1. Physical Quantities and Units

1.2 SI units

Paper 2

Question Paper

1 The drag force F_D acting on an object falling through air is given by

$$F_D = \frac{1}{2} C\rho A v^2$$

where A is the cross-sectional area of the object,
v is the velocity of the object in the air,
ρ is the density of the air and
C is a constant called the drag coefficient.

(a) Use SI base units to show that the drag coefficient has no units.

[3]

2 **(a)** The list below shows some SI quantities.

Underline the quantity that is **not** an SI base quantity.

charge current length time [1]

3 **(b)** A sphere falls vertically through a liquid that has density 830 kg m^{-3}. The sphere has radius r and constant velocity v, as shown in Fig. 1.1.

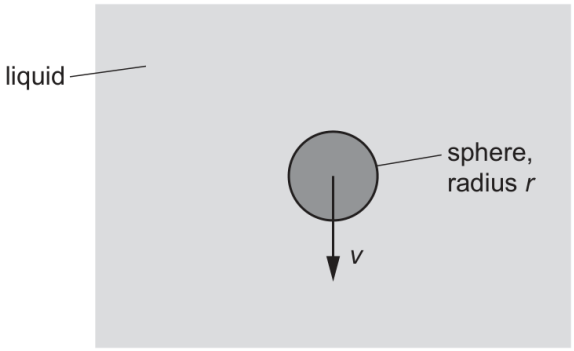


Fig. 1.1

(i) The drag force D acting on the sphere is given by

$$D = 6\pi r\eta v$$

where η is a property of the liquid.

Determine the SI base units of η.

SI base units ..... [3]

4 **(a)** **(ii)** Use the definition of power to show that the SI base units of power are $\text{kg m}^2\text{ s}^{-3}$.

[1]

(b) The intensity I of a sound wave moving through a gas is given by

$$I = f^2A^2vk$$

where f is the frequency of the wave,
A is the amplitude of the wave,
v is the speed of the wave
and k is a constant that depends on the gas.

Determine the SI base units of k.

SI base units ..... [3]

5 **(a)** **(ii)** Use the answer to **(a)(i)** to show that the SI base units of pressure are $\text{kg m}^{-1}\text{ s}^{-2}$.

[1]

(b) A horizontal pipe has length L and a circular cross-section of radius R. A liquid of density ρ flows through the pipe. The mass m of liquid flowing through the pipe in time t is given by

$$m = \frac{\pi(p_2 - p_1)R^4\rho t}{8kL}$$

where p_1 and p_2 are the pressures at the ends of the pipe and k is a constant.

Determine the SI base units of k.

SI base units ..... [3]

6 **(a)** In the following list, underline **all** quantities that are SI base quantities.

charge electric current force time [1]

7 **(a)** In the following list, underline all units that are SI base units.

ampere degree Celsius kilogram newton [1]

8 **(a)** The boxes in Fig. 1.1 contain terms on the left-hand side and examples of these terms on the right-hand side.

Draw a line between each term on the left and the correct example on the right.

base quantity	coulomb
base unit	electric current
derived quantity	force
derived unit	kilogram

Fig. 1.1

[2]

9 **(b)** Use the answer to **(a)** to determine the SI base units of power.

SI base units ..... [2]

10 **(c)** The density ρ of the rock from which the pebble in **(b)** is composed is given by

$$\rho = \frac{Mr^n}{kL}$$

where n is an integer and k is a constant, with no units, that is equal to 2.094.

(i) Use SI base units to show that n is equal to –2.

[2]

11 **(a)** A unit may be stated with a prefix that represents a power-of-ten multiple or submultiple.

Complete Table 1.1 to show the name and symbol of each prefix and the corresponding power-of-ten multiple or submultiple.

Table 1.1

prefix	power-of-ten multiple or submultiple
kilo (k)	10^3
tera (T)	
( )	10^{-12}

[2]

(b) In the following list, underline all the units that are SI base units.

ampere coulomb metre newton [1]

12 **(a)** Use an expression for work done, in terms of force, to show that the SI base units of energy are $\text{kg m}^2\text{ s}^{-2}$.

[2]

(b) **(i)** The energy E stored in an electrical component is given by

$$E = \frac{Q^2}{2C}$$

where Q is charge and C is a constant.

Use this equation and the information in **(a)** to determine the SI base units of C.

SI base units ..... [2]

13 (b) The drag force F_D acting on a car moving with speed v along a straight horizontal road is given by

$$F_D = v^2Ak$$

where k is a constant and A is the cross-sectional area of the car.

Determine the SI base units of k.

SI base units ..... [2]

14 (a) (ii) Determine the SI base units of the moment of a force.

base units ..... [1]

15 (b) The electric field strength E at a distance x from an isolated point charge Q is given by the equation

$$E = \frac{Q}{x^2 b}$$

where b is a constant.

(ii) Use the units for E given in **(b)(i)** to determine the SI base units of b.

SI base units of b ..... [2]

16 **(b)** State the SI base units of force.

.....[1]

(c) The force F between two point charges is given by

$$F = \frac{Q_1 Q_2}{4\pi r^2 \varepsilon}$$

where Q_1 and Q_2 are the charges,
r is the distance between the charges,
ε is a constant that depends on the medium between the charges.

Use the above expression to determine the base units of ε.

base units .....[2]

17 **(a)** The kilogram, metre and second are all SI base units.

State two other SI base units.

1. .....

2. .....
[2]