Questions

1 Express the following units in terms of the SI fundamental units.

a) newton (N)

b) watt (W)

c) pascal (Pa)

d) coulomb (C)

e) volt (V)

(5 marks)

2 Express the following numbers to three significant figures.

a) 257.52

b) 0.002 347

c) 0.1783

d) 7873

e) 1.997

(5 marks)

3 Complete the following calculations and express your answers to the most appropriate number of significant figures.

a) 1.34×3.2

b) $\dfrac{1.34 \times 10^2}{2.1 \times 10^3}$

c) $1.87 \times 10^2 + 1.97 \times 10^3$

d) $(1.97 \times 10^5) \times (1.0 \times 10^4)$

e) $(9.47 \times 10^{-2}) \times (4.0 \times 10^3)$

(5 marks)

4 Use the appropriate metric multiplier instead of a power of ten in the following.

a) 1.1×10^4 V

b) 4.22×10^{-4} m

c) 8.5×10^{10} W

d) 4.22×10^{-7} m

e) 3.5×10^{-13} C

(5 marks)

5 Write down the order of magnitude of the following (you may need to do some research).

a) the length of a human foot

b) the mass of a fly

c) the charge on a proton

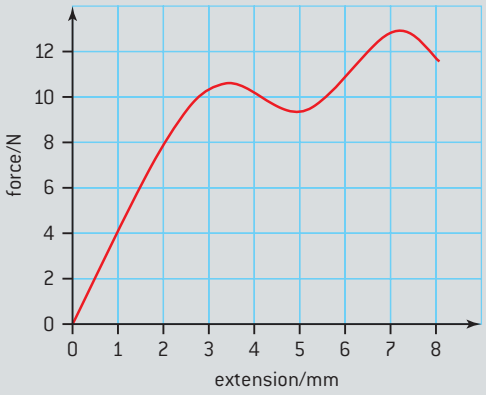
d) the age of the universe

e) the speed of electromagnetic waves in a vacuum

(5 marks)

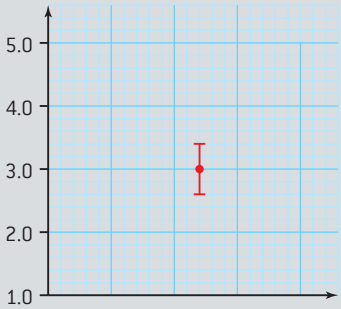
6 **a)** Without using a calculator estimate to one significant figure the value of $\dfrac{2\pi 4.9}{480}$.

b) When a wire is stretched, the area under the line of a graph of force against extension of the wire gives the elastic potential energy stored in the wire. Estimate the energy stored in the wire with the following characteristic:



(4 marks)

7 The grid below shows one data point and its associated error bar on a graph. The *x*-axis is not shown. State the *y*-value of the data point together with its absolute and percentage uncertainty.



(3 marks)

8 A ball falls freely from rest with an acceleration g. The variation with time t of its displacement s is given by $s = \frac{1}{2}gt^2$. The percentage uncertainty in the value of t is $\pm 3\%$ and that in the value of g is $\pm 2\%$. Calculate the percentage uncertainty in the value of s.

(2 marks)

9 The volume V of a cylinder of height h and radius r is given by the expression $V = \pi r^2 h$. In a particular experiment, r is to be determined from measurements of V and h. The percentage uncertainty in V is $\pm 5\%$ and that in h is $\pm 2\%$. Calculate the percentage uncertainty in r.

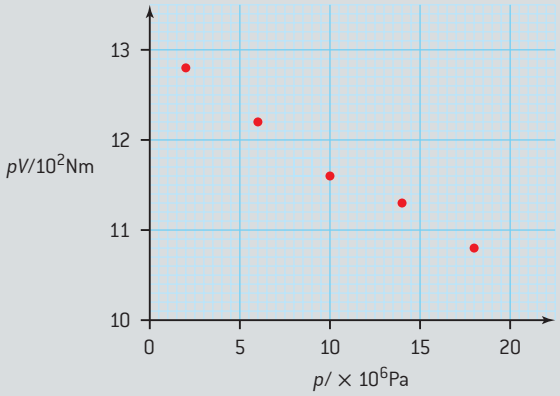
(3 marks)

10 (*IB*)

At high pressures, a real gas does not behave as an ideal gas. For a certain range of pressures, it is suggested that for one mole of a real gas at constant temperature the relation between the pressure p and volume V is given by the equation

$pV = A + Bp$ where A and B are constants.

In an experiment, 1 mole of nitrogen gas was compressed at a constant temperature of 150 K. The volume V of the gas was measured for different values of the pressure p. A graph of the product pV against p is shown in the diagram below.



a) Copy the graph and draw a line of best fit for the data points.

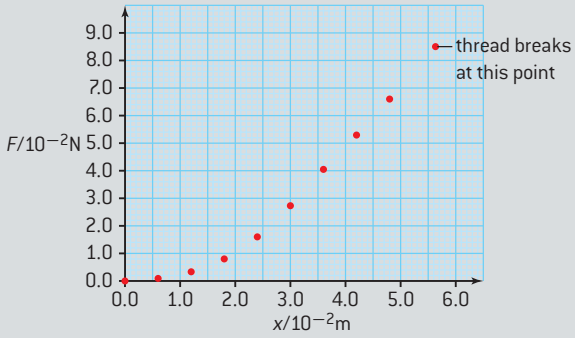
b) Use your graph to determine the values of the constants A and B in the equation $pV = A + Bp$

c) p was measured to an accuracy of 5% and V was measured to an accuracy of 2%. Determine the absolute error in the value of the constant A.

(6 marks)

11 (*IB*)

An experiment was carried out to measure the extension x of a thread of a spider's web when a load F is applied to it.



a) Copy the graph and draw a best-fit line for the data points.

b) The relationship between F and x is of the form

$F = kx^n$

State and explain the graph you would plot in order to determine the value n.

c) When a load is applied to a material, it is said to be *under stress*. The magnitude p of the stress is given by

$$p = \frac{F}{A}$$

where A is the cross-sectional area of the sample of the material.

Use the graph and the data below to deduce that the thread used in the experiment has a greater breaking stress than steel.

Breaking stress of steel $= 1.0 \times 10^9$ N m^{-2}

Radius of spider web thread $= 4.5 \times 10^{-6}$ m

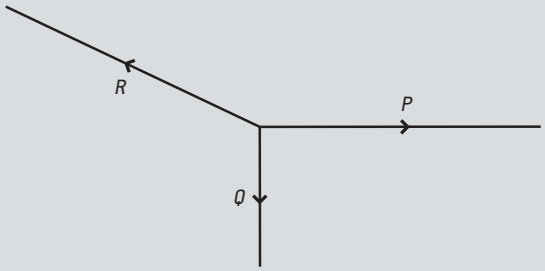
d) The uncertainty in the measurement of the radius of the thread is $\pm 0.1 \times 10^{-6}$ m. Determine the percentage uncertainty in the value of the area of the thread.

(9 marks)

12 A cyclist travels a distance of 1200 m due north before going 2000 m due east followed by 500 m south-west. Draw a scale diagram to calculate the cyclist's final displacement from her initial position.

(4 marks)

13 The diagram shows three forces *P*, *Q*, and *R* in equilibrium. *P* acts horizontally and *Q* vertically.



When $P = 5.0\,\text{N}$ and $Q = 3.0\,\text{N}$, calculate the magnitude and direction of *R*.

(3 marks)

14 A boat, starting on one bank of a river, heads due south with a speed of 1.5 m s^{-1}. The river flows due east at 0.8 m s^{-1}.

a) Calculate the resultant velocity of the boat relative to the bank of the river.

b) The river is 50 m wide. Calculate the displacement from its initial position when the boat reaches the opposite bank.

(7 marks)

15 A car of mass 850 kg rests on a slope at 25° to the horizontal. Calculate the magnitude of the component of the car's weight which acts parallel to the slope.

(3 marks)