InkPhysics

ANSWER BOOK

SI units and prefixes

Measurements · Year 12

AQA 3.1.1 · CIE 1.1.1, 1.2.1, 1.2.2, 1.2.3, 1.2.4, 15.1.1
OCR A 2.1.1(a), 2.1.2(a), 2.1.2(b), 2.1.2(c), 2.1.2(d), 2.1.2(e), 2.1.2(f), 3.2.1(b), 4.2.5(c)

19 questions · 53 marks

NAVY EDITION

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SECTION A · Warm-up

A1 Mass (kilogram, kg) and length (metre, m) (1); time (second, s) and electric current (ampere, A) (1); temperature (kelvin, K) and amount of substance (mole, mol) (1). One mark for each two correct pairs. [3]

A2 (a) 5.0 km = 5000 m, that is 5.0×10^3 m (1)
(b) 2.5 GHz = 2.5×10^9 Hz (1) [2]

A3 From F = ma (1), 1 N = 1 kg m s^{-2} (1). [2]

A4 (a) 85 pF = 8.5×10^{-11} F (1). (b) 2.4 fm = 2.4×10^{-15} m (1). [2]

A5 Energy in eV = energy in J ÷ (1.60×10^{-19}) (1) = $3.2 \times 10^{-19}/(1.60 \times 10^{-19})$ = 2.0 eV (1). [2]

SECTION B · Standard

B1 (a) J = N m (1) = kg m^2 s^{-2} (1). (b) W = J s^{-1} = kg m^2 s^{-3} (1). [3]

B2 (a) 3.0 mA = 3.0×10^{-3} A (1). (b) 450 nm = 4.5×10^{-7} m (1). (c) 12 MΩ = 1.2×10^7 Ω (1). [3]

B3 LHS: $(\text{m s}^{-1})^2 = \text{m}^2\,\text{s}^{-2}$ (1)
RHS: a × s = $(\text{m s}^{-2})(\text{m}) = \text{m}^2\,\text{s}^{-2}$ (1)
Both sides have the same units, so the equation is homogeneous (1) [3]

B4 Pa = N m^{-2} = kg m s^{-2} / m^2 (1) = kg m^{-1} s^{-2} (1). [2]

B5 (a) 90 minutes = 1.5 h (1), so energy = 2.4 × 1.5 = 3.6 kW h (1). (b) Energy = 3.6 × 3.6×10^6 = 1.3×10^7 J (1). [3]

B6 1 mm^2 = $(10^{-3}\ \text{m})^2$ = 10^{-6} m^2: the prefix must be squared with the unit (1). 0.020 mm^2 = 2.0×10^{-8} m^2 (1). [2]

B7 580 nm = 5.8×10^{-7} m and 0.65 µm = 6.5×10^{-7} m (1); 0.00071 mm = 7.1×10^{-7} m (1). Order: 580 nm < 6.2×10^{-7} m < 0.65 µm < 0.00071 mm (1). [3]

B8 Unit of l/g = m/(m s^{-2}) (1) = s^2 (1). Taking the square root gives the unit of √(l/g) as s, so T is in seconds (2π has no unit) (1). [3]

SECTION C · Stretch

C1 Rearranging, $G = Fr^2/(Mm)$ (1) [3]
Units = $(\text{kg m s}^{-2} \times \text{m}^2)/(\text{kg} \times \text{kg})$ (1)
= $\text{m}^3\ \text{kg}^{-1}\ \text{s}^{-2}$ (1)

C2 (a) $2.7\ \text{g cm}^{-3} \times 1000$ (1) [4]
= $2700\ \text{kg m}^{-3}$ (1)
(b) $90\ \text{km h}^{-1} = (90 \times 1000)/3600$ (1)
= $25\ \text{m s}^{-1}$ (1)

C3 A correct physical equation must have the same units on both sides (1). If the units do not match, the equation must be wrong (1), so a units check quickly catches errors such as a missing factor or a wrongly placed quantity, before any numbers are used (1). [3]

C4 Convert both prefixes: $2.5\ \text{mJ} = 2.5 \times 10^{-3}$ J and $6.0\ \text{ns} = 6.0 \times 10^{-9}$ s (1). $P = E/t = 2.5 \times 10^{-3}/(6.0 \times 10^{-9}) = 4.2 \times 10^5$ W (1) = about 0.42 MW (or 420 kW) (1). [3]

C5 Unit of $T/\mu = (\text{kg m s}^{-2})/(\text{kg m}^{-1}) = \text{m}^2\ \text{s}^{-2}$ (1), so $\sqrt{(T/\mu)}$ has unit m s^{-1}, the unit of speed (1). $\sqrt{(\mu/T)}$ would have unit s m^{-1}, so only $v = \sqrt{(T/\mu)}$ can be correct (1). [3]

C6 Energy each day = $3.0 \times 2.0 = 6.0$ kW h (1). Energy in the month = $6.0 \times 30 = 180$ kW h (1). Evidence of cost = 180×28p (1); cost = £50.40 (1). [4]