FUNDAMENTALS OF MOTION

Many scientists have studied motion and its properties because of its importance to life. The Italian, Galileo Galilei, who lived from 1564 to 1642, did the first systematic study of motion. The science of the study of motion done by Galileo is known as kinematics. Isaac Newton was another scientist who did detailed work on the study of motion.

Motion involves a change of position of a body with time. It also involves how things move and what makes them to move. Kinematics is the description of how objects move without regard to forces causing their motion, and dynamics deals with why objects move as they do.

TYPES OF MOTION

There are four basic – types of motion. There are as follows.

1. TRANSLATIONAL MOTION: When a body moves from a point A, along the line AB to another point B (see Fig. 4.1), we say that the body is translated from A to B, and the motion performed is known as translational motion. For example, when an aeroplane flies from Abuja to Lagos or a car traveling from Lagos to Enugu

A B

Fig. 4.1 A horizontal line

2. OSCILLATORY MOTION: In this type of motion, a body moves to and fro, about a fixed point. Examples are the vibration of a plucked guitar string, the motion of a pendulum as it swings back and forth, the vibration of the molecules of a solid.

3. RANDOM MOTION: In this type of motion, the body moves in zigzag direction continuously so that they do not trace definite path. This type of motion is exhibited by molecules in gases. Other examples of random motion is the Brownian motion – an irregular motion of particles of various kinds suspended in water or smoke particles suspended in air e.t.c.

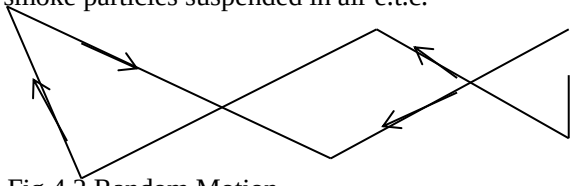

Fig 4.2 Random Motion

4. ROTATIONAL MOTION: This is the motion of a body which travels in a circle or ellipse and rotates about an axis. Examples are (i) the rotation of the earth about its axis (ii) the rotation of blades of an electric fan about its axis (iii) the rotation of a tap about a central axis.

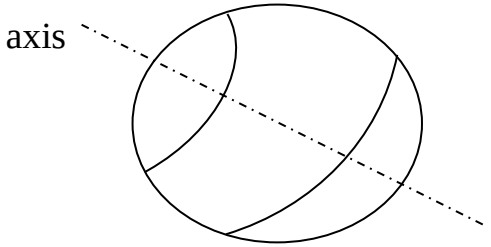

Fig. 4.3 The earth rotating on its axis

RELATIVE MOTION

If two bodies, A and B are moving on a straight line, the velocity of A relative to B is found by adding the Velocity of B revered to the velocity of A. For instance, if a car traveling on a straight road at 100km/hr passes a bus going in the same direction at 60km/hr, the velocity of the car relative to the bus is (-60+100) = 40km/hr. If the car and the bus are traveling in opposite direction with the same velocities of 100km/r and 60km/hr respectively, the velocity of the car relative to the bus is (-(-60) + 100) = (60 +100) = 160 km/hr.

NB: When the velocities are not in the same straight line, the parallelograms law should be used to add this since velocities are vectors, and their magnitudes and direction must be taken into consideration.

CAUSES OF MOTION

We have been describing the motion of a body without regard to what causes the motion. A block of wood resting on a table will remain at rest until it is pushed or pulled by an agent. Such an agent that change or tends to change the state of rest or uniform motion in a straight line of a body is called **force**.

TYPES OF FORCE

There are two main types of forces, contact force and force field.

1. CONTACT FORCE: This may be regarded as a force which exists between surfaces in contact. It includes pushing and pulling forces, frictional forces, reaction and tension forces in strings and wires.
2. FORCE FIELDS: These are force whose sources do not require contact with the body to which they are applied. Examples are gravitational force, electrostatic and magnetic forces

ASSIGNMENT 1

1. Explain the types of motion.
2. Differentiate between contact & field force.

SIMPLE IDEA OF CIRCULAR MOTION

An object moving with a constant speed along a circular path is said to have a uniform circular motion. Examples are the moon circling the earth, the planets moving round the sun, earth moving round the sun, stone tied to a string which is whirled in a horizontal vertical circle.

Circular motion has three characteristics:

(1) constant speed (2) changing or variable velocity (3) centripetal acceleration.

The acceleration that is directed towards the centre of the circular path is known as centripetal acceleration. Its magnitude a is given by $a = \frac{V^2}{r}$

Where V is the uniform speed and r is the radius of the circular path.

Centripetal force F_T is defined as that inward force required to keep an object moving with a constant speed in a circular path

The centripetal force is given by $F_T = \frac{mv^2}{r}$ where m is the mass of the object moving with a uniform velocity v in a circular path or radius r.

Centrifugal force: The centrifugal force is the reaction force that tends to move a body away from the centre. In other words, it acts in opposite direction to the centripetal force $\left(\frac{-mv^2}{r}\right)$

Centrifuge: A centrifuge is a device used to separate particles in suspension from the liquid in which they are contained.

ASSIGNMENT 2

1. Differentiate between centripetal & centrifugal force.
2. A stone tied to a string is made to revolve in a horizontal circle of radius 4m with an angular speed of 2 rad/s. With what is tangential velocity will the stone move off the circle if the string cuts?