Physical Quantities & Units
Question paper 1

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 × 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 ρ 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 $1.8\,\mathrm{m\,s^{-1}}$.
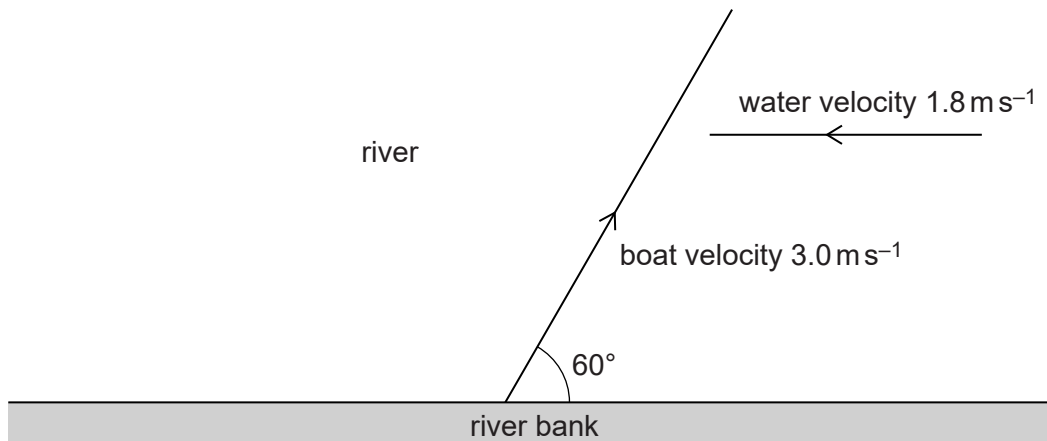The velocity vectors for the boat and the river water are shown to scale in Fig. 1.1.

water velocity $1.8\,\mathrm{m\,s^{-1}}$

river

boat velocity $3.0\,\mathrm{m\,s^{-1}}$

60°

river bank

Fig. 1.1 (shown to scale)

In still water the speed of the boat is $3.0\,\mathrm{m\,s^{-1}}$. 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 = ... $\mathrm{m\,s^{-1}}$ [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.
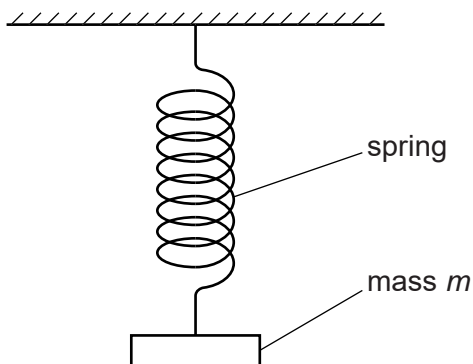

Fig. 1.1

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.

object

Y
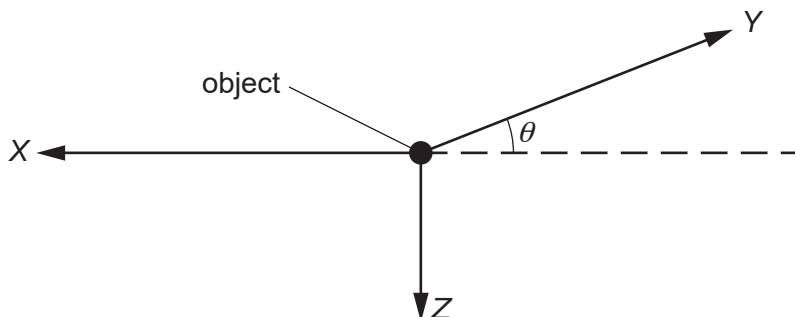
X

θ

Z

Fig. 3.1

The force Z is vertical and X is horizontal. The force Y is at an angle θ 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.
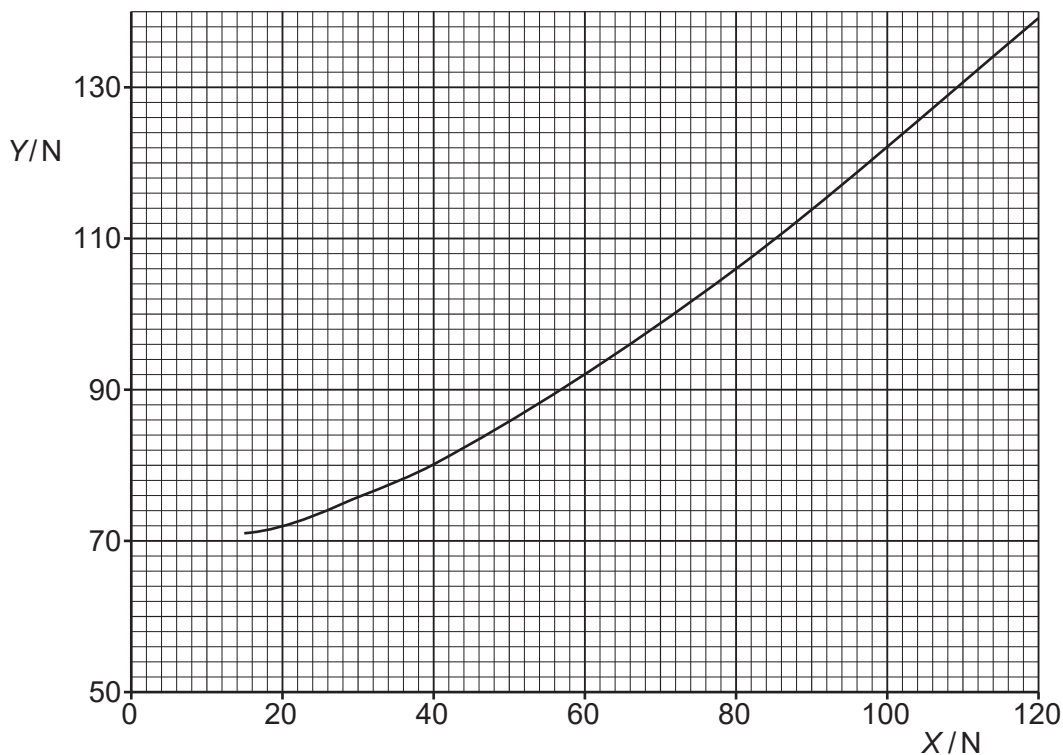
Y/N

130

110

90

70

50

0   20   40   60   80   100   120

X/N

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 *θ* 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 *θ*,

θ = ... ° [2]

2. the magnitude of force *Y*.

Y = ... N [2]

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

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

where C is a constant,
    σ 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.
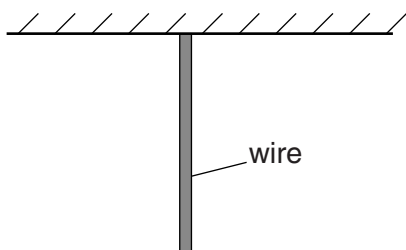
Fig. 1.1

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 $kg\,m^2\,s^{-2}$.

[2]

(ii) The elastic potential energy E is given by

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

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

Determine the SI base units of C.

SI base units of C ....[3]
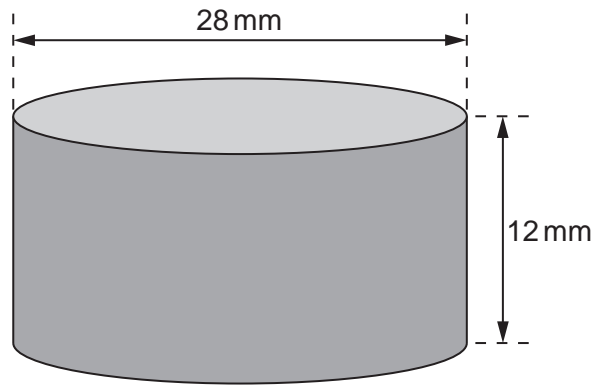
10 A cylindrical disc is shown in Fig. 1.1.

Fig. 1.1

The disc has diameter 28 mm and thickness 12 mm.
The material of the disc has density 6.8×10^3 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.
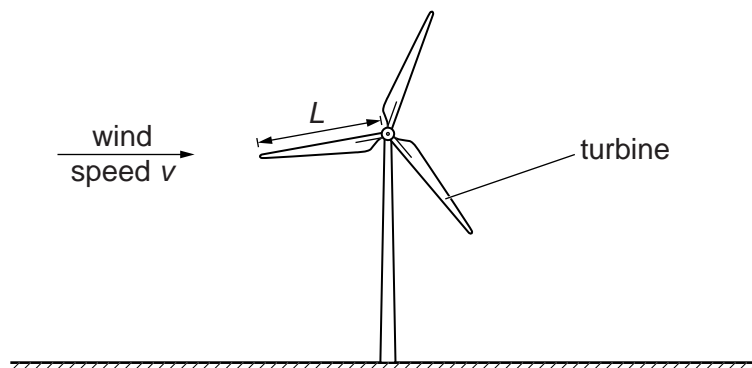

Fig. 1.1

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,
           ρ 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 ρ 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 3.50×10^5 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]