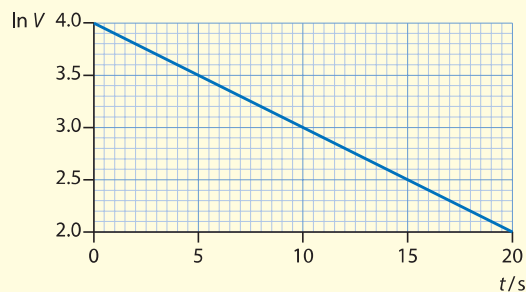




## ? Test yourself

- 23 The magnitudes of two forces are measured to be  $120 \pm 5$  N and  $60 \pm 3$  N. Find the sum and difference of the two magnitudes, giving the uncertainty in each case.
- 24 The quantity  $Q$  depends on the measured values  $a$  and  $b$  in the following ways:
- $Q = \frac{a}{b}$ ,  $a = 20 \pm 1$ ,  $b = 10 \pm 1$
  - $Q = 2a + 3b$ ,  $a = 20 \pm 2$ ,  $b = 15 \pm 3$
  - $Q = a - 2b$ ,  $a = 50 \pm 1$ ,  $b = 24 \pm 1$
  - $Q = a^2$ ,  $a = 10.0 \pm 0.3$
  - $Q = \frac{a^2}{b^2}$ ,  $a = 100 \pm 5$ ,  $b = 20 \pm 2$
- In each case, find the value of  $Q$  and its uncertainty.
- 25 The centripetal force is given by  $F = \frac{mv^2}{r}$ . The mass is measured to be  $2.8 \pm 0.1$  kg, the velocity  $14 \pm 2$  m s<sup>-1</sup> and the radius  $8.0 \pm 0.2$  m; find the force on the mass, including the uncertainty.
- 26 The radius  $r$  of a circle is measured to be  $2.4 \text{ cm} \pm 0.1 \text{ cm}$ . Find the uncertainty in:
- the area of the circle
  - the circumference of the circle.
- 27 The sides of a rectangle are measured as  $4.4 \pm 0.2$  cm and  $8.5 \pm 0.3$  cm. Find the area and perimeter of the rectangle.
- 28 The length  $L$  of a pendulum is increased by 2%. Find the percentage increase in the period  $T$ .
- $$\left(T = 2\pi\sqrt{\frac{L}{g}}\right)$$
- 29 The volume of a cone of base radius  $R$  and height  $h$  is given by  $V = \frac{\pi R^2 h}{3}$ . The uncertainty in the radius and in the height is 4%. Find the percentage uncertainty in the volume.
- 30 In an experiment to measure current and voltage across a device, the following data was collected:  $(V, I) = \{(0.1, 26), (0.2, 48), (0.3, 65), (0.4, 90)\}$ . The current was measured in mA and the voltage in mV. The uncertainty in the current was  $\pm 4$  mA. Plot the current versus the voltage and draw the best-fit line through the points. Suggest whether the current is proportional to the voltage.

- 31 In a similar experiment to that in question 30, the following data was collected for current and voltage:  $(V, I) = \{(0.1, 27), (0.2, 44), (0.3, 60), (0.4, 78)\}$  with an uncertainty of  $\pm 4$  mA in the current. Plot the current versus the voltage and draw the best-fit line. Suggest whether the current is proportional to the voltage.
- 32 A circle and a square have the same perimeter. Which shape has the larger area?
- 33 The graph shows the natural logarithm of the voltage across a capacitor of capacitance  $C = 5.0 \mu\text{F}$  as a function of time. The voltage is given by the equation  $V = V_0 e^{-t/RC}$ , where  $R$  is the resistance of the circuit. Find:
- the initial voltage
  - the time for the voltage to be reduced to half its initial value
  - the resistance of the circuit.



- 34 The table shows the mass  $M$  of several stars and their corresponding luminosity  $L$  (power emitted).
- Plot  $L$  against  $M$  and draw the best-fit line.
  - Plot the logarithm of  $L$  against the logarithm of  $M$ . Use your graph to find the relationship between these quantities, assuming a power law of the kind  $L = kM^\alpha$ . Give the numerical value of the parameter  $\alpha$ .

Mass $M$ (in solar masses)	Luminosity $L$ (in terms of the Sun's luminosity)
$1.0 \pm 0.1$	$1 \pm 0$
$3.0 \pm 0.3$	$42 \pm 4$
$5.0 \pm 0.5$	$230 \pm 20$
$12 \pm 1$	$4700 \pm 50$
$20 \pm 2$	$26\,500 \pm 300$