**P.36 (15 – 21)**

15. (a) (i) A systematic error is a constant deviation of the readings in one direction from the true value. It is usually caused by instruments or mistakes made by the observer.

(ii) A random error is a scatter of readings about a mean value. It is not predictable but can be revealed by repeated measurements.

(b) (i) Due to limited sensitivity of the meter, the meter reading would not be constant but scattered about a mean.

This can be kept minimum by repeating the readings using the same meter and using the mean of the readings.

(ii) If the resistance of the meter is not large enough, it will draw a current. Therefore, the current in the circuit would be higher than its true value without using the meter.

(c) (i) $R = \frac{V}{I} = \frac{1.30}{0.76} = 1.7105$

% error in V = $\frac{0.01}{1.30}$ x100% = 0.77%

% error in I = $\frac{0.01}{0.76}$ x100% = 1.32%

% error in R = % error in V + % error in I = 2.1%

error in R = 1.7105x 2.1% = 0.04

R = $(1.71 \pm 0.04)\ \Omega$

(ii) resistivity $\rho = \frac{RA}{l} = \frac{1.71\left[\pi\left(0.54\text{x}10^{-3}\right)^2\right]/4}{75.4\text{x}10^{-2}} = 5.194\text{x}10^{-7}\ \Omega m$

% error in R = 2.1%

% error in d = $\frac{0.02}{0.54}$ x100% = 3.7%

% error in $l$ = $\frac{0.2}{75.4}$ x100% = 0.27%

% error in $\rho$ = % error in R + 2 x % error in d + % error in $l$

= 2.1% + 2 x 3.7% + 0.27% = 10%

error in $\rho$ = 5.194 x $10^{-7}$ x 10% = 0.5 x $10^{-7}$

$\rho$ = (5.2±0.5) x $10^{-7}\ \Omega$m

(d) This reduce the effect of random errors as the resistance is not calculated from a single reading. The plotted line also helps to check for "poor" readings to be excluded and identify systematic errors (eg. From intercept) to avoid it.

16. (a) ampere, mole

(b) It is called derived unit because energy can be expressed in terms of the basic units (kg $m^2$ $s^{-2}$).

(c) (i) 1. density $\rho = \dfrac{\text{mass}}{\text{volume}}$

base units of density $\rho = \dfrac{kg}{m^3} = kgm^{-3}$.

2. Pressure $= \dfrac{\text{Force}}{\text{Area}}$

base units of pressure $= \dfrac{kgms^{-2}}{m^2} = kgm^{-1}s^{-2}$.

(ii) unit of c $= \left(\dfrac{kgm^{-1}s^{-2}}{kgm^{-3}}\right)^{\frac{1}{2}} = ms^{-1}$

(iii) c may represent speed of sound in a gas as it has the unit of speed.

17.

| Prefix | Decimal equivalent |
|---|---|
| pico | $10^{-12}$ |
| micro | $10^{-6}$ |
| giga | $10^{9}$ |
| tera | $10^{12}$ |

18. (a) It introduces a systematic error. It is because it produces a constant deviation of the readings in one direction from the true value.

(b) The reading is precise because repeated reading can be close to each other.
The reading is not accurate because their mean is not close to the true value.

19. (a) 0.2kg

(b) 1000 x (60 x 60) = 3,600,000J

(c) 7 x $10^{-7}$m

(d) P = ρ g h = 1000 x 10 x 10 = $10^5$Pa

20.

| Quantity | Unit |
|---|---|
| Speed | $ms^{-1}$ |
| Density | kg $m^{-3}$ |
| Frequency | $s^{-1}$ |
| Electric field strength | N $C^{-1}$ |
| Momentum | Kg $ms^{-1}$ |

21. (a) mass, temperature rise

(b) (i) units of thermal energy = J = Nm = kg $ms^{-2}$ m = kg $m^2s^{-2}$

(ii) units of c $= \dfrac{\text{units of thermal energy}}{\text{unit of mass x unit of temperature}} = \dfrac{kgm^2s^{-2}}{kg \text{ x K}} = m^2s^{-2}K^{-1}$