UTME PHYSICS

CHAPTER 1: UNIT AND DIMENSSIONS

In this chapter, we will be treating all the UTME questions on units and dimensions plus the exam possible questions.

LET'S START THE CLASS

Unit can be expressed in two ways:

I. Name method
II. Formula method

LETS UNDERSTAND THIS ONE BY ONE

Name method: using the name of the discoverer to express a unit is known as Name Method.
For example; Force as Newton's, Pressure as Pascal, Workdone as Jonles etc.

Listen lets discuss here

There is a limitation when it comes to Name method of expressing units, so the limitation introduces us to Formula method.

FORMULA METHOD
Using formulas to express units is known as formula method. This is the best method we use in expressing units in any level.

Key point: to express any unit using formula method, the formula must be known.

STEPS IN CALCULATING UNITS USING FORMULA METHOD.
Step 1: Know the formula of the quantity.
Step 2: Reduce the formula to its fundamental quantity and simplify.

***Don't be confused let's break down the topic here;***

The Familiar Formulas you must know in physics:

QUANTITIES & FORMULAS

| Quantities | Formula |
|---|---|
| Speed | $\frac{\text{Distance}}{\text{Time}}$ |
| Velocity | $\frac{\text{Displacement}}{\text{Time}}$ |
| Acceleration | $\frac{\text{Velocity}}{\text{Time}}$ |
| Force | Mass X Acceleration |
| Moment (M) | Force X Distance |
| Impulse (I) | Force X Time |
| Gravitational constant (G) | $G = \frac{FR^2}{M_1M_2}$ |
| Gravitational Force ($F_G$) | $F_a = \frac{Gm_1m_2}{R^2}$ |
| Surface Tension (r) | $r = \frac{\text{Force}}{\text{Length}}$ |
| Coefficient of Viscosity ($\eta$) | $\eta = \frac{\text{Force}}{\text{Area X Velocity Dradient}}$ |

Before we solve an example lets explain what fundamental quantities are.

***Let's Go Here***

Fundamental Quantities and units:

| Fundamental Quantities | Units |
|---|---|
| Mass | Kg |
| Length | M |
| Time | S |

**N/B:** To finally express any formula in the unit, it must be reduced to its fundamental quantity. It can either be mass or length of time.
Understand this, any formula that is not of mass of length should be under time, and any formula that is not length and time should be under mass etc.

***Example 1:*** Find the unit of velocity.

***Solution.***

Step 1: Write down the formula of velocity

$$\text{Vel} = \frac{\text{Displacement}}{\text{Time}}$$

Step 2: Reduce the formula to its fundamental quantity and express the unit.

Vel = M/s

**N/B:** $1/x = X^{-1}$

Simplifying the above expression in linear

$1/X^2 = X^{-2}$

Vel = M X 1/s

From the law of indices whenever we take any letter/number from numerator to denominator or from denominator to numerator the power changes.

So, Vel. = M X $1/S^1$ = M X $S^{-1}$ = $MS^{-1}$

***Example 2:*** Find the unit of Acceleration

***Solution***.

Let's write down the formula of Acceleration.

$$\text{Acceleration} = \frac{\text{Velocity}}{\text{Time}}$$

Replace the unit of Vel. = $MS^{-1}$

We have; Acceleration $= \frac{MS^{-1}}{S}$

Making the above expression linear;

Acceleration = $ms^{-1}. s^{-1}$

= $ms^{-2}$

***Example 3:*** Find the unit of force

***Solution.***

Let's write down the formula

Force = Mass X Acceleration

Substitute respectively

Force = Kg X $MS^{-2}$

= kg $MS^{-2}$

**ADVANCED EXAMPLES IN UNITS (UTME PHYSICS)**

***Example:*** find the unit of gravitational constant (G)

***Solution.***

Gravitational constant (G) can be gotten from Gravitational force. i.e;

$$F_G = \frac{GM_1M_2}{R^2} \longrightarrow (1)$$

Where $F_G$ = Force, G = Gravitational constant

$M_1$ = Mass – 1, $M_2$ = Mass -2, R = Radius.

Making G the subject from equation (1)

We have; $G = \frac{FR2}{M_1M_2}$

We cross multiplied then made G the Subject.

Reducing the above formula to its fundamental quantity and express their units.

F = Kg $MS^{-2}$, $R^2 = (m)^2$, $M_1M_2$ = kg X kg

Substitute into equation (2) i.e.;

$$G = \frac{Kgms^{-2} \text{ X } (m^2)}{Kg \text{ X } kg}$$

$$G = \frac{m^3 s^{-2}}{Kg}$$ (making this linear)

$G = kg^{-1}m^3s^{-2}$

**N/B;** We placed $kg^{-1}$ at the first position because we always arrange the units according to the fundamental quantity. i.e. Kg comes before meter, meter comes before second.

## EXAM POSSIBLE QUESTIONS ON UNITS (UTME PHYSICS)

1. Which of the following is the unit of

(A). $NS\text{-}M^2$ (B). $NS\text{-}M^2$ (C) $NS^{-1}$ (D) $NS^2 - M^2$

***Solution.***

Remember our step in using formula method in expressing unit.

Write down the formula of Viscosity

$$\text{Viscosity } (\eta) = \frac{\text{Force}}{\text{Vel. Dradient}} \qquad \text{Equation (1)}$$

**N/B:** Force = $Kgms^{-2}$, Area = $M^2$
Vel. gradient = $\frac{m/s}{Length}$

**N/B:** whenever the word gradient is attached to any quantity, it means that the quantity will be divided by length. Like pressure gradient will be;

$$\text{Pressure} = \frac{\text{force}}{\text{Area/Length}}$$

$$\text{So, vel. Gradient} = \frac{\text{Displacement}}{\text{Time/Length}}$$

***LET'S GO HERE***

Vel. Gradient = $ms^{-1} = s^{-1}$

$$\frac{}{M}$$

Replace all the units into equation (1)

Viscosity ($\eta$) $= \frac{kgms^{-2}}{Ms^{-1}}$

Making the expression linear i.e

$\eta = kgm^{-1} s^{-2} \text{ X } s^{1}$
$= kgm\text{-}1\ s^{-2+1}$

$\eta = kgm^{-1}s^{-1}$ or $\eta = \frac{F}{A \text{ X } V_g}$

$= \frac{N}{M^2 \text{ X } S^{-1}}$

$\eta = Nm^{-2}S$

***Answer (B)*** $Nm^{-2}S$

2. Find the units of power

***Solution:***

Power $= \frac{\text{workdone}}{\text{Time}}$

$= \frac{F \text{ X } D}{\text{Time}} = \frac{kgms^{-2} \text{ X } m}{S}$

Power $= kgm^2 s^{-2} \text{ X } s^{-1}$
$= kgm^2 s^{-3}$

# DIMENSIONS (UTME PHYSICS)

Dimension can be defined as expressing the fundamental quantities in their initial letters. For instance, mass as M, length as L and Time as T

Let us look into the chart of fundamental quantity units and dimension to understand this topic properly;

| Fundamental Qty | Unit | Dimension |
|---|---|---|
| Mass | Kg | M |
| Length | M | L |
| Time | S | T |

***KEYPOINT:*** To calculate any dimension, the unit must be known.

For us to find any dimension, we must find the units then we can represent the Dimension.

***Example 1:*** find the dimension of power:

***Solution:***
From the previous solution, we got the unit of power = $kgm^2s^{-3}$

Remember:

| Fund. Qty. | Unit | Dimension |
|---|---|---|
| Mass | kg | M |
| Length | M | L |
| Time | S | T |

So kg will be replaced by L and S by T

***LET'S GO HERE***

Power = $ML^3T^{-3}$

***Example 2:*** Find the dimension of young modulus.

Step 1: find the units of the quantity
Step 2: replace the corresponding dimension.

Let's find the unit of Young Modulus

$$\text{Young Modulus (E)} = \frac{\text{Tensile Stress}}{\text{Tensile strain}}$$

$$\text{Where Tensile Stress} = \frac{\text{force}}{\text{Area}}$$

$$\text{Tensile strain} = \frac{\text{extension}}{\text{Length}}$$

$$\text{Young modulus (E)} = \frac{\text{Force/Area}}{\text{Extension/length}}$$

**N/B:** Force = $kgms^{-2}$, Area = $ms^2$, extension = m and length = m

$$E = \frac{Kgms^{-2}/m^2}{m/m}$$