INKPHYSICS FLASHCARDS

Turning points

Year 13 · 33 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 AQA 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/physics/flashcards.

DEFINITION

Define: Specific charge of the electron.

CATHODE RAYS AND THE ELECTRON

RECALL

State Thomson's specific charge result.

CATHODE RAYS AND THE ELECTRON

DEFINITION

Define: Thermionic emission.

CATHODE RAYS AND THE ELECTRON

RECALL

State how to find the speed of electrons leaving an electron gun.

CATHODE RAYS AND THE ELECTRON

RECALL

State what crossed fields add to the electron gun.

CATHODE RAYS AND THE ELECTRON

SPOT THE ERROR

Say what is wrong with this claim:

The atom is the smallest unit of matter; nothing can be pulled out of one.

CATHODE RAYS AND THE ELECTRON

RECALL

Explain how Millikan's droplets became charged.

MILLIKAN'S OIL DROP EXPERIMENT

RECALL

State the condition for a droplet falling at terminal speed.

MILLIKAN'S OIL DROP EXPERIMENT

RECALL

Thomson measured e/m at about 1800 times hydrogen's, the first evidence for a particle far less massive than any atom.

CATHODE RAYS AND THE ELECTRON

DEFINITION

The magnitude of the electron's charge divided by its mass: e/m.

CATHODE RAYS AND THE ELECTRON

RECALL

The work done by the accelerating pd becomes kinetic energy: $eV = \frac{1}{2}mv^2$.

CATHODE RAYS AND THE ELECTRON

DEFINITION

Electrons gain enough kinetic energy from a heated metal to escape its surface.

CATHODE RAYS AND THE ELECTRON

SPOT THE ERROR

Atoms are not indivisible: Thomson showed cathode rays have the same specific charge whatever the cathode metal, about 1800 times hydrogen's, so a particle far lighter than any atom comes from inside atoms.

CATHODE RAYS AND THE ELECTRON

RECALL

The undeflected condition gives the beam speed, which combined with the gun energy equation yields e/m.

CATHODE RAYS AND THE ELECTRON

RECALL

The viscous drag $6\pi\eta rv$ equals the droplet's weight.

MILLIKAN'S OIL DROP EXPERIMENT

RECALL

By friction as the spray left the atomiser.

MILLIKAN'S OIL DROP EXPERIMENT

RECALL

Explain why the droplet is timed falling with the field off.

MILLIKAN'S OIL DROP EXPERIMENT

SPOT THE ERROR

Say what is wrong with this claim:

Electric charge comes in any amount you like, like water from a tap.

MILLIKAN'S OIL DROP EXPERIMENT

RECALL

State the nature of an electromagnetic wave.

THE NATURE OF LIGHT

RECALL

State Maxwell's formula for the speed of electromagnetic waves.

THE NATURE OF LIGHT

RECALL

Explain why Young's dark fringes rule out particles.

THE NATURE OF LIGHT

RECALL

State what Hertz's experiments showed.

THE NATURE OF LIGHT

SPOT THE ERROR

Say what is wrong with this claim:

A theory backed by a great enough scientist counts as proved.

THE NATURE OF LIGHT

DEFINITION

Define: The ultraviolet catastrophe.

QUANTA AND WAVE-PARTICLE DUALITY

SPOT THE ERROR

Charge is quantised: Millikan's droplets only ever carried whole-number multiples of 1.6 × 10^{-19} C, so charge comes in units of the electron charge, never in arbitrary amounts.

MILLIKAN'S OIL DROP EXPERIMENT

RECALL

Its terminal speed gives the radius through Stokes' law, and the radius gives the otherwise unweighable mass.

MILLIKAN'S OIL DROP EXPERIMENT

RECALL

$c = 1/\sqrt{(\mu_0 \varepsilon_0)}$, built entirely from the two electrical constants.

THE NATURE OF LIGHT

RECALL

Oscillating electric and magnetic fields at right angles, needing no medium.

THE NATURE OF LIGHT

RECALL

Electrically generated radio waves travel at c, so light belongs to an electromagnetic family.

THE NATURE OF LIGHT

RECALL

Two particle streams can only add; only waves arriving out of step can cancel to darkness.

THE NATURE OF LIGHT

DEFINITION

Classical wave theory predicts black-body intensity rising without limit at short wavelengths, contrary to measurement.

QUANTA AND WAVE-PARTICLE DUALITY

SPOT THE ERROR

Authority is not evidence: Newton's particle theory predicted light travels faster in glass, wave theory predicted slower, and Foucault's measurement found it slower, deciding for waves.

THE NATURE OF LIGHT

DEFINITION

Define: Planck's quantum hypothesis.

QUANTA AND WAVE-PARTICLE DUALITY

RECALL

State the de Broglie wavelength of an electron accelerated through pd V.

QUANTA AND WAVE-PARTICLE DUALITY

SPOT THE ERROR

Say what is wrong with this claim:

Waves are waves and particles are particles, and nothing is ever both.

QUANTA AND WAVE-PARTICLE DUALITY

DEFINITION

Define: Inertial frame of reference.

THE MICHELSON-MORLEY EXPERIMENT

RECALL

State what the Michelson-Morley experiment set out to detect.

THE MICHELSON-MORLEY EXPERIMENT

RECALL

Explain why the interferometer was rotated through 90°.

THE MICHELSON-MORLEY EXPERIMENT

DEFINITION

Define: First postulate of special relativity.

THE MICHELSON-MORLEY EXPERIMENT

SPOT THE ERROR

Say what is wrong with this claim:

Light must travel through something; empty space cannot carry a wave.

THE MICHELSON-MORLEY EXPERIMENT

RECALL

$\lambda = h/\sqrt{(2meV)}$.

QUANTA AND WAVE-PARTICLE DUALITY

DEFINITION

Energy is emitted and absorbed in discrete quanta of size $E = hf$.

QUANTA AND WAVE-PARTICLE DUALITY

DEFINITION

A frame moving at constant velocity, in which Newton's first law holds.

THE MICHELSON-MORLEY EXPERIMENT

SPOT THE ERROR

Everything shows both behaviours: light diffracts as a wave yet exchanges energy in photons, and electrons diffract through crystals. Which behaviour appears depends on the experiment.

QUANTA AND WAVE-PARTICLE DUALITY

RECALL

Rotation swaps the arms, reversing any ether-wind time difference, so the fringes should shift.

THE MICHELSON-MORLEY EXPERIMENT

RECALL

The Earth's absolute motion through the ether, as an ether wind across the apparatus.

THE MICHELSON-MORLEY EXPERIMENT

SPOT THE ERROR

Light needs no medium: the interferometer could have detected the supposed aether wind but found no significant shift in any orientation or season, undermining the aether picture and supporting the postulate that light's speed is the same in every inertial frame.

THE MICHELSON-MORLEY EXPERIMENT

DEFINITION

Physical laws have the same form in all inertial frames.

THE MICHELSON-MORLEY EXPERIMENT

DEFINITION

Define: Proper time.

THE CONSEQUENCES OF SPECIAL RELATIVITY

DEFINITION

Define: Time dilation.

THE CONSEQUENCES OF SPECIAL RELATIVITY

DEFINITION

Define: Rest mass.

THE CONSEQUENCES OF SPECIAL RELATIVITY

DEFINITION

Define: Proper length.

THE CONSEQUENCES OF SPECIAL RELATIVITY

DEFINITION

Define: Length contraction.

THE CONSEQUENCES OF SPECIAL RELATIVITY

RECALL

State the evidence for time dilation.

THE CONSEQUENCES OF SPECIAL RELATIVITY

DEFINITION

Define: Bertozzi's experiment.

THE CONSEQUENCES OF SPECIAL RELATIVITY

EQUATION · NOT ON THE AQA DATA SHEET

Kinetic energy at a relativistic speed:

$E_k = ?$

THE CONSEQUENCES OF SPECIAL RELATIVITY

DEFINITION

An observer moving relative to the events measures a longer time than the proper time: $t = t_0/\sqrt{(1 - v^2/c^2)}$.

THE CONSEQUENCES OF SPECIAL RELATIVITY

DEFINITION

The time between two events measured in the frame in which they happen at the same place: t_0.

THE CONSEQUENCES OF SPECIAL RELATIVITY

DEFINITION

The length of an object measured in its own rest frame: l_0.

THE CONSEQUENCES OF SPECIAL RELATIVITY

DEFINITION

The mass of an object measured in the frame where it is at rest: m_0.

THE CONSEQUENCES OF SPECIAL RELATIVITY

RECALL

Far more cosmic-ray muons reach the ground than their rest lifetime allows without dilation.

THE CONSEQUENCES OF SPECIAL RELATIVITY

DEFINITION

A moving object is measured shorter along its direction of motion: $l = l_0\sqrt{(1 - v^2/c^2)}$.

THE CONSEQUENCES OF SPECIAL RELATIVITY

EQUATION · NOT ON THE AQA DATA SHEET

$$\mathbf{E_k = (m - m_0)c^2}$$

THE CONSEQUENCES OF SPECIAL RELATIVITY

DEFINITION

Measured electron speed by time of flight against kinetic energy from the pd, finding speed levelling off just below c.

THE CONSEQUENCES OF SPECIAL RELATIVITY

SPOT THE ERROR

Say what is wrong with this claim:

With a strong enough accelerator you could push an electron past the speed of light.

THE CONSEQUENCES OF SPECIAL RELATIVITY

SPOT THE ERROR

Nothing can be pushed past c: the energy needed grows without limit as speed approaches c, because in AQA's relativistic-mass convention the effective mass $m_0/\sqrt{(1 - v^2/c^2)}$ grows without limit while the rest mass stays fixed, so electrons approach but never reach c.