

01 Measurements and uncertainties review questions

Part A: Measurements

- 1) State the six fundamental units and the quantities they measure.
- 2) Why have definitions of the fundamental units changed from those originally set up.
- 3) Give the equivalent in fundamental units of:
 - a. Newtons
 - b. Coulombs
 - c. Joules
 - d. Volts
- 4) What quantity is measured by:
 - a. the electron-volt, eV
 - b. kgms^{-1}
 - c. Watt
- 5) A body is moving with constant speed in a horizontal circular motion at a radius of 0.5m and a rate of 3.14 rads^{-1} .
 - a. Calculate the magnitude of the velocity of the motion.
 - b. Explain why speed is constant but velocity is not.

Part B Uncertainty, error, precision, accuracy.

- 1) In an experiment speed was measured several times and was judged to be between 6.82 and 8.02 ms^{-1} . Express this as a value with:
 - a. an absolute uncertainty range
 - b. a fractional uncertainty
 - c. a percentage uncertainty.
- 2) To measure the resistance of an Ohmic component you use a voltmeter accurate to 0.1V and an ammeter accurate to 0.02A . The voltage reading is 4.3V and the current reading is 0.21A .
 - a. State the most likely value for the resistance of the component.
 - b. What is the absolute uncertainty of your resistance calculation?
 - c. What is the percentage uncertainty of your resistance calculation?
 - d. How could you improve the percentage accuracy of your result without changing the meters?
- 3) A student is performing an experiment measuring the resistance of a thermistor (temperature dependent resistor). The thermistor is in oil whose temperature is controlled and measured.

The student has not realized that the voltmeter he is using reads a value 5% smaller than the real value.

There is variation in EMF of the power supply used.

There is a small amount of heat generated inside the thermistor.

The milli-ammeters, contacts and wires that he is using have resistance.

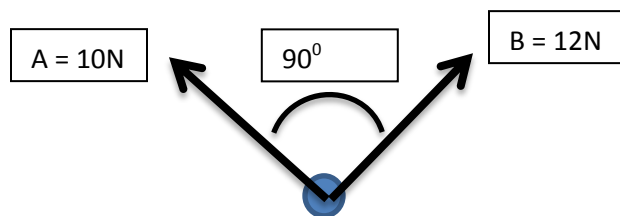
The ammeter records current to the nearest milliamp.

The voltmeter records voltage to the nearest one hundredth of a volt.

- List the systematic errors
- Identify the random error and state how it could be reduced without changing an apparatus.
- Based on the precision of the instruments state the uncertainty that should be recorded.
- What is the percentage uncertainty in a voltmeter reading of 0.8V?
- What is the percentage uncertainty in a ammeter reading of 50mA?
- What is the percentage uncertainty in the measured value of the resistance?
- If the measured resistance values are 4% different to those stated by the manufacturer of the thermistor what should the conclusion of the student be?

Part C Vectors and Scalars

- Give four examples of scalar quantities and four examples of vector quantities.
- A rocket is flying 500m/s at an elevation of 50° to the horizontal what are the vertical and horizontal components of its velocity?
- An object is being pushed by two forces A and B as shown. What is the size of the resultant force?



Part D: Magnitude calculations - radius of Earth 6380 km – mass of Earth 6×10^{24} kg

- What is the ratio of the size of an atom (radius= 10^{-10} m) to the size of the Earth?
- The plank length is, according to theory, the smallest possible measureable length and is equal to 1.6×10^{-35} m. What is the radius of the Earth expressed in units of the Planck length?
- How many heartbeats are there in the lifetime of a person?
- Using the molar mass of water of 18g mol^{-1} , how many molecules of water are there in you?
- Write these lengths in metres: a) 5.356 nm, b) c) 3.4 mm.
- Write these energies in Joules: a) 4.834 MJ, b) 364 GeV.
- Write these times in seconds: a) 47.6 ns, b) 24.0 ms.
- What is the velocity of an electron that covers a distance of 15.68 mm in 87.50 ns?