INKPHYSICS FLASHCARDS

Measurements

Year 12 · 17 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: SI base quantities.

SI UNITS AND PREFIXES

CHECK YOURSELF

(a) Write 250 μm in metres, in standard form. (b) An electron has 5.0 keV of kinetic energy. How many joules is that?

Hint: Take one prefix at a time: micro first, then kilo, then the eV to J factor.

SI UNITS AND PREFIXES

SPOT THE ERROR

Say what is wrong with this claim:

Units are labels you attach once the number is finished.

SI UNITS AND PREFIXES

DEFINITION

Define: Accuracy.

UNCERTAINTY AND ERROR

DEFINITION

Define: Precision.

UNCERTAINTY AND ERROR

DEFINITION

Define: Repeatability.

UNCERTAINTY AND ERROR

DEFINITION

Define: Reproducibility.

UNCERTAINTY AND ERROR

DEFINITION

Define: Resolution.

UNCERTAINTY AND ERROR

CHECK YOURSELF

(a) Micro means 10^{-6}, so 250 μm = 250 × 10^{-6} m = 2.5 × 10^{-4} m.

(b) 5.0 keV = 5.0 × 10^{3} eV. Each eV is 1.60 × 10^{-19} J, so the energy is 5.0 × 10^{3} × 1.60 × 10^{-19} = 8.0 × 10^{-16} J.

SI UNITS AND PREFIXES

DEFINITION

The quantities from which all others at A-level are built: mass (kg), length (m), time (s), electric current (A), temperature (K) and amount of substance (mol).

SI UNITS AND PREFIXES

DEFINITION

How close a result is to the true value.

UNCERTAINTY AND ERROR

SPOT THE ERROR

Units are part of the physics, not decoration. Carry them through a calculation and they check the algebra as you go; an answer with the wrong unit is wrong before you look at the number.

SI UNITS AND PREFIXES

DEFINITION

The same experimenter, using the same method and equipment, obtains consistent results.

UNCERTAINTY AND ERROR

DEFINITION

How closely repeated readings cluster together; a precise result need not be accurate.

UNCERTAINTY AND ERROR

DEFINITION

The smallest change in a quantity that an instrument can display.

UNCERTAINTY AND ERROR

DEFINITION

A different experimenter, or a different method or equipment, still obtains consistent results.

UNCERTAINTY AND ERROR

DEFINITION

Define: Uncertainty.

UNCERTAINTY AND ERROR

DEFINITION

Define: Random error.

UNCERTAINTY AND ERROR

DEFINITION

Define: Systematic error.

UNCERTAINTY AND ERROR

EQUATION — NOT ON THE DATA SHEET

Percentage uncertainty:

percentage uncertainty = ?

UNCERTAINTY AND ERROR

CHECK YOURSELF

A wire's diameter is measured as 0.40 ± 0.01 mm. What is the percentage uncertainty in its cross-sectional area?

Hint: Area depends on the diameter squared. What does the power rule do to a percentage uncertainty?

UNCERTAINTY AND ERROR

SPOT THE ERROR

Say what is wrong with this claim:

A measurement is a number.

UNCERTAINTY AND ERROR

DEFINITION

Define: Order of magnitude.

ESTIMATION AND ORDERS OF MAGNITUDE

CHECK YOURSELF

Estimate, to the nearest order of magnitude, the energy needed to climb one flight of stairs.

Hint: The force is your weight. Take g as 10 and a flight as about 3 m.

ESTIMATION AND ORDERS OF MAGNITUDE

DEFINITION

Error that scatters readings unpredictably either side of the true value; reduced by repeating and averaging.

UNCERTAINTY AND ERROR

DEFINITION

The interval within which the true value can reasonably be expected to lie, quoted after a ± sign.

UNCERTAINTY AND ERROR

EQUATION — NOT ON THE DATA SHEET

percentage uncertainty = (uncertainty)/(value) × 100

UNCERTAINTY AND ERROR

DEFINITION

Error that shifts every reading the same way, such as a zero error; repeating does not reduce it.

UNCERTAINTY AND ERROR

SPOT THE ERROR

A number alone is not a measurement. A measurement is a value, a unit and an uncertainty, because every instrument has finite resolution and every method has scatter.

UNCERTAINTY AND ERROR

CHECK YOURSELF

Percentage uncertainty in the diameter: (0.01 / 0.40) × 100 = 2.5%.

The area goes as d^2, so the power rule doubles it: the area is uncertain by 5%.

Working through the radius changes nothing: halving a value halves its absolute uncertainty too, so the percentage uncertainty is untouched.

UNCERTAINTY AND ERROR

CHECK YOURSELF

Weight of a person: about 70 kg × 10 = 700 N. Height of a flight: about 3 m.

Energy = force × distance ≈ 700 × 3 = 2100 J, so the order of magnitude is 10^3 J, a couple of kilojoules.

The exact answer depends on the person and the staircase, and that is fine. Anyone whose calculation of this quantity produces 10^6 J has found an error, not a big staircase.

ESTIMATION AND ORDERS OF MAGNITUDE

DEFINITION

A value expressed to the nearest power of ten.

ESTIMATION AND ORDERS OF MAGNITUDE

SPOT THE ERROR

Say what is wrong with this claim:

If it came out of the calculator, it must be right.

ESTIMATION AND ORDERS OF MAGNITUDE

SPOT THE ERROR

Calculators execute keystrokes; they cannot notice a slip. An order-of-magnitude estimate made first is what catches the misplaced power of ten.

ESTIMATION AND ORDERS OF MAGNITUDE