INKPHYSICS FLASHCARDS

Thermal physics

Year 13 · 12 cards · fronts and backs

Print double-sided, flipping on the long edge, and each answer lands behind its question. Cut along the card borders.

Definitions in mark-scheme wording, the equations that are not on the data sheet, each lesson's check question, and the misconceptions that lose marks. The same cards run on the website with spaced-repetition scheduling, at inkphysics.co.uk/flashcards.

DEFINITION

Define: Internal energy.

THERMAL ENERGY TRANSFER AND SPECIFIC HEAT CAPACITY

DEFINITION

Define: Specific heat capacity.

THERMAL ENERGY TRANSFER AND SPECIFIC HEAT CAPACITY

DEFINITION

Define: Specific latent heat.

THERMAL ENERGY TRANSFER AND SPECIFIC HEAT CAPACITY

CHECK YOURSELF

A 2.2 kW kettle holds 0.80 kg of water at 15 °C. How long does it take to reach 100 °C? (c of water = 4200 J kg^{-1} K^{-1}; assume no losses.)

Hint: Price the temperature rise first, then divide by the power.

THERMAL ENERGY TRANSFER AND SPECIFIC HEAT CAPACITY

SPOT THE ERROR

Say what is wrong with this claim:

Heat and temperature are the same thing.

THERMAL ENERGY TRANSFER AND SPECIFIC HEAT CAPACITY

DEFINITION

Define: Absolute zero.

IDEAL GASES AND THE GAS LAWS

EQUATION — NOT ON THE DATA SHEET

Work done by a gas at constant pressure:

W = ?

IDEAL GASES AND THE GAS LAWS

CHECK YOURSELF

A cylinder of volume 0.020 m^3 holds gas at 250 kPa and 300 K. How many moles does it contain, and roughly how many molecules is that?

Hint: One equation for n, then cross the bridge.

IDEAL GASES AND THE GAS LAWS

DEFINITION

The energy needed to raise the temperature of one kilogram of a substance by one kelvin without a change of state.

THERMAL ENERGY TRANSFER AND SPECIFIC HEAT CAPACITY

DEFINITION

The sum of the randomly distributed kinetic and potential energies of the particles in a body.

THERMAL ENERGY TRANSFER AND SPECIFIC HEAT CAPACITY

CHECK YOURSELF

Energy needed: $Q = mc\Delta\theta = 0.80 \times 4200 \times 85 = 2.86 \times 10^5$ J.

Time: $t = Q/P = 2.86 \times 10^5 / 2200 = 130$ s, a little over two minutes.

A real kettle takes slightly longer: some energy heats the kettle body and the room, which is exactly the loss the continuous-flow method is designed to cancel.

THERMAL ENERGY TRANSFER AND SPECIFIC HEAT CAPACITY

DEFINITION

The energy needed to change the state of one kilogram of a substance without a change of temperature.

THERMAL ENERGY TRANSFER AND SPECIFIC HEAT CAPACITY

DEFINITION

The temperature at which the particles of a substance have minimum internal energy: 0 K, or -273 °C.

IDEAL GASES AND THE GAS LAWS

SPOT THE ERROR

Temperature and heat are different quantities. Temperature measures the average kinetic energy of the particles; heat is energy in transit between objects at different temperatures. A sparkler at 1000 °C carries far less energy than a bath at 40 °C.

THERMAL ENERGY TRANSFER AND SPECIFIC HEAT CAPACITY

CHECK YOURSELF

$n = pV/RT = (250 \times 10^3 \times 0.020)/(8.31 \times 300) = 2.0$ mol.

Molecules: $N = nN_A = 2.0 \times 6.02 \times 10^{23} = 1.2 \times 10^{24}$.

Sense check: about four grams' worth of hydrogen or fifty-six of nitrogen, a perfectly ordinary cylinderful, and already a trillion trillion particles.

IDEAL GASES AND THE GAS LAWS

EQUATION — NOT ON THE DATA SHEET

$$\mathbf{W = p\Delta V}$$

IDEAL GASES AND THE GAS LAWS

SPOT THE ERROR

Say what is wrong with this claim:

Zero degrees means zero heat.

IDEAL GASES AND THE GAS LAWS

DEFINITION

Define: Brownian motion.

MOLECULAR KINETIC THEORY

CHECK YOURSELF

Find the root mean square speed of nitrogen molecules (molar mass 0.028 kg mol^{-1}) at 300 K. ($R = 8.31$ J K^{-1} mol^{-1}.)

Hint: Write the average-KE equation with molar quantities, then solve for c_{rms}.

MOLECULAR KINETIC THEORY

SPOT THE ERROR

Say what is wrong with this claim:

Air pressure comes from air's weight pressing down.

MOLECULAR KINETIC THEORY

DEFINITION

The random jittering of visible particles suspended in a fluid, evidence for the random motion of the molecules bombarding them.

MOLECULAR KINETIC THEORY

SPOT THE ERROR

0 °C is just the freezing point of water — an arbitrary zero. Molecules there still rush around at hundreds of metres per second. Minimum internal energy sits at absolute zero, -273 °C, which is why the gas laws only work in kelvin.

IDEAL GASES AND THE GAS LAWS

SPOT THE ERROR

Pressure comes from bombardment, not weight: countless molecular impacts each reversing momentum against the walls. That is why a sealed tyre pushes outward in every direction, up included — weight alone could never do that.

MOLECULAR KINETIC THEORY

CHECK YOURSELF

Per mole: $\frac{1}{2}M(c_{rms})^2 = 3RT/2$, so $(c_{rms})^2 = 3RT/M$.

$(c_{rms})^2 = 3 \times 8.31 \times 300 / 0.028 = 2.67 \times 10^5$ m^2 s^{-2}, giving $c_{rms} = 520$ m s^{-1}.

Faster than the speed of sound in air, which is no coincidence: sound is carried by exactly these molecules, and cannot outrun its messengers.

MOLECULAR KINETIC THEORY