



QUESTION WORKBOOK

Estimation and orders of magnitude

Measurements · Year 12

AQA 3.1.3 · CIE 1.1.2 · OCR A 2.1.1(b)

18 questions · 54 marks

NAVY SCREEN EDITION

SECTION A · Warm-up

A1 State what is meant by the order of magnitude of a quantity. [2]

A2 State the order of magnitude of (a) the mass of an apple and (b) the speed of a car on a motorway. [2]

A3 Give the order of magnitude of (a) 4.5×10^6 and (b) 2.0×10^{-4} . [2]

A4 State the order of magnitude of (a) the diameter of an atom and (b) the height of a door. [2]

- A5** A student's calculation gives the mass of a family car as 1.5×10^6 kg. Use an estimate to explain why this answer must be wrong. [2]

SECTION B · Standard

- B1** Estimate the number of times a human heart beats in a lifetime, and give the answer to the nearest order of magnitude. (Take about 70 beats per minute and a lifetime of about 80 years.) [3]

- B2** Estimate how many 1 cm^3 cubes would fit inside a 1 m^3 box. [3]

- B3** Estimate the kinetic energy of a person running, and give the order of magnitude. (Take a mass of about 70 kg and a speed of about 5 m s^{-1} .) [4]

- B4** Estimate the order of magnitude of the ratio of the mass of the Earth ($\approx 6 \times 10^{24}$ kg) to the mass of a person (≈ 60 kg). [3]

- B5** Estimate the mass of the air in a school laboratory, and give the order of magnitude of your answer. (Take the density of air as 1.2 kg m^{-3} .) [3]

- B6** Estimate the total volume of water a person drinks in an 80-year lifetime, in m^3 , and give the order of magnitude. (Take about 2 litres a day; $1 \text{ litre} = 10^{-3} \text{ m}^3$.) [3]

- B7** Estimate the gravitational potential energy gained by a walker climbing a mountain 1000 m high, and give the order of magnitude. (Use $E = mgh$ and take g as 10 m s^{-2} .) [3]

SECTION C · Stretch

- C1** Estimate the number of breaths a person takes in one day, and hence in an 80-year lifetime, expressing each to the nearest order of magnitude. (Take about 15 breaths per minute.) [4]

- C2** Estimate the energy needed to heat a mug of water for a hot drink, and give the order of magnitude of your answer. (Take about 0.25 kg of water, $c = 4200 \text{ J kg}^{-1} \text{ K}^{-1}$ and a temperature rise of about 80°C .) [4]

- C3** Explain why order-of-magnitude estimates are useful in physics. [3]

- C4** A student calculates the kinetic energy of a served tennis ball to be 7.5×10^4 J. Make your own estimate of this energy, stating the values you assume, and deduce whether the student's answer is reasonable. Suggest the error the student is most likely to have made. [4]

- C5** A grain of sand is roughly a cube of side 0.5 mm, and an atom has a diameter of about 10^{-10} m. Estimate the number of atoms in the grain, and give the order of magnitude. [4]

- C6** Estimate the number of times a car wheel turns during the car's working life, and give the order of magnitude. (Take a lifetime distance of about 150 000 km and a wheel circumference of about 2 m.) [3]