• Homogeneity of a Physical Equation

- An equation is said to be homogeneous if base units on L.H.S are identical to the base unit on the R.H.S (for eq.)

- For any equation to be classified as a correct Equation, it must satisfy the test of homogeneity.

(1) $d = s \times t$

$m = (ms^{-1}) \times (s)$

$m = m$ [homogeneous]

(2) $v = f\lambda$

$ms^{-1} = (s^{-1})(m)$

$ms^{-1} = ms^{-1}$

(3) $P = \rho \cdot g \cdot h$

$kg\,m^{-1}s^{-2} = (kg\,m^{-3})(ms^{-2})(m)$

$kg\,m^{-1}s^{-2} = kg\,m^{-1}s^{-2}$ [homogeneous]

(4) $v = u + at$

If an eq. contains more than one term on any one side, than to check for homogeneity, firstly break down the equation.

- Compare v with u

ms^{-1} ms^{-1}

- compare v with at

ms^{-1} $(ms^{-2})(s)$

ms^{-1}

Hence now the equation can be classified as a correct eq/ homogeneous Eq

Q: In the following example suggest which equation is correct / homogeneous?

E = Energy
m = mass
V = velocity
f = freq
g = acc. of free fall
λ = wavelength

(1) $E = mv$

$kg\,m^2s^{-2} = (kg)(ms^{-1})$

not homogeneous

(2) $v = fg$

$ms^{-1} = (s^{-1})(ms^{-2})$

$= ms^{-3}$

not homogeneous

(3) $E = \frac{1}{2} f v^3$

$kg\,m^2s^{-2} = (s^{-1})(ms^{-1})^3$

not homogenous

(4) $v = \sqrt{g\lambda}$ [correct / homogeneous]

$ms^{-1} = \sqrt{(ms^{-2})(m)}$

$= \sqrt{m^2s^{-2}}$

$ms^{-1} = ms^{-1}$

Ques: Given that the equation shown below is homogeneous, use this information to find the base units of P and Q?

$$3\left(L + \frac{a^2}{P}\right) = QT^2\sin\theta$$

L = Length a = radius T = time

Simplify

$$3L + \frac{3a^2}{P} = QT^2\sin\theta$$

3L compares with $QT^2\sin\theta$

$m = Q\,s^2$ ignore (no units)

$Q = ms^{-2}$ Answer

$\frac{3a^2}{P}$ compares with $QT^2\sin\theta$ ignore

$\frac{m^2}{P} = (ms^{-2})(s^2)$

Cross multiply P on the other side to get

$P = m$ Answer