OCR A A-Level Physics

5.1 Thermal Physics

Flashcards

How do you convert from Celsius to Kelvin?

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Add 273.

Eg. 10 degrees C = 283 K

Why is the absolute scale used?

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It doesn't arbitrarily depend on the properties of a given substance (eg. water's melting and boiling point for the Celsius scale).

0K (absolute zero) means that the particles have minimum internal energy.

Describe the arrangement and energy of particles in a solid, a liquid and a gas.

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Solid - regular arrangement, vibrate around fixed positions.

Liquid - close together, constantly moving past each other.

Gas - spaced very far apart, free to move in all directions.

How does Brownian motion give evidence for the particle model of matter?

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Smoke particles suspended in air can be seen to move randomly in all directions. This must be as a result of random collisions with particles making up the air.

What is Internal energy ?

What is Internal energy ?

The sum of the potential and kinetic energies of a system.

True or false: At a given temperature, all particles in a material have the same kinetic energy.

True or false: At a given temperature, all particles in a material have the same kinetic energy.

False. The kinetic energies will be randomly distributed around a central ‘most likely’ amount.

How can you increase the thermal energy of a system?

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We can increase it by heating it up or doing work on the object.

Explain the energy changes that occur during a change of state.

Explain the energy changes that occur during a change of state.

During change of state the potential energy of the particles change but the kinetic energies don't change.

What equation can be used to determine the energy required to change the temperature of a substance?

What equation can be used to determine the energy required to change the temperature of a substance?

$$Q = mc\Delta\theta$$

Where Q = energy, m = mass, c = specific heat capacity, $\Delta\theta$ = temperature change.

What is the specific heat capacity of substance?

What is the specific heat capacity of substance?

The energy required to raise the temperature of 1kg of a substance by 1K.

Give the equation to work of the energy for change of state?

Give the equation to work of the energy for change of state?

$$Q = ml$$

Where Q = energy, m = mass, l = specific latent heat (‘of fusion’ if melting/freezing, ‘of vaporisation’ if condensing/evaporating)

What is the specific latent heat of a substance?

What is the specific latent heat of a substance?

The energy required to change the state per unit mass of a substance, while keeping the temperature constant.

In an experiment to find ‘c’ for water, lots of energy input escapes to the surroundings. Will this lead to an over or underestimate of specific heat capacity?

In an experiment to find ‘c’ for water, lots of energy input escapes to the surroundings. Will this lead to an over or underestimate of specific heat capacity?

- An overestimate.
- Specific heat capacity is calculated as: $c = Q / m\Delta\theta$
- The energy input will be used, but the temperature change of the water will be lower than it should be due to the escaped energy - therefore c will be too high.

What is Avogadro's constant? (in words)

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The number of atoms there are in one mole of a substance.

What are the key assumptions in the kinetic theory of gases?

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- There are a large number of molecules in random, rapid motion.
- Particles are negligibly small compared to the total volume of the gas.
- All collisions are perfectly elastic.
- The time taken for a collision is negligibly small compared with the time between collisions.
- Between collisions there are no forces between particles.

Why do gases exert a pressure on the container they're in?

Why do gases exert a pressure on the container they're in?

- Gas particles collide with the surfaces of the container.
- The container exerts a force on the particles to change their direction. The particles exert an equal and opposite force on the container.
- Pressure is force applied (in total, by all particles) per unit area.

What is an ideal gas?

What is an ideal gas?

A gas where:

- The gas molecules don't interact with each other.
- The molecules are thought to be perfectly spheres.

What is the ideal gas equation?

What is the ideal gas equation?

$$pV=nRT$$

Where p = pressure, V = volume, n = number of moles, R = the ideal gas constant, T = absolute temperature

What is Boyle's law?

What is Boyle's law?

Pressure is inversely proportional to volume, providing temperature is constant.

i.e. pV = constant

Assuming constant volume, how are the pressure and temperature of a gas related?

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They're directly proportional.

ie. P/T = constant

Use the kinetic theory of gases to explain why a temperature increase leads to an increase in pressure.

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- A temperature increase means the particles have more kinetic energy.
- More kinetic energy means a greater change in momentum during collisions with the container. There are also more frequent collisions.
- Change in momentum is proportional to force applied, and therefore to pressure as well.

What equation links N, V, p, m and c?

What equation links N, V, p, m and c?

$$pV = \frac{1}{3}Nm\overline{c^2}$$

Where p = pressure, V = volume, N = number of particles, m = mass of a particle, ‘c’ = mean square speed.

What is meant by the root mean square speed?

What is meant by the root mean square speed?

The square root of the mean of the squares of the speeds of the molecules.

What does the area under a Maxwell-Boltzmann curve represent?

What does the area under a Maxwell-Boltzmann curve represent?

The total number of particles.

How does the Maxwell-Boltzmann curve change if the temperature of a gas is increased?

How does the Maxwell-Boltzmann curve change if the temperature of a gas is increased?

The average particle speed, and maximum particle speed both increase (curve shifts right).

The curve becomes lower and more spread out.

What are the units of the Boltzmann coefficient?

What are the units of the Boltzmann coefficient?

J/K

The average kinetic energy of a particle in an ideal gas is equal to what?

The average kinetic energy of a particle in an ideal gas is equal to what?

1.5 kT

True or false: ‘The internal energy of an ideal gas is proportional to absolute temperature’

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True.

In an ideal gas there is no ‘potential energy’ component in the internal energy. This means the internal energy is proportional to the kinetic energy (which is, in turn, dependent on temperature).