ASSIGNMENT 1

**Q1**

**(a).** State the SI base units of force.

**(b).**

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,
$\varepsilon$ is a constant that depends on the medium between the charges.

Use the above expression to determine the base units of $\varepsilon$.

**Q2**

**(a).** State the base units in which density is measured.

**(b)** The speed $v$ of sound in a gas is given by the expression

$$v = \sqrt{\left(\frac{\gamma p}{\rho}\right)},$$

where $p$ is the pressure of the gas of density $\rho$. $\gamma$ is a constant.

Given that $p$ has the base units of $\mathrm{kg\,m^{-1}\,s^{-2}}$, show that the constant $\gamma$ has no unit.

**Q3**

**(a)** The current in a wire is $I$. Charge $Q$ passes one point in the wire in time $t$. State

**(i)** the relation between $I$, $Q$ and $t$,

**(ii)** which of the quantities $I$, $Q$ and $t$ are base quantities.

**(b)** The current in the wire is due to electrons, each with charge $q$, that move with speed $v$ along the wire. There are $n$ of these electrons per unit volume.
For a wire having a cross-sectional area $S$, the current $I$ is given by the equation

$$I = nSqv^k,$$

where $k$ is a constant.

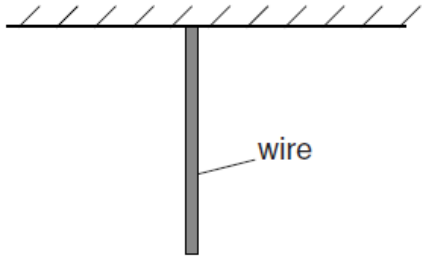
**(i)** State the units of $I$, $n$, $S$, $q$ and $v$ in terms of the base units.

**(ii)** By considering the homogeneity of the equation, determine the value of $k$.

**Q4**

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

**(b)** A metal wire has original length $l_0$. It is then suspended and hangs vertically as shown in 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 $\text{kg m}^2\text{ s}^{-2}$.

**(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 $C$.