# Physical Quantities & Units

## Question paper 1

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|---|---|
| **Level** | International A Level |
| **Subject** | Physics |
| **Exam Board** | CIE |
| **Topic** | Physical Quantities & Units |
| **Sub Topic** | |
| **Paper Type** | Theory |
| **Booklet** | Question paper 1 |

**Time Allowed:** **90 minutes**

**Score:** **/75**

**Percentage:** **/100**

| A* | A | B | C | D | E | U |
|---|---|---|---|---|---|---|
| >85% | '77.5% | 70% | 62.5% | 57.5% | 45% | <45% |

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

[2]

**(b)** Use an expression for electrical power to determine the SI base units of potential difference.

units .....[2]

**2 ( a)** Use the definition of work done to show that the SI base units of energy are kg $m^2 s^{-2}$.

[2]

**(b)** Define potential difference.

.....

..... [1]

**(c)** Determine the SI base units of resistance. Show your working.

units ..... [3]

**3** **(a)** The distance between the Sun and the Earth is $1.5 \times 10^{11}$ m. State this distance in Gm.

distance = ..... Gm [1]

**(b)** The distance from the centre of the Earth to a satellite above the equator is 42.3 Mm. The radius of the Earth is 6380 km.
A microwave signal is sent from a point on the Earth directly below the satellite.

Calculate the time taken for the microwave signal to travel to the satellite and back.

time = ..... s [2]

**(c)** The speed $v$ of a sound wave through a gas of density $\rho$ and pressure $P$ is given by

$$v = \sqrt{\frac{CP}{\rho}}$$

where $C$ is a constant.

Show that $C$ has no unit.

[3]

**(d)** Underline all the scalar quantities in the list below.

acceleration energy momentum power weight [1]

**(e)** A boat travels across a river in which the water is moving at a speed of $1.8\,m\,s^{-1}$. The velocity vectors for the boat and the river water are shown to scale in Fig. 1.1.

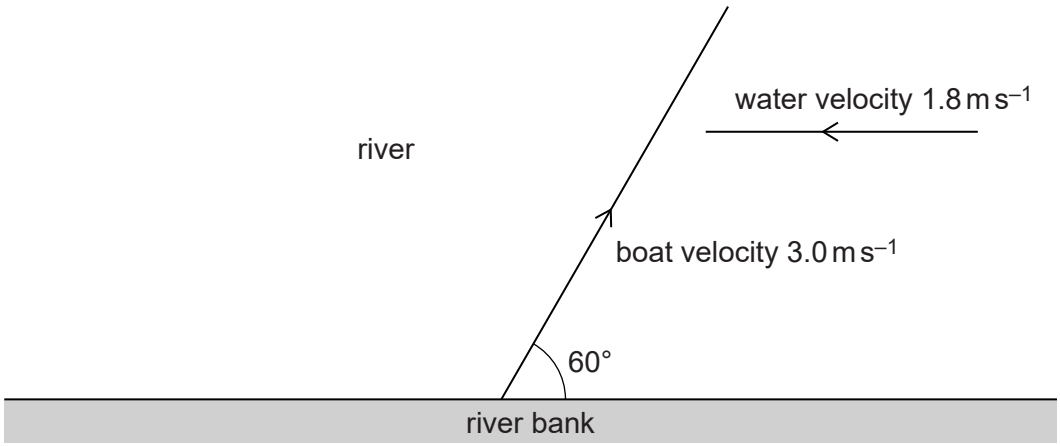


**Fig. 1.1** (shown to scale)

In still water the speed of the boat is $3.0\,m\,s^{-1}$. The boat is directed at an angle of 60° to the river bank.

**(i)** On Fig. 1.1, draw a vector triangle or a scale diagram to show the resultant velocity of the boat. [2]

**(ii)** Determine the magnitude of the resultant velocity of the boat.

resultant velocity = ..... $m\,s^{-1}$ [2]

**4** **(a)** Mass, length and time are SI base quantities.

State two other base quantities.

1. .....

2. .....

[2]

**(b)** A mass *m* is placed on the end of a spring that is hanging vertically, as shown in Fig. 1.1.

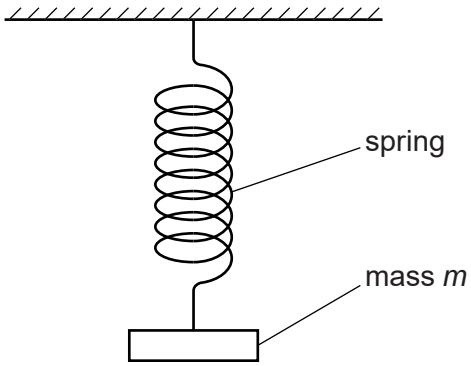


**Fig. 1.1**

The mass is made to oscillate vertically. The time period of the oscillations of the mass is *T*.

The period *T* is given by

$$T = C\sqrt{\frac{m}{k}}$$

where *C* is a constant and *k* is the spring constant.

Show that *C* has no units.

[3]

.

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

State two other base units.

1. .....

2. .....
[2]

**(b)** Determine the SI base units of

**(i)** stress,

SI base units .....[2]

**(ii)** the Young modulus.

SI base units .....[1]

**6** **(a)** Force is a vector quantity. State three other vector quantities.

1. .....

2. .....

3. .....

[2]

**(b)** Three coplanar forces *X*, *Y* and *Z* act on an object, as shown in Fig. 3.1.

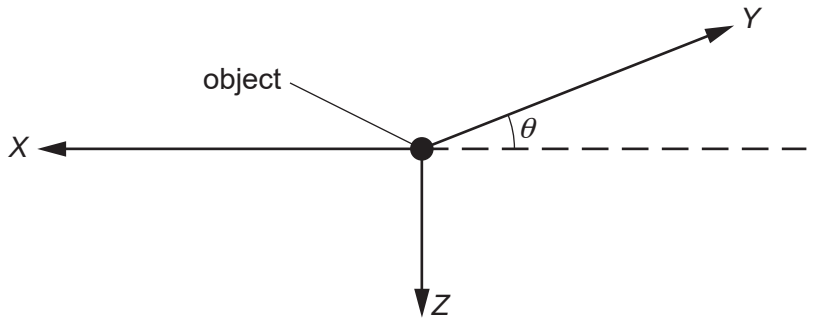


**Fig. 3.1**

The force *Z* is vertical and *X* is horizontal. The force *Y* is at an angle $\theta$ to the horizontal. The force *Z* is kept constant at 70 N.

In an experiment, the magnitude of force *X* is varied. The magnitude and direction of force *Y* are adjusted so that the object remains in equilibrium.

Fig. 3.2 shows the variation of the magnitude of force *Y* with the magnitude of force *X*.

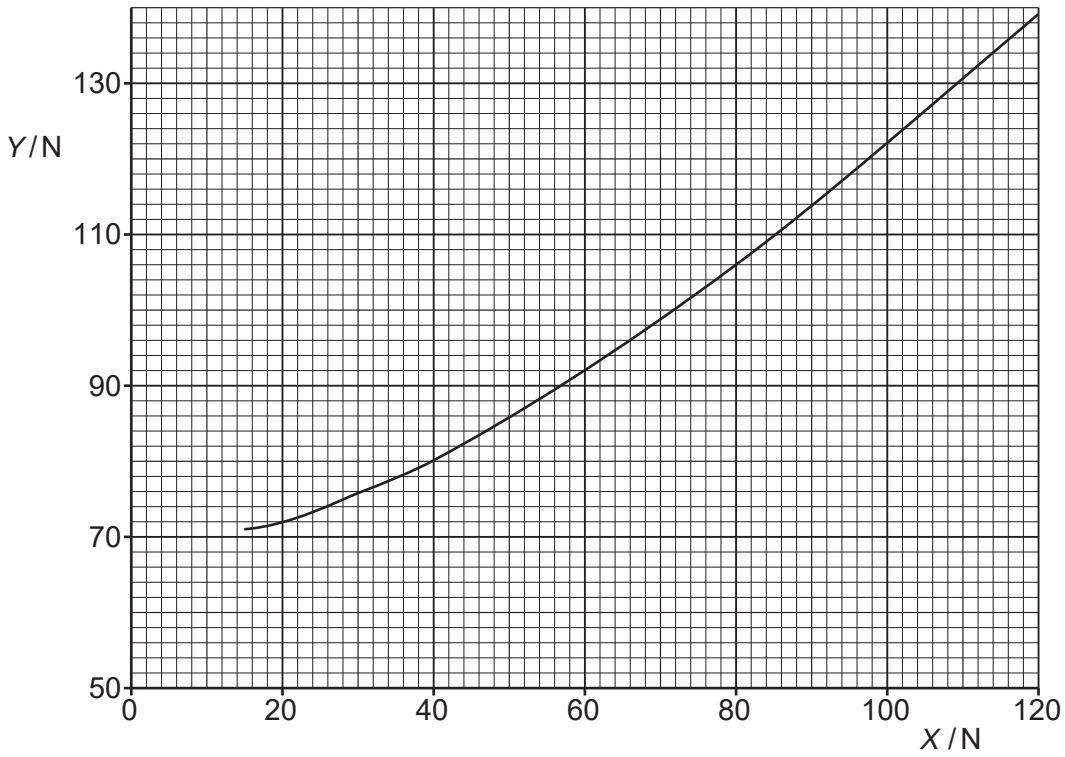


**Fig. 3.2**

**(i)** Use Fig. 3.2 to estimate the magnitude of $Y$ for $X = 0$.

$Y =$ ..... N [1]

**(ii)** State and explain the value of $\theta$ for $X = 0$.

.....

.....

.....[2]

**(iii)** The magnitude of $X$ is increased to 160 N. Use resolution of forces to calculate the value of

**1.** angle $\theta$,

$\theta =$ ..... ° [2]

**2.** the magnitude of force $Y$.

$Y =$ ..... N [2]

**(c)** The angle $\theta$ decreases as $X$ increases. Explain why the object cannot be in equilibrium for $\theta = 0$.

.....

.....

.....[1]

**7** **(a)** Show that the SI base units of power are kg $m^2 s^{-3}$.

[3]

**(b)** The rate of flow of thermal energy $\frac{Q}{t}$ in a material is given by

$$\frac{Q}{t} = \frac{CAT}{x}$$

where $A$ is the cross-sectional area of the material,
$T$ is the temperature difference across the thickness of the material,
$x$ is the thickness of the material,
$C$ is a constant.

Determine the SI base units of $C$.

base units ..... [4]

**8** **(a)** Underline **all** the base quantities in the following list.

ampere charge current mass second temperature weight

[2]

**(b)** The potential energy $E_P$ stored in a stretched wire is given by

$$E_P = \tfrac{1}{2}C\sigma^2V$$

where $C$ is a constant,
$\sigma$ is the strain,
$V$ is the volume of the wire.

Determine the SI base units of $C$.

base units .....[3]

**9** **(a)** State two SI base units other than the kilogram, metre and second.

1. .....

2. .....

[2]

**(b)** A metal wire has original length $l_0$. It is then suspended and hangs vertically as shown in Fig. 1.1.

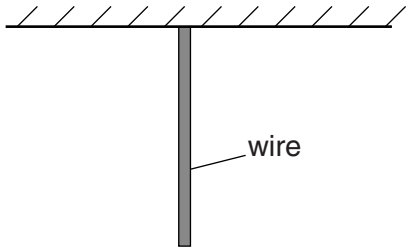


**Fig. 1.1**

The weight of the wire causes it to stretch. The elastic potential energy stored in the wire is *E*.

**(i)** Show that the SI base units of *E* are $\text{kg m}^2\text{ s}^{-2}$.

[2]

**(ii)** The elastic potential energy $E$ is given by

$$E = C\rho^2 g^2 A l_0^3$$

where $\rho$ is the density of the metal,
$g$ is the acceleration of free fall,
$A$ is the cross-sectional area of the wire
and $C$ is a constant.

Determine the SI base units of $C$.

SI base units of $C$ .....[3]

**10** A cylindrical disc is shown in Fig. 1.1.

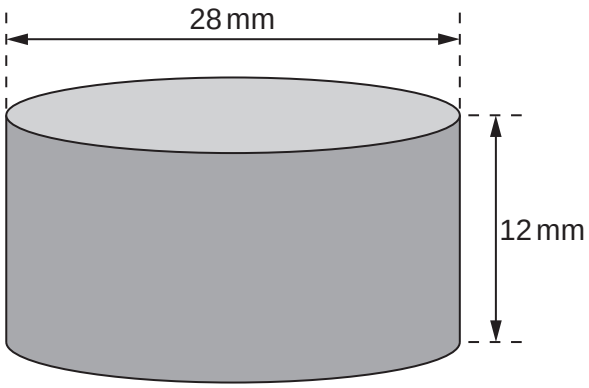


**Fig. 1.1**

The disc has diameter 28 mm and thickness 12 mm.
The material of the disc has density $6.8 \times 10^3$ kg m$^{-3}$.

Calculate, to two significant figures, the weight of the disc.

weight = ..... N [4]

**11** **(a)** Determine the SI base units of power.

SI base units of power ..... [3]

**(b)** Fig. 1.1 shows a turbine that is used to generate electrical power from the wind.

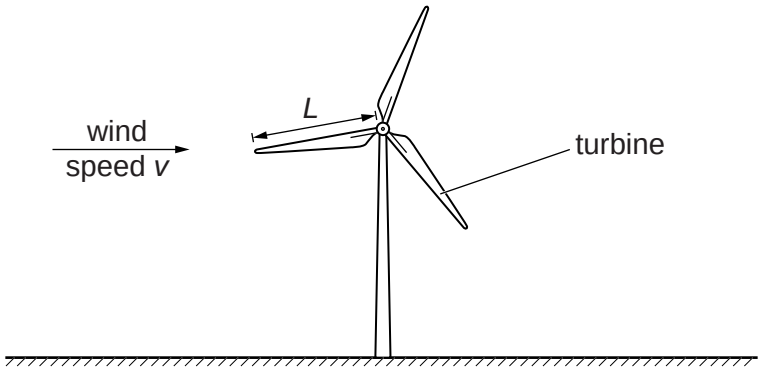


**Fig. 1.1**

The power *P* available from the wind is given by

$$P = CL^2\rho v^3$$

where $L$ is the length of each blade of the turbine,
$\rho$ is the density of air,
$v$ is the wind speed,
$C$ is a constant.

**(i)** Show that $C$ has no units.

[3]

**(ii)** The length $L$ of each blade of the turbine is 25.0 m and the density $\rho$ of air is 1.30 in SI units. The constant $C$ is 0.931.
The efficiency of the turbine is 55% and the electric power output $P$ is $3.50 \times 10^5$ W.

Calculate the wind speed.

wind speed = ..... $m\,s^{-1}$ [3]

**(iii)** Suggest two reasons why the electrical power output of the turbine is less than the power available from the wind.

1. .....

.....

2. .....

.....
[2]