## Solutions

Each answer shows the steps, then the **result**.

**2.1**

- a scalar has size only; a vector has size **and** direction

**2.2**

- period = total time / number of swings

$$T = \frac{30\ \text{s}}{20} = \mathbf{1.5}\ \text{s}$$

**2.3**

- period = total time / number of swings

$$T = \frac{31.0\ \text{s}}{20} = \mathbf{1.55}\ \text{s}$$

- the timing error is shared between 20 swings, so its effect on one period is 20 times smaller

**2.4**

- weight, velocity, momentum, gravitational field strength

**3.1 C**

- velocity has both size and direction

**3.2**

(a) Pythagoras on the 3.0 N and 4.0 N sides

$$R = \sqrt{(3.0\ \text{N})^2 + (4.0\ \text{N})^2} = \sqrt{25\ \text{N}^2} = \mathbf{5.0}\ \text{N}$$

(b) it has both a size and a direction

**3.3**

- measure the total thickness of a known large number of sheets (e.g. 100) with the ruler
- divide the total thickness by the number of sheets

**3.4**

(a) use a stopwatch or digital timer

- start it as the pendulum passes the centre of its swing and count from zero
- time 20 complete swings and repeat, then take an average

(b) $T$ = total time / number of swings

$$T = \frac{25.6\ \text{s}}{20} = \mathbf{1.28}\ \text{s}$$



(c) her reaction time affects the total once, at the start and the stop

- dividing by 20 divides that error by 20 as well, so each period is far more accurate

(d)

$$\frac{9.0\ \text{mm}}{100} = \mathbf{0.090}\ \text{mm}$$

- one sheet is far thinner than the smallest division on the ruler, so measuring it directly would give a very large percentage error