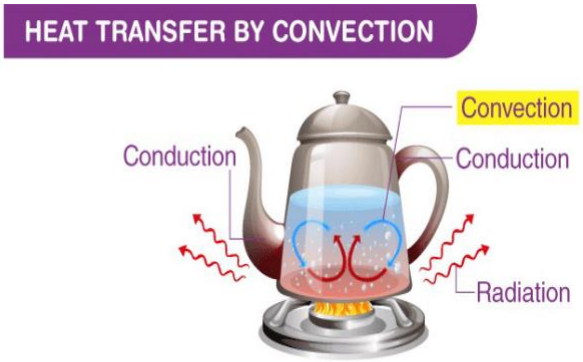
Thermal energy translation can take place in 3 ways:

- Thermal conduction: is the transfer of internal energy by microscopic collisions of particles and movement of electrons within a body. The colliding particles, which include molecules, atoms and electrons, transfer disor-ganized microscopic kinetic and potential energy, joint-ly known as internal energy.

- Thermal convection: is the process of heat transfer by the bulk movement of molecules within fluids such as gases and liquids. The initial heat transfer between the object and the fluid takes place through conduction, but the bulk heat transfer happens due to the motion of the fluid.

- **Radiation:** is the energy that is emitted by matter in the form of photons or electromagnetic waves.

- By radiation can take place in the vacuum (No need for medium)



Calorimeter: an object used for calorimetric, or the process of measuring the heat of chemical reactions or physical changes as well as heat capacity.

1. The temperature of an object depends on.

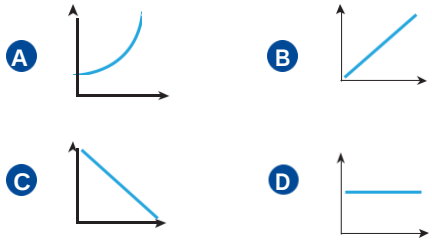
A Number of atoms of the object

B number of molecules of the object

C Average kinetic energy of the object

D Average kinetic energy of molecules of the object

2. Which chart represents the relation between the average kinetic energy of objects and temperature? Where Temperature is the vertical axes and average kinetic energy is the horizontal axis.



3. The state at which two substances in physical contact have no difference in their body temperatures.

A Thermal energy B Thermal equilibrium

C Thermal slope D Specific heat

4 Conduction is one type of heat translation, its faster in

A Liquids
B Space
C Gases
D Minerals

5. The heat transition by convection happens due to the liquid movement because of.

A :tromagnetic waves
B :hanical waves
C Equal temperatures
D Different temperatures

6. Radiation is heat transition by ……Waves.

A Electromagnetic waves
B Mechanical waves
C Longitudinal waves
D Stopped waves

7. Use the …… to measure the change in thermal energy.

A Alcohol thermometer
B Mercury thermometer
C Joule device
D Calorimeter

Specific heat:

- The amount of heat energy that required to raise up the temperature of 1 kg of matter 1C.
- Heat energy depends on: the mass, specific heat, and the change in the temperature.

$$Q = mC(T_f - T_i) \qquad Q = mC\Delta T$$

Q is the transferred heat energy [J], m is the mass [kg], C is the specific heat [J/kg.Co], Tf is the final temperature [^{o}C], Ti is the initial temperature [^{o}C], ΔT is the change in temperature [^{o}C].

Fusion (melting):

- Melting point: is the temperature at which the solid and liquid forms of a pure substance can exist in equilibrium.
- Latent heat of fusion: is the amount of heat energy that required to melt 1 kg of a substance.
- Q is the total amount of heat energy [J], m is the mass [kg], Hf is the latent heat of fusion [J/kg].

Evaporation:

- Boiling point: the temperature at which a liquid boils and turns to vapor.
- Latent heat of vaporization: The amount of heat energy that required to evaporate 1 kg of a liquid substance.

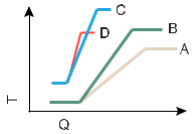
$$Q = mH_f$$

Q is the total heat energy required to evaporation [J], m is the mass [kg], Hv is the latent heat of vaporization [J/kg].

8. The amount of heat energy that required to raise up the temperature of 1 kg of matter 1C is

A Specific heat
B Temperature
C the latent heat of fusion
D the latent heat of vaporization

9. In the chart, the relation between temperature (T) and heat energy (Q) for four different liquids, heating from fusion to boiling, which liquid has the most specific heat?



A A
B B
C C
D D

10. Calculate the energy that a 0.5 kg mass metal object will lose when its temperature decreases 20K, (knowing that its specific heat is. $376 J/kg \cdot K$

A 15040 J
B 7520 J
C 3760 J
D 1880 J

Solution

Q = mcΔT = 0.5 x 376 x 20 = 3760 J
, So the answer is C

11. If the specific heat of Zink is, so 97 J heat will…

A Increase the temperature of 1kg of Zink 1 K
B Increase the temperature of 1kg of Zink 97 K
C Increase the temperature of 97kg of Zink 1 K
D Increase the temperature of 0.25kg of Zink 1K

12. The temperature at which the solid substance can turn to liquid is.

A Freezing temperature
B Boiling temperature
C Melting temperature
D Evaporation temperature

13. To turn 1kg of substance from liquid to gas, we need to heat with latent heat of.

A freeze
B evaporation
C adaptation
D fusion

Thermodynamics

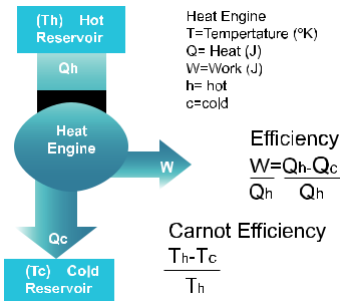
The first law of thermodynamics:
Defines the internal energy (E) as equal to the difference of the heat transfer (Q) into a system and the work (W) done by the system.

The heat or thermal engine:
A heat engine can be defined as a device that converts thermal energy into work. The thermal energy results from a temperature difference that is provided by a hot and a cold reservoir. The heat engine utilizes this difference in a thermodynamic cycle.

Entropy:
the measure of a system's thermal energy per unit temperature that is unavailable for doing useful work. Or can be defined as "The measuring of disorder in the system".

Δs is the change in entropy [J/K], Q is the heat that added to the system [J], T is the temperature [K].

$$\Delta s = \frac{Q}{T}$$



To convert from kelvin to Celsius

$$K = C + 273$$

$$C = K - 273$$

K is Kelvin and C is Celsius.

The second law of thermodynamics: that there exists a useful state variable called entropy S. The change in entropy delta S is equal to the heat transfer delta Q divided by the temperature T.

Fluids:
a substance that has no fixed shape and yields easily to external pressure; a gas or (especially) a liquid.

Density:
is the mass divided by the volume of an object.

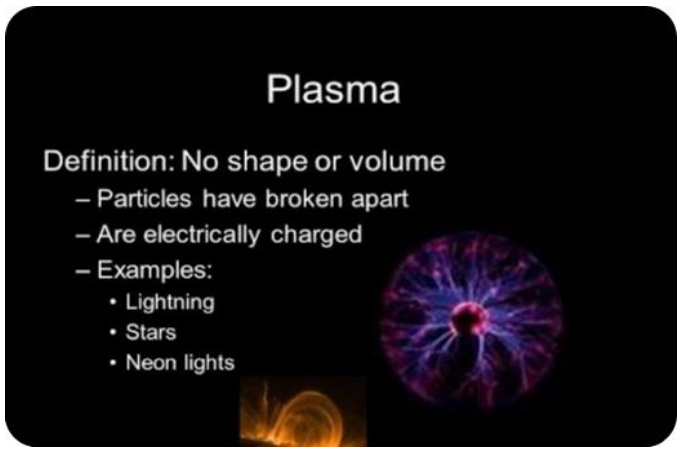
$\rho = \frac{m}{V}$ [kg/m³] where m is the mass and V is the volume.

Pressure:
The normal force divided by the area of the surface.

$$P = \frac{F}{A}$$

P is pressure [N/m²] or [Pa], F is the force [N], A is the area [m²].
Pressure is directly proportional with force and inversely proportional to the area.

- **Solid:** A substance that has definite shape and volume.
- **Liquid:** A substance that takes the shape of the container and has definite volume.
- **Gas:** a substance or matter in a state in which it will expand freely to fill the whole of a container, having no fixed shape (unlike a solid) and no fixed volume (unlike a liquid).
- **Plasma:** an ionized gas consisting of positive ions and free electrons in proportions resulting in more or less no overall electric charge, typically at low pressures (as in the upper atmosphere and in fluorescent lamps) or at very high temperatures (as in stars and nuclear fu-sion reactors.



15. Calculate the amount of change in Entropy for an amount of water gained heat 600 J at 27 °C

A 2.22 J/K B 2 J/K
C 0.5 J/k D 20 J/k

Solution

Δs = Q/T = 600/(27+273) = 600/300
= 2J/K , So the answer is B.

16. Liquids are

A Gases only B Gases and liquids
C Liquids only D Liquids and solid

17. A density of an object

A The mass of an object relative to its volume
B The volume of an object relative to its mass
C The mass of object
D The gravitational force of the object

18. If the maximum pressure that a floor can bear is 9.8×10^3 Pa for each $1m^2$, so, the maximum weight that can be beard is.

A $98\times10N$ B $9.8\times10^3\,N$
C $10N$ D $9.8\,N$

Solution

P=F/A
F = PA = 9.8x10³ x 1 = 9.8 x 10³ N , So the answer is B

19. We have to ……. of the car tires, so that they don't stuck in the sand.

A Increase the weight B Increase the mass
C Increase the width D Increase the circumference

20. An athlete stands on one foot and rises the other, so

A Weight and pressure increase
B Weight increase but pressure doesn't
C Weight and pressure don't increase
D Weight doesn't increase but pressure i crease

21. Most stars and galaxies are

A Solid B Liquid
C Gas D Plasma

Intermolecular forces in fluids:

Intermolecular forces:
are the forces that hold atoms together within a molecule. Intermolecular forces are forces that exist between molecules.

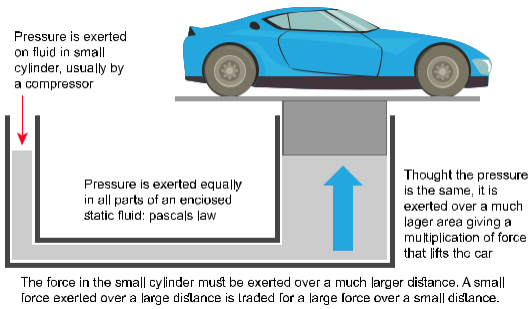
Cohesive forces:
Attractive forces between molecules of the same type. Example about this force the surface tension.

Surface tension:
The property of the surface of a liquid that allows it to resist an external force, due to the cohesive nature of its molecules.

Example from life about the surface tension:
The mosquito can stand on the surface of water as shown in the figure.

- Adhesive forces: Forces of attraction between a liquid and a solid surface.
- Example about the adhesive forces is the capillarity.
- Some applications of capillarity:
  1. Clothes absorb water
  2. The water moves up in the stem to the leaves.

- The fluid raises up more in the narrow pipes than the wide pipes.
- Pascale principle: Pascal's law says that pressure applied to an enclosed fluid will be transmitted without a change in magnitude to every point of the fluid and the walls of the container. The pressure at any point in the fluid is equal in all directions.
- Applications:



22. Attractive forces between molecules of the same type are.

A Cohesive forces B Adhesive forces
C Buoyancy forces D Friction forces

23. The surface tension happens due to.

A Cohesive forces B Adhesive forces
C Viscosity forces D Friction forces

24. The property that allows a mosquito to stand in the surface of water is

A Viscosity B Surface tension
C Capillary action D Buoyancy forces

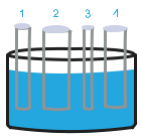
25. Cotton clothes absorbing sweat or water is an application of:

A Pascal Principle B Surface Tension
C Capillary action D Gravity

26. The water raises up in the narrow pipes is an application of:

A capillary action B Surface Tension
C Bernoulli's principle D Pascal Principle

27. In the figure, if the pipes are at the same level of water surface, in which pipe the liquid will raise more?



A 1 B 2 C 3 D 4

28. The reason that makes a mercury drop balls is that the cohesive forces are.

A Less than adhesive forces
B More than adhesive forces
C Equal adhesive forces
D Not existing

29. The hydraulic system depends on.

A Bernoulli's Principle
B Archimedes' Principle
C Pascal's Principle
D Bohr's Principle

Liquid pressure

- The pressure inside the fluid on any point is given as:

$$P = \rho g h$$

P is the pressure [Pa], ρ is the density of the fluid [kg/m³], h is the height of the fluid above the point [m], g is the gravitational acceleration [m/s²].

- All the points inside a static fluid at the same depth have the same pressure.

The buoyancy:

- Archimedes principle: Archimedes' principle states that a body immersed in a fluid is subjected to an upwards force equal to the weight of the displaced fluid. This is a first condition of equilibrium.
- The buoyant force: is a force acting on an object opposite to gravity by fluid which is being submerged partially or completely in fluid. It opposes weight of object. Buoyant force is given by volume displaced by object into density of fluid into gravitational acceleration.

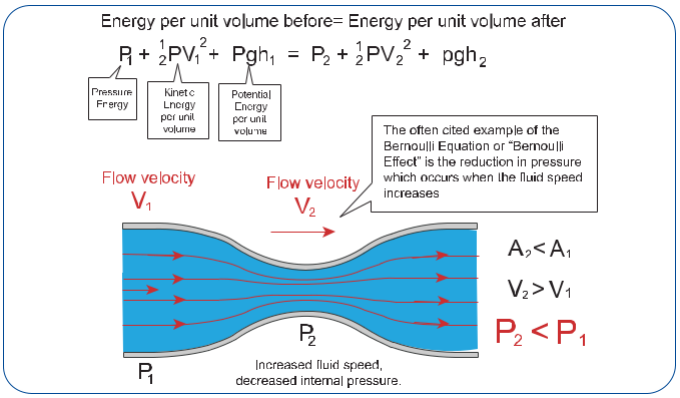
$$F_{bouyant} = \rho_{fluid} V g$$

F is the buoyant force [N], ρ is the density of fluid [kg/m3], V is the volume of immersed object [m3], g is the gravitational acceleration [m/s²].

- Applications: ships, submarines.
- Note: the mass of an object does not change inside the fluid.

Viscosity and Bernoulli's principle:

- Viscosity: is a measure of a fluid's resistance to flow.
- Bernoulli's principle: states the following within a horizontal flow of fluid, points of higher fluid speed will have less pressure than points of slower fluid speed.



- Note: When the area of the flow decreases then the velocity of the flow increases and its pressure decreases.
- Applications: paint sprayer, perfume atomizer.

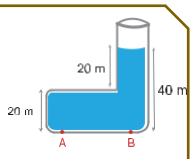
Expansion of solids:

- In physics, Thermal expansion can be defined as the change in the length, width, height, or volume of any material on changing the temperature. Thermal expansion is very evident in solids as atoms are densely packed. Thermal expansion of solids has loads of applications in day to day life.
- Applications: the separation distance in the bridges to expand in hot summer days and contract in cold winter days freely to avoiding the cracks and destroyed. (as shown below).

30. Which of these DON'T affect the liquid pressure on an object?

A Density of fluid
B Depth of an object in fluid
C Gravity acceleration
D Specific heat

31. In the figure, the pressure at point A ……. the pressure at point B.



A Double
B Equals
C Half
D Quarter

32. A pupil easily moves a box immersed in water, because the box.

A Increases weight and decreases mass
B Increases weight and doesn't change in mass
C decreases weight and mass
D decreases weight and doesn't change in mass

33. Measure of a fluid's resistance to flow is.

A Fluidity
B Viscosity
C Surface tension
D Cohesive and adhesive

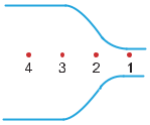
34. When the velocity of the fluid increases then its pressure.

A Increases
B Decreases
C Doesn't change
D Equals zero

35. Bernoulli's principle applied on……. fluid.

A constant
B streaming regularly
C streaming un regularly
D turbulent (not uniform)

36. At which point the flow of water become faster ?



A Point 1
B Point 2
C Point 3
D Point 4

37. The perfume atomizer is an example of.

A Bernoulli's Principle
B Archimedes' Principle
C Pascal's Principle
D Heisenberg's Principle

38. The reason why there's a space between the pipes of a railway is.....

A **To** Increases the width of pipes
B To let the pipes expand
C To let the pipes cool down
D To let the pipes shrink

Chapter (4) ANSWER KEY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
D	B	B	D	D	A	D	A	A	C	D	C	B	D	B	B	A	B	C	D

21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
D	A	A	B	C	A	C	B	C	D	B	D	B	B	B	A	A	B