**PHYSICS SS 1**

**THIRD TERM**

**SCHEME OF WORK**

**WEEKS TOPICS**

1. Introduction to Physics; Familiarization of Physics Laboratory
2. Measurement of Mass, Weight, Length and Time;

3. Motion in Nature, Force, Circular Motion, Centripetal and Centrifugal Forces 4. Frictions

1. Vector and Scalar Quantity, Distance/Displacement, Speed/Velocity, Acceleration,Distance/Displacement-Time Graph, Speed/Velocity-Time Graph, equations of uniformly acceleration
2. Calculations on velocity-time graph.
3. Density and Relative Density
4. Upthrust, Archimedes Principle, Law of floatation, Pressure
5. Work, Energy and power. Work Done in a Force Field, Types of Energy andEnergy Conversion.
6. Viscosity11. Revision

**WEEK ONE**

# TOPIC: INTRODUCTION TO PHYSICS

**CONTENT**

**MEANING OF PHYSICS**

**FUNDAMENTAL QUANTITIES AND UNITS**

**DIMENSIONS OF PHYSICAL QUANTITIES**

## MEANING OF PHYSICS

Physics is the scientific study of matter and energy and how they interact with each other. This energy can take the form of motion, light, electricity, radiation, gravity etc. Physics deals with matter on scales ranging from sub-atomic particles (i.e. the particles that make up the atom and the particles that make up those particles) to stars and even the entire galaxies. It can also be defined as a natural science that involves the study of matter and its motion through space-time, as well as all applicable concepts, such as energy and force. More broadly, it is the general analysis of nature, conducted in order to understand how the universe behaves.

Physics is one of the oldest academic disciplines, perhaps the oldest through its inclusion of astronomy. Over the last two millennia, Physics had been considered synonymous with Philosophy, Chemistry, and certain branches of Mathematics and Biology, but during the scientific revolution in the 16th century, it emerged to become a unique modern science in its own right. However, in some subject areas such as in mathematical physics and quantum chemistry, the boundaries of physics remain difficult to distinguish.

Physics is both significant and influential, in part because advances in its understanding have often translated into new technologies, but also because new ideas in Physics often resonate with other sciences, Mathematics, and Philosophy. For example, advances in the understanding of electromagnetism or Nuclear physics led directly to the development of new products which have dramatically transformed modern-day society, such as television, computers, domestic appliances, and nuclear weapons; advances in thermodynamics led to the development of motorized transport; and advances in mechanics inspired the development of calculus.

In order to understand clearly the fundamental concepts, Physics is divided into two main branches:

Classical Physics – This consists of the following: mechanics, heat, optics, wave and sound, electricity and magnetism.

Modern Physics – This covers the aspects of matter energy and their relations at atomic and sub-atomic levels.

Other fields of Physics are: Geophysics, Astrophysics, Bio-physics, Nuclear physics, Engineering physics etc.

**EVALUATION**

1. What do you understand by the term “Physics’’?
2. State the step involved in scientific method?

## FUNDAMENTAL QUANTITIES AND UNIT

Measurements play an important role in Physics. A unit has to be defined before any kind of measurement can be made. Different systems of units have been used in the past. These include the foot – pound – second (FPS) system, the centimetre – gramme – second (CGS) system, and the metre – kilogramme – second (MKS) system. The new system which has now gained universal acceptance is the systeme international d’units, usually called S.I. units.

Physical quantities are often divided into fundamental quantities and derived quantities.

**FUNDAMENTAL QUANTITIES:**

These are the basic quantities that are independent of others and cannot be defined in terms of other quantities.

They are the basic quantities upon which most (though not all) quantities depend.

## FUNDAMENTAL UNITS

These are the basic unit upon which other units depend. They are the units of the fundamental quantities.

The three most important basic quantities in Physics are length, mass and time.

**Length** may be defined as the extent of space or distance extended.

**Mass** is commonly defined as the quantity of matter or material in the body.

**Time** is defined as that in which events are distinguishable with reference to before or after. Examples of fundamental quantities and their units are shown below:

## Table 2.0 Fundamental Quantities and Units

Quantity Unit Unit – abbreviation

|  |  |  |
| --- | --- | --- |
| Length | Metre | M |
| Time | Second | S |
| Mass | Kilogram | Kg |
| Electric current | Ampere | A |
| Temperature | Kelvin | K |
| Amount of substance | Mole | mol |

Luminous intensity Candela Cd

## DERIVED QUANTITIES AND UNITS

Derived quantities and units are those obtained by some simple combination of the fundamental quantities and units. They are dependent on the fundamental quantities and units. Some examples of derived quantities and units are shown below:

**Table 2.1 derived quantities and units**

**Derived Quantity Derivation Derived unit**

|  |  |  |
| --- | --- | --- |
| Area (A) | Length × breadth | m2 |
| Volume (V) | Length × breath × height | m3 |
| Density |  | Kg.m-3 |
| Velocity (V) |  | m.s-1 |
| Acceleration (a) |  | m.s-2 |

Force (F) Mass × acceleration Newton (N)

The unit of volume is obtained by multiplying three lengths m x m x m = m3 pronounced ‘CUBE METRE” or “METRE CUBED”. Density is the ratio of mass and volume therefore the unit of density is kg/m3 or kgm-3 pronounced “KILOGRAMME PER METRE CUBED.”

## Difference between Fundamental and Derived Units

Fundamental Units Derived Units

|  |  |
| --- | --- |
| 1. They are standard units of measurement | They are not standard units of measurement |
| 2. They are generally accepted all over the world | Not all are generally accepted all over the world |
| 3. They form the basis of measurement | They are not the basis of measurement |
| 4. They are accepted by international organisations | Though accepted internationally, they are formulated by individuals |

5. They are known as S.I. units, i.e. They are known as units international system

## Difference between Fundamental and Derived Quantities

Fundamental Quantities Derived Quantities

|  |  |
| --- | --- |
| 1. They are generally accepted | They are just accepted |
| 2. They are based on international system | They are formulated from international system |
| 3. They can stand alone | They cannot stand alone |
| 4. They have direct calculations | Their calculations are derived |

5. They are basic units of measurement They are not basic units of measurement

## DIMENSIONS OF PHYSICAL QUANTITIES

The dimension of a physical quantity is the way it is related to the quantities of mass, length and time. The dimension of unit mass is M, for unit length, L and for unit time T. see the table below:

**Table 2.2**

**Quantity Unit Dimension**

|  |  |  |
| --- | --- | --- |
| Mass | Kilogramme, kg | M |
| Length | Metre, m | L |

Time T

## DIMENSION ANALYSIS OF SOME PHYSICAL QUANTITIES

1. Density: This is mass per unit volume

The dimensional equation of density =

=

Velocity: This is the rate of change of displacement with time.

Velocity =

=

Acceleration: This is the rate of change of velocity with time.

Acceleration =

=

Force: This is the product of mass and acceleration.

= Dimension of mass x Dimension of acceleration

= kg × ms-2

= m × LT-2

= MLT-2

Below is a table of a few important physical quantities and their dimensions:

**Table 2.3**

**Physical Quantity Units Dimensions**

|  |  |  |
| --- | --- | --- |
| Velocity | ms-1 | LT-1 |
| Acceleration | ms-2 | LT-2 |
| Force | N(ma) | MLT-2 |
| Momentum | kgms-1 | MLT-1 |
| Density | kgm-3 | ML-3 |

Pressure Nm-2 ML-1 T-2

**EVALUATION**

1. State the dimension of the following quantities;

(a) Acceleration (b) pressure (c) density

2 From the following quantities given below, list out the derived and fundamental quantities in a tabular form: Velocity, mass, weight, length, volume, density, torque, speed, acceleration, power, energy, temperature, heat capacity, electric current, relative density

**WEEKEND ASSIGNMENT**

1. Which of the units of the following physical quantities is not derived unit?

(a) Area (b) Thrust (c) Pressure (d) Mass

1. Which of the following is a fundamental unit? (a) Kgm−3 (b) m3 (c) Nm−2 (d) Kg
2. Which of the following quantities has the same unit as energy? (a) Power (b) Work (c) Force (d) Momentum
3. Which of the following is a derived unit?
   1. Ampere (b) Kilogramme (c) Second (d) Ohm
4. Which of the following is a derived unit?
   1. Tension (b) Impulse (c) Upthrust (d) Distance
5. The international agreed system of unit (S.I.) for physical measurement are
   1. lb, ft, sec (b) g, m, sec (c) kg, m, sec (d) cm, g, sec
6. Which of the units of the following physical quantities are derived?

I. Area; II. Thrust; III. Pressure; IV. Mass

* 1. I, II, III and IV (b) I, II and III only (c) I, II and IV only (d) I and IVonly

**THEORY**

1. State the dimension of the following;

(a) stress(Force/Area) (b) Energy(force x perpendicular distance)

(c) Momentum (mass x velocity)

2 Determine the dimension of the following physical quantities.

(a) Impulse (b) potential energy (c) pressure (d) young’s modulus

3 At what respective value of a, b, and c would the unit of impulse be dimensionally equivalent to MaLbTc?

4. The dimension of pressure is given as MxLyTz, deduce the values of x, y, and z. (Hint: Pressure= Force/Area, the unit is Nm-2)

**WEEK TWO**

# TOPIC: MEASUREMENT OF MASS, WEIGHT, LENGTH & TIME

**CONTENT**

Measurement of Length Measurement of Time

Measurement of Mass

Measurement of Volume

## TECHNIQUES AND MEASUREMENT

Measurement is an important aspect of physics or other sciences. No fact in science is accepted, no law is established, unless it can be exactly measured and quantified. As physics is based on exact measurements, every such measurement requires two things; first a number or quantity, secondly a unit, e.g. 20 metres as the length of a table tennis’s board.

## MEASUREMENT OF LENGTH

THE METRE RULE: The metre rule is often used to measure distances of a few centimetres to some metres, for example, the dimensions of a table or room. When longer distances are involved, tape rule can be used. 0.1 cm or 1mm is the smallest graduation on a metre rule.

**CALLIPERS:**

Callipers are used to measure distances on solid objects where an ordinary metre rule cannot be applied directly. They are made of hinged steel jaws which are closed (in the case of external callipers) until they touch the desired part of the object being measured. The distance between the jaws is then measured on a graduated scale such as the metre rule.

**THE VERNIER CALLIPERS**

These can measure length more accurately than the metre rule. To measure small lengths, to the nearest 0.1mm, e.g the thickness of a metre rule, the internal and external diameters of a tube, or the diameter of a rod, we use the vernier callipers. The instrument has two sets of jaws and two scales, the main and the vernier scales

**THE MICROMETER SCREW GAUGE**

This instrument measures even smaller lengths (e.g diameter of a wire) than the vernier callipers. It has a higher reading accuracy and can read up to 0.01mm or 0.001cm. It can be used to measure the thickness of a piece of paper, the diameter of a small ball (e.g. pendulum bob).

## MEASUREMENT OF TIME

The time internal between two events is the difference between the times when the event occurred when the time internal is of the order of minutes or hours, clocks and watches can be used. These are the instruments which indicate the time of the day. For shorter time intervals of the order of seconds, stop clocks or stop watches are used.

**EVALUATION**

1. Define (a) length (b) time.
2. List five instrument for measuring length.

## MEASUREMENT OF MASS

The mass of a body is a measure of the quantity of matter it contains. Mass is usually measured by comparing it with standard masses, using a balance.

There are various types e.g. beam or chemical balance, lever balance, a dial spring, direct reading balance etc

**WEIGHT**: of a body is the force acting on the body due to the earth’s gravitational pull. One instrument used for measuring weight is the spring balance. Weight is measured in Newtons.

## Differences between Mass and Weight

Mass Weight

|  |  |
| --- | --- |
| 1. Mass is the quantity of matter present in a body. | Weight occurs due to the force of gravity acting upon an object. |
| 2. Mass is constant. | Weight varies. |
| 3. Mass is a scalar quantity. | Weight is a vector quantity. |
| 4. The unit of mass is the kg. | The unit of weight is the Newton (N). |
| 5. Mass is measured by chemical or beam balance. | Weight is measured by spring balance. |

6. The principles of moment is applied The instruments for measuring weight to obtain the mass. obeys Hook’s law.

## Relationship Between mass & weight

W=mg

Where, W = weight(N) m=mass(kg) g= acceleration due to gravity(m/s2)

## MEASUREMENT OF VOLUME

**GRADUATED CYLINDER:** A graduated cylinder can be used for measurement of volumes of liquids. It is accurate to the nearest 1cm3. It can also be used in measuring the volume of irregular shaped objects e.g stone, with the aid of the displacement or eureka can.

**HOW TO READ A VERNIER CALLIPER**

In reading a vernier calliper, the whole number (digit before the decimal point) and the first digit after the decimal point are read from the main scale while the second digit after the decimal point is read from the vernier scale (sliding scale). This is the point or mark that coincides with that of the main scale.

See example below:

Example 3.1

Fig. 3.3

Solution

What is the reading on the main scale = 4.30

Reading on the vernier scale = 0.07 i.e. point of coincidence = 0.07

\ Total reading on the scale = 4.30

= 0.07

4.37cm

Note: The last digit before the end “A” of vernier inscribed on the main scale is 4.3 and the point of coincidence is 7 which is taken as 0.07. The rough end of the main scale indicates continuity, i.e the main scale is still extended.

Example 3.2 (How to read the micrometer scale)

What is the reading on the micrometer screw gauge shown below?

Fig. 3.4

Solution

Reading on the sleeve = 17.00

Reading on the thimble = 11 x 0.01

= 0.11

Reading on the scale = 17.1mm or 1.711cm

**EVALUATION**

1. Differentiate between mass & weight
2. The weight of an object of mass 5000g is ……. (take g = 10m/s2)

**WEEKEND ASSIGNMENT**

1. Which of the following instrument is suitable for taking the most accuratemeasurement of the internal diameter of a test-tube? (a) Metre rule (b) A pair of callipers (c) A micrometer screw gauge (d) A tape rule
2. Which of the following statements about mass and weight of a body is notcorrect? Its (a) mass is a scalar quantity (b) weight is a function of the gravitational pull on it (c) mass on earth and on the moon is the same (d) weight at the equator and at the poles is the same
3. The diagram below represents a portion of a micrometer screw guage. What isthe reading? (a) 3.72mm (b) 3.50mm (c) 3.30mm (d) 3.25mm
4. The weight of a body is measured with
   1. spring balance\ (b) beam balance (c) chemical balance (d) lever balance
5. Which instrument is best for measuring small quantity of liquid?
   1. Burette (b) Pipette (c) Cylinder (d) Beaker
6. What is the dimension of force? (a) MLT−2 (b) ML2T (c) ML2T−2 (d) MLT−3
7. The diagram below represents a portion of a vernier calliper. What is its reading?
   1. 4.36cm (b) 4.43cm (c) 5.53cm (d) 5.44cm
8. Which of the following instruments is the best for measuring the diameter of theconstantan wire? (a) Callipers (b) Mere rule (c) Micrometer screw guage (d) watt meter
9. Hydrometer is an instrument used for measuring
   1. relative humidity (b) dew point (c) relative density (d) attitude
10. What is the reading on the instrument? (a) 5.25mm (b) 10.16mm (C) 10.15mm

(d) 5.10mm

**THEORY**

1. Mention the instrument that is suitable to measure the following quantities;

(a) The weight of a body (b) The internal diametre of a test tube

(c) The mass of a body (d) The dimension of a compound

(e) The length of a table (f) The diameter of a wire

1. The diagrams below represents the portion of a micro meter screw gauge. Whatare the readings?

(a)

(b)

1. The length of a piece of glass block was measured by means of a vernier calliperas shown below. The length of the glass block is?

1. The diagram below represents a portion of a vernier calliper. What is the reading?

1. The internationally agreed system of units (SI) for physical measurements are \_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. 6. Mention three differences between mass and weight

**WEEK THREE**

**TOPIC: MOTION IN NATURE**

**CONTENT**

Definition of Motion

Causes of Motion

Circular Motion

Centripetal Acceleration & Force

**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 travels from Lagos to Enugu

A B

Fig. 4.1 A horizontal line

Fig 4.2 Random Motion

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 forces whose sources do not require contact with the body to which they are applied. Examples are gravitational force, electrostatic and magnetic forces

**EVALUATION**

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:

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

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

Centripetal force FT 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 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

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

**EVALUATION**

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?

**WEEKEND ASSIGNMENT**

1. Which of the following types of motion does a body undergo when moving in ahaphazard manner? (a) Random motion (b) Translatory motion (c) Rotational motion (d) Vibratory motion
2. What type of motion does the skin of a talking drum perform when it is struck witha drum stick? (a) Rotational (b) Translational (c) Random (d) Vibratory
3. The motion of the prongs of sounding turning fork is
   1. rotational (b) vibratory (c) vibratory and rotational (d) random
4. A body moves with a constant speed but has an acceleration. This is possible if it
   1. moves in a straight line (b) moves in a circle (c) is oscillating

(d) is in equilibrium (e) has a varying

1. A body moves along a circular path with uniform angular speed of 0.6rads−1 and at a constant speed of 3.0ms−1. Calculate the acceleration of the body towards the centre of the circle.
   1. 25.0ms−2 (b) 5.4ms−2 (c) 5.0ms−2 (d) 1.8ms−2
2. The angular speed of an object describing a circle of radius 4m with a linearconstant speed of 10ms−1 is (a) 40rads−1 (b) 14rads−1 (c) 2.5rads−1 (d) 0.40rad−1
3. A body moving at a constant speed accelerates when it is in (a) rectilinear motion

(b) translational motion (c) circular motion (d) vibrational motion

1. The study of motion without involving the force which causes the motion is called

(a) kinematics (b) inertia (c) electromagnetic (d) dynamics

1. The magnitude of the force required to make an object of mass M move withspeed V in a circular path of radius R is given by the expression

(a) (b) (c) (d)

1. The following are types of motion except (A) random motion (b) rotational motion (c) nuclear motion (d) oscillatory motion.

1. The motion of the prongs of a sounding turning fork is (a) random (b)

translational (c) rotational (d) vibratory

1. A body moving in a circle at constant speed has
   1. a velocity tangential to the circle
   2. a constant kinetic energy
   3. an acceleration directed towards the circumference of the circle. Which of the statement above are correct

(a) i & ii only (b) ii & iii only (c) I & iii only (d) i, ii & iii

1. A loaded test – tube which floats upright in water is carefully and slightly depressed and then released. which of the following best describes the subsequent motion of the test tube (a) circular (b) rotational (c) random (d) oscillatory.
2. Which of the following correctly gives the relationship between linear speed v & angular velocity w of a body moving uniformly (a) v=w r (b) v=w2r (c) v=wr2 (d) v=w/r

**THEORY**

1. Mention and describe two practical situations where centripetal force must betaken into account.
2. A body weighing 100N with a speed of 5ms-1 in a horizontal circular path of radius 5m. Calculate the magnitude of the centripetal force acting on the body (g= 10ms-2). (WAEC, 1999)
3. A piece of stone attached to one end of spring is whirled round in a horizontalcircle of radius 7m. When the constant speed of the stone is 40ms-1, calculate the centripetal acceleration.
4. A keke (tricycle) moves around Mary Slessor roundabout of radius 50m, at aconstant speed of 20ms-1, find (a) Centripetal acceleration (b) Centripetal force
5. A particle of mass 100kg is fixed to the tip of a fan blade which rotates withangular velocity of 100rads-1. If the radius of the blade is 0.2m, find the centripetal force.
6. A body of mass 5kg moving in a circular path with a velocity of 5m/s for 10 completerevolution within 4s. If the radius of the circular path is 30m. Find (a) the centripetal force

(b) the centripetal acceleration (c) angle subtended in radian (d) angular velocity

**WEEK FOUR**

**TOPIC: FRICTION**

**CONTENT**

Definition of Friction

Laws Governing Solid Friction

Advantages & Disadvantages of Friction

Reducing Friction

**DEFINITION OF FRICTION**

Friction (Fr) is defined as a force which acts at the surface of separation between two objects or two bodies in contact and tend to oppose the motion of one over the other. It is simply force of opposition. We have two types of friction:

1. Static friction, Fs
2. Dynamic friction, Fd. Fs is greater than Fd

**LAWS OF SOLID FRICTION**

* 1. Friction opposes the relative motion of two surfaces in contact.
  2. It is independent of the area of the surface of contact.
  3. It depends on the nature of the surface.
  4. It is proportional to normal reaction (R).
  5. It is independent of relative velocity between the surfaces Fr α R

Fr = μR………………….1.

where Fr-frictional force μ-coefficient of friction & R-normal reaction

W

**R**

R

F **W**

The weight ( W) of an object is acting vertically downward.. the normal reaction (R ) is always acting perpendicular to the plane.. the normal reaction is equal to the weight.

R

R

W

W R W

W = mg

At equilibrium, R = mg, this implies that,

R = W [ g is acceleration due to gravity = 10m/s2]

R = mg

F = μ mg

**Fr = μmg**…………………… 2

R

Fr P

W

Case one: if the force P is applied, and the object is stationary.

P – Fr = ma

Since no motion a = 0

P – F Fr = O

**P = Fr …………………….. 3**

Case two: when the force P is applied and the body moves.

P – Fr = ma

P = Fr + ma

But Fr = μmg

P = μmg + ma

**P = m [ μg + a ] …………………………….. 4**

For an object on a smooth inclined plane

**Case one**: if the body moves upward, a > 0

P – mgsinø = ma

**P = mgsinø + ma …………………………. 5**

**Case two:**  if the body is stationary a = 0

P – mgsinø = ma

P – mgsinø = 0

**P = mgsinø ……………………………… 6**

**Case three:** if the body slides down the plane, a >0 mgsinø – P = ma

**P = ma + mgsinø ………………………… 7**

For a body on a rough inclined plane.

P – mgsinø – Fr = ma

But Fr = μmg

**P – mgsinø – μmg = ma ………………………. 8**

**Also**, R = mg cosø

**P – mgsinø – μ** **mg cosø = ma …………………………… 9**

If the body moves upward the incline plane

**μ = tanӨ………………………………….. 10**

**EVALUATION**

1. Differentiate between static and dynamic friction.
2. State the laws governing solid friction.

**ADVANTAGES OF FRICTION**

1. It makes walking and running possible.
2. It enables gripping of belt in machines possible.
3. It enables nails to stay in the wall when driven.
4. It stops tires from slipping.
5. Enable cars to stop when breaks are applied.
6. Enables human to use mouse in surfing web.

**DISADVANTAGES OF FRICTION**

1. Causes wear and tear.
2. Causes the efficiency of the machines.
3. Causes a lot of energy to be consumed by the machine.
4. Causes loss of resources.

**REDUCING FRICTION**

1. Lubricating surfaces with grease, oil etc.
2. Using ball or roller on wheels.
3. Smoothing or polishing the surface.
4. By streamlining.

**EVALUATION**

1. State three (3) advantages & two (2) disadvantages of friction.

1. State three (3) ways of reducing friction.

**WEEKEND ASSIGNMENT**

1. Friction depends on the area of surface in contact (a) true (b) false (c) true & false

(d) none of the above

1. A metal block of mass 8kg lies on a rough horizontal platform. If the horizontalresistive force is 10N, find the coefficient of static friction (g=10m/s2) (a) 0.25 (b) 0.125 (c) 0.8 (d) 0.124
2. Which of the statement is correct (a) static friction is less than dynamic friction (b) static friction equals dynamic friction (c) static friction is greater than dynamic friction (d) none of the above
3. A metal block of mass 0.5kg lies on a rough horizontal plane, what is the normalreaction (g=10m/s2)(a) 50N (b) 0.05N (c) 500N (d) 5N
4. If the angle between the incline length and the horizontal platform of an inclineplane is 300 calculate the coefficient of friction (a) 0.542 (b) 0.577 (c) 0.467 (d) 0.866

**THEORY**

1. Define friction and state the laws governing solid friction.
2. A body of weight 6N rest on a plane inclined at an angle of 300 to the horizontal(a) what force keeps it sliding down the plane? (b) what is the coefficient of friction?
3. State **two**
   1. Laws of friction
   2. Advantages of friction.
   3. Methods of reducing friction (WAEC,2006)

A force, 10N drags a mass 10kg on a horizontal table with an acceleration of 0.2ms2. If the acceleration due to gravity is 10ms-2. Calculate the coefficient of friction between the moving mass and the table. (UME,1998)

**WEEK FIVE AND SIX**

**TOPIC: VECTOR & SCALAR QUANTITY, DISTANCE/DISPLACEMENT,**

**SPEED/VELOCITY, ACCELERATION, DISTANCE/DISPLACEMENT –TIME GRAPH,**

**SPEED/VELOCITY–TIME GRAPH**

**CONTENT**

Scalar & Vector Quantity

Distance & Displacement

Speed & Velocity

Acceleration & Retardation

Distance/Displacement – Time Graph

Speed/Velocity – Time Graph

**SCALAR & VECTOR QUANTITY**

**A scalar quantity** is defined as a quantity that has magnitude only but no direction. Typical examples of scalar quantities are time, distance, speed, temperature, volume, work, power, electric potential etc. A scalar quantity or parameter has no directional component, only magnitude. For example, the units for time (minutes, days, hours, etc.) represent an amount of time only and tell nothing of direction. Additional examples of scalar quantities are density, mass, and energy.

**A vector quantity** is defined as a quantity that has both magnitude and direction. Typical examples of vector quantities are velocity, displacement, acceleration, force, momentum, moment, electric field intensity etc

**POSITION**

Position is referred to as the point in which an object can be located or the place object is found. The position of an object on a plane can be given by its co-ordinates, i.e., the signed distances of the point from two perpendicular axes, OX and OY

Y

0

X

**Fig. 6.0 Cartesian co-ordinates**

The – co-ordinates is called abscissa while the – co-ordinate is called ordinate. The co-ordinate is written first, before the – co-ordinates, i.e. (X,Y)

**DISTANCE AND DISPLACEMENT**

**Distance**: This is the gap between any two positions in space. It is denoted by S and measured in metre(m) it is a scalar quantity and is calculated as the product of average speed and time.

Thus, distance = average speed X time.

**Displacement**: This is the distance covered in a specific direction. it is a vector quantity measured in metre(m). The direction of motion of bodies can be found by using the compass.

Displacement = average velocity X time. It is denoted by X

**The Use of Bearing to Indicate Direction and Displacement**

The bearing of an object from the origin is the angle which it makes with the north pole in the clockwise sense. It is specified in two ways:

1. The use of cardinal points: N – North, S – South, W – West, and E – East
2. The use of three digit notation. Students should note that bearing which are located by cardinal points are with respect or reference to the North and South.

NW N NE W E SW S SE

Fig. 6.1 cardinal points and their directions

**SPEED AND VELOCITY**

**Speed**: Speed is defined as the rate of change of distance moved in an unspecified direction or the rate of change of distance per unit time in an unspecified direction. It is measured in metre per second (m/s). It is a scalar quantity.

The mathematical expression of speed is

**Average Speed**: Average speed is defined as the ratio of the total distance travelled to the total time taken. It is a scalar quantity and measured in m/s or ms-1

This, average speed =

When a body covers equal distance in equal time intervals, no matter how small the time interval may be, it is said to be a **uniform speed or constant speed.**

**Velocity**: Velocity is defined as the rate of change of distance moved in a specific direction or the rate of change of displacement. Velocity is a vector quantity. For instance, it would be easy and correct to say that a car travelling at a steady speed of 50km/h in a direction of N40oE has a velocity of 50km/h, N40oE.

velocity =

**Uniform velocity**

*Fig 6.2 Uniform Velocity*

**Uniform (constant) velocity:** An object is said to undergo (constant) velocity, if the rate of change of displacement is constant, no matter how small the interval may be.

Example 1:

A train moves with a speed of 54km/h for one quarter minute. Find the distance travelled by the train.

Solution:

Speed = 54km/h = 15m/s

Time = ¼ min = ¼ × 60 = 15s

Distance = speed (m/s) × time (s)

= 15(m/s) × 15(s)

= 225m

**ACCELERATION & RETARDATION**

Acceleration is defined as the increasing rate of change of velocity. It is measured in m/s2.

Acceleration (a) = Increasing Velocity change

Time taken . ……………………………………5.

When the velocity of a moving body increases by equal amount in equal intervals of time, no matter how small the time intervals may be, it is said to move with **uniform acceleration.**

Retardation is defined as the decreasing rate of change of velocity. It is measured in m/s2.It is also known as deceleration or negative acceleration

Retardation (ar) = Decreasing Velocity Change

Time Taken

**EQUATION OF UNIFORMLY ACCELERATED MOTION**

S = (v+u) t ………………………………………………………7

2

v = u + at ……………………………………………………….8 v2 = u2 + 2 aS ……………………………………………………….9

S = ut + ½ at2  ……………………………………………………….10

Equations (7) to (10) are called equations of uniformly accelerated motion and could be used to solve problems associated with uniformly accelerated motion

where u- initial velocity( m/s), v – final velocity (m/s), a – acceleration (m/s2), s – distance covered and t – time (m).

**Example** 2

A car moves from rest with an acceleration of 0.2mls2 . Find its velocity when it has moved a distance of 50m.

Solution:

a = 0.2mls2 , S = 50m, u = 0m/s , v = ?

v2 = u2 + 2 as v2 = 02 + (2×0.2×50) = 20 v = √20 m/s

**EVALUATION**

1. State the differences & similarity between speed &

velocity. 2. A car has a uniform velocity of 108km/hr. How far does it travel in ½ minute?

### GRAPHS

The motion of an object is best represented or described with graphs. These graphs are i. Distance- time

1. Displacement – time
2. Velocity – time

### Distance – time

0, 0

DX

In a distance-time graph, its slope or gradient gives the speed.

(i) Uniform speed (ii) Non-uniform speed

Fig. 6: Distance-time graph

Gradient/slope = speed =

### Displacement – time graph

A displacement-time graph could be linear or curved. For a linear graph, the gradient gives the velocity.

a) Non-uniform velocity

Fig. 6.4 Displacement-time graph

Gradients/slope = velocity (v) =

### Velocity – time graph

The velocity-time graph is more useful than any of the two graphs described above because it gives more useful information concerning the motion of objects. The following information can be obtained from the graphs (i) acceleration (ii) retardation (iii) distance (iv) average speed.

The motion of objects can form shapes such as square, triangle, trapezium, rectangle or a combination of two or more shapes. Thus, the sum of the areas of the shapes formed corresponds to the distance moved, covered or travelled by the objects.

Example 3

A motor car accelerates for 10secs to attain a velocity of 20m/s. It continues with uniform velocity for a further 20 seconds and then decelerates so that it stops in 20 seconds. Calculate (i) Acceleration (ii) Deceleration (iii) The distance travelled.

i)

or

20 = A = ii) Deceleration =

iii) Using area of trapezium

½ × (AB + OC) h = ½ × (20 + 50) 20

= ½ × (70) × 20 = 700m

Example 4

A car starts from rest and accelerates uniformly until it reaches a velocity of 30mls after 5 seconds. It travels with uniform velocity for 15 seconds and is then brought to rest in 10s with a uniform retardation. Determine (a) the acceleration of the car (b) The retardation (c) The distance covered after 5s (d) The total distance covered (use both graphical and analytical method).

The velocity – time diagram for the journey is shown above, from this diagram

1. the acceleration = slope of OA

= AE / EO

= (30-0) /(5-0)=30/5

= 6mls2

1. the retardation = slope of BC = CB / CD

= (0-30) / (30-20) = -30/10

= -3mls2  (the negative sign indicate that the body is retarding)

1. Distance traveled after 5s = area of A E O

= ½ x b x h

= ½ x 5 x 30

= 75m

Total distance covered = area of the trapezium OABC

= ½ (AB + OC) AE

= ½ (15 + 30) 30

= 675m.

Using equations of motion.

a. U = O, V = 3, t = 5 V = u + t a = v-u/t = 30 – 0 / 5 a = 30/5 = 6ms-2 a o in a = v – u / t = 0-30 / 10 a = -3 mls2

1. S = ( u + v) 5

2

= 30 / 2 x 5

= 75m

1. To determine the total distance travelled, we need to find the various distance for thethree stages of the journey and then add them.

for the 1st part S= 75m from (c) for the 2nd stage where it moves with uniform velocity.

S = vt

= 30 x 15

= 450m

for the last stage S = ½ (u + v) t

= ½ (30 + 0) 10

= 150m.

Total distance = 75 + 450 + 100 = 675m.

**EVALUATION**

* 1. A train slows from 108km/hr with uniform retardation of 5mls2. How long will it take to reach 18km/hr and what is the distance covered?.
  2. Why is velocity – time more useful than displacement time graph?

**WEEKEND ASSIGNMENT**

1. A body which is uniformly retarded comes to rest in 10s after travelling a distanceof 20m. Calculate its initial velocity (a) 0.5 ms−1 (b) 2.0ms−1 (c) 4.0ms−1 (d) 20.0 ms−1 (e) 200.0 ms−1
2. The distance travelled by a particle starting from rest is plotted against the squareof the time elapsed from the commencement of the motion. The resulting graph is linear. The sped of the graph is a measure of (a) initial displacement (b) initial velocity (c) acceleration (d) speed
3. Which is the in correct formula for a body accelerating for a body accelerating

uniformly? (a) (b) (c)

(d) (e)

1. The slope of a displacement-time graph is equal to
   1. acceleration (b) uniformly velocity (c) uniform speed (d) instantaneousspeed
2. A body moving with uniform acceleration has two points (5, 15) and (20, 60) onthe velocity-time graph of its motion. Calculate (a) 0.25 ms−2 (b) 3.00 ms−2 (c) 4.00 ms−2 (d) 9.00ms−2
3. A moving object is said to have uniform acceleration if its (a) displacementdecreases at a constant rate (b) speed is directly proportional to time (c) velocity increases by equal amount in equal time intervals (d) velocity varies inversely with time
4. The diagram shows a velocity-time graph of the motion of a car. What is the totaldistance covered after the journey? (a) 75m (b) 150m (c) 300m (d) 375m
5. The area under a velocity-time graph represents (a) final velocity attained

(b) direct covered (c) acceleration (D) workdone

1. A body accelerators uniformly from rest at 2ms−2. Calculate its velocity after travelling 9m. (a) 36 ms−1 (b) 18 ms−1 (c) 6 ms−1 (d) 4.5 ms−1
2. A moving object is said to have uniform acceleration if its
   1. displacement decreases at a constant rate (b) speed is directly proportionalto time (c) velocity increases by equal amount in equal time intervals (d) velocity varies inversely with time

**THEORY**

1. A body moving with uniform acceleration a, has two points (5, 15) and (20, 60) onthe velocity-time graph of its motion. Calculate the acceleration a.
2. Two points on a velocity- time graph coordinates (5s, 10ms-1) and (20s, 20ms-1). Calculate the mean acceleration between the two points.
3. A car starts from rest and accelerates uniformly for 5s until it attains a velocity of

30ms-1. It then travels with uniform velocity for 15s before decelerating uniformly to rest in 10s;

* 1. Sketch a graph of the motion
  2. Using the graph above, calculate the
  3. Acceleration during the first 5s
  4. Deceleration during the last 10s
  5. Total distance covered through the motion

1. A car starts from rest and accelerates uniformly for 10s, until it attains a velocity of25m/s, it then travels with uniform velocity for 20s before decelerating uniformly to rest in 5s.
2. Calculate the deceleration during the last 5s
3. Calculate the acceleration during the first 10s
4. Sketch a graph of the motion and calculate the total distance covered throughout themotion.

5. (a) Using a suitable diagram, explain how the following can be obtained from a velocity-time graph

(i) Acceleration (ii) Retardation (iii) Total distance

(b) Show that the displacement of a body moving with uniform acceleration a is given by

S = ut + 1/2at2, where u is the velocity of the body at time t=0

(c) A particle moving in a straight line with uniform deceleration has a velocity of 40m/s at a point P, 20m/s at a point Q and comes to rest at a point R, where QR=50m. Calculate the:

(i) Distance PQ (ii) Time taken to cover PQ (iii) Time taken to cover PR (WAEC, 1990)

1. (a) What is meant by the statement *the acceleration of free fall due to gravity on the equator is 9.78ms-2*

(b) State two factors that affect the value of the acceleration due to gravity.

(WAEC,2006)

1. Using suitable diagram, explain how the following can be obtained from a velocitytime graph: (a)Acceleration (b) Total distance covered (c) A body at rest is given an initial uniform acceleration of 6.0ms-2 for 20s after which the acceleration is reduced to 4.0ms-2 for the next 10s. The body maintains the speed attained for 30s. Draw the velocity-time graph of the motion using the information provided above. From the graph, calculate the:
2. Maximum speed attained during the motion
3. Total distance travelled during the first 30s
4. Average speed during the same time interval as in (ii) above (WAEC, 2009)
5. (a) Sketch a distance-time graph for a particle moving in a straight line:

(i) Uniform speed (ii) Variable speed (NECO, 1010)

(b) A body starts from rest and travels distances of 120, 300, and 800m in successive equal time intervals of 12s. During each interval the body is uniformly accelerated.

* 1. Calculate the velocity of the body at the end of each successive interval.
  2. Sketch the velocity- time graph of the motion. (WAEC, 2010)

1. (a) Explain the terms: uniform acceleration and average speed.
2. A body at rest is given an initial uniform acceleration of 8.0ms-2 for 30s after which the acceleration is reduced to 5.0ms-1 for the next 20s. The body maintained the speed attained for 60s after which it is brought to rest in 20s.Draw the velocity-time graph of the motion using the information given above.
3. Using the graph, calculate the:
   1. Maximum speed during the motion.
   2. Average retardation as the body is being brought to rest.
   3. Total distance travelled during the first 50s.
   4. Average speed during the same interval as in (ii) above ( WAEC, 1991)

10. (a) State two reasons why the acceleration due to gravity varies on the surface of the earth. (NECO, 2008)

(b) State the difference between centripetal and centrifugal force.(NECO, 2011)

11. (i) Define velocity and acceleration

(ii)List two physical quantities that can be deduced from a velocity-time graph.

Define the following terms; (a) average speed (b) Instantaneous velocity

(c) A car travels at an average speed of 20ms-1. Calculate the distance covered in 1hour

1. Starting from rest, a vehicle accelerates at 2m/s2 for 5secs it then travels for 5secs at the velocity, Vo reached and is brought to rest with a uniform retardation after the next 5s.

1. Sketch the velocity-time graph for the journey

1. Calculate the value of Vo,

1. What is the retardation

1. The total distance covered

**WEEK SEVEN**

**TOPIC: DENSITY & RELATIVE DENSITY**

**CONTENT**

Definition of Density

Determination of Density

Relative Density

Determination of Relative Density of Solids & Liquid

**DEFINITION OF DENSITY**

The density of a substance is the mass per unit volume of the substance.

Density = mass of a given substance

Volume of the substance

Density is scalar quantity& measured in kgm-3 (kilogram per cubic meter)

**Determination of Density**

The determination of density involves the determination of a mass and a volume. The mass can be found by weighing. The density of a substance can be determined using a graduated density bottle.

**Relative Density**

Relative density is also known as specific gravity. Relative density of a substance is defined as the density of the substance per density of water.

R.D = Density of the substance

Density of water

R.D is also equal to the ratio weight of a substance to weight of an equal volume of water. As weight is proportional to mass R.D = mass of substance mass of equal volume of water

**Determination of R.D of Solid (e.g. Sand)**

Mass of empty bottle = m1

Mass of bottle + sand = m2

Mass of bottle + sand + water = m3

Mass of bottle + water only= m4

Mass of sand = m2 – m1

Mass of water added to sand = m3 –m2

Mass of water filling the bottle = m4 – m1

Mass of water having the same volume as sand = (M4-M1) – (M3-M2)

Relative density = Mass of sand

Mass of equal volume of water

R.D = m2 – m1

(m4 – m1) – (m3 -m2 )

**EVALUATION**

1. Differentiate between density & relative density
2. A glass block of length 100cm width 60cm and thickness 20cm has a mass of 4000g.

calculate the density of the glass **Determination of R.D of Liquid** mass of empty density bottle = m1 mass of bottle filled with water = m2 mass of bottle filled with liquid = m3

R.D of liquid = m3 – m1

m2 – m1

Example **–** A glass block of length 10cm width 8cm and thickness 2cm has a mass of 400g. calculate the density of the glass. Solution l = 10cm = 0.1m, b = 8cm = 0.08cm, h = 2cm = 0.02m, m = 400g = 0.4kg

V = lbh = 0.1 x 0.08 x 0.02 = 0.00016m3

Density = Mass (m) = 0.4 = 2500kgm3

Volume (V) 0.00016

Example – Calculate the volume in m3 of a piece of wood of mass 500g and density 0.76 gcm-3 mass of the wood = 500g density = 0.76gcm-3 volume = ?

volume = mass / density= 500

0.76 volume = 658cm3 = 6.58 x 10-4 m3

Example – An empty relative density bottle has a mass of 15.0g. when completely filled with water, its mass is 39.0g. what will be its mass if completely filled with acid of relative density 1.20?

solution m1, mass of empty bottle = 15.0g m2, mass of bottle + water = 39.0g mass of acid = n – 15 . 0g mass of water = 39.0 – 15.0g

= 24.0g

R.D = 1.20

R.D = n – 15.0g

39.0 – 15.0g

1.20 = n –15.0

24.0

n- 15.0= 1.20×24.0 n- 15= 28.8 n =28.8+15 n=43.8g

**NB:** The hydrometer is an instrument used to measure the relative density of liquids

**EVALUATION**

1. **The volume of an object is 1.5x10m and its mass is 3.0×10 kg. Calculate its density.**
2. **A relative density bottle weighs 20g when empty, 80gwhen filled with water & 100g when filled with liquid. Find the relative density of the liquid.**

# WEEKEND ASSIGNMENT

1. Find the density of a substance, if the mass of the substance is 150,000g and the dimension is 20m by 10m by 500cm.
   1. 0.5kg1m b. 0.24kg1m c. 1.50kg/m.
2. What is the height of a cylindrical iron if the density is 7900kg/m3? The mass is 700kg and the radius is 0.1m.
   1. 2.918m b. 2.819m c. 3.418m.
3. Density is defined as the ratio of mass to——-
   1. Pressure b. area c. volume
4. Relative density is the ratio of mass of a substance to——
   1. Mass of 2an equal volume of water b. volume of a substance c. density
5. The S.I unit of density is ————- a. g1cm b. kg1m c.kg1m .

**THEORY**

1. Alcohol of mass 33.2g and density 790kg1m is mixed with 9g of water. What is the density of the resulting mixture?(density of water is 1g1cm ).
2. Define relative density of liquid.

**WEEK 8**

**TOPIC:** **PRESSURE , ARCHIMEDES’ PRINCIPLES**, **UPTHRUST** & **LAWS OF**

**FLOATATION**

**CONTENT**

**Pressure**

**Archimedes’ Principles & Upthrust**

**Laws of Floatation**

**PRESSURE**

Pressure is defined as the perpendicular force per unit area acting on a surface. It is a scalar quantity & measured in N/m2 or Pascal (pa).It can also be defined as the force per unit area, which is calculated by taking the total force and dividing it by the area over which the force acts. Force and pressure are related but different concepts. A very small pressure, if applied to a large area, can produce a large total force.

P = F ……………………………..1. Where P-pressure, F- force (N) & A-area (m2 )

**A**

**NB:** 1 bar = 105 N/m2 = 105 pa

Example – A force of 40N acts on an area of 5m2. What is the pressure exerted on the surface?

Solution

F = 40N, A = 5m2, P = ?

P = F/A = 40/5 = 8pa

**Pressure in Liquid**

Pressure in liquid has the following properties

1. Pressure increases with depth
2. Pressure depend on density
3. Pressure at any point in the liquid acts equally in all direction
4. Pressure at all points at the same level within a liquid is the same
5. It is independent of cross-sectional area

P = hℓg ……………………..2.

where p-pressure, h-height & g-acceleration due to gravity

**Pascal’s principle** : Pressure applied to an enclosed fluid is transmitted undiminished to every part of the fluid, as well as to the walls of the container. The operation of the hydraulic press & the car brakes system is based on this principle.

**The ideal press consists of two pistons of areas ( a , A ) enclosed between them incompressible liquid as in figure**

**When a small force ( f ) acts on the small piston ( a ) , it exerts a pressure ( p = f/a ).**

To keep the large piston (A) at equilibrium with the small one (a) a load = F is placed on the large piston . P = f/a = F/A

**EVALUATION**

1. Define pressure
2. State five characteristics of pressure in liquid

**Archimedes’ Principle & Upthrust**

Archimedes’ principle is a law that explains buoyancy or upthrust. It states that When a body is completely or partially immersed in a fluid it experiences an upthrust, or an apparent loss in weight, which is equal to the weight of fluid displaced. According to a tale, Archimedes discovered this law while taking a bath. An object experiences upthrust due to the fact that the pressure exerted by a fluid on the lower surface of a body being greater than that on the top surface, since pressure increases with depth. Pressure, *p* is given by *p* = *hρg,* where:

*h* is the height of the fluid column

*ρ* (rho) is the density of the fluid

*g* is the acceleration due to gravity

Let us confirm this principle theoretically. On the figure on the left, a solid block is immersed completely in a fluid with density *ρ.* The difference in the force exerted, *d* on the top and bottom surfaces with area *a* is due to the difference in pressure, given by

*d* = *h*2*aρg* – *h*1*aρg* = (*h*2 – *h*1)*aρg*

But (*h*2– *h*1) is the height of the wooden block. So, (*h*2 – *h*1)*a* is the volume of the solid block, *V*.

*d* = *Vρg*

Upthrust = *Vρg*

In any situation, the volume of fluid displaced (or the volume of the object submerged) is considered to calculate upthrust, because (*h*2 – *h*1) is the height of the solid block only when it is completely immersed. Furthermore, the pressure difference of the fluid acts only on the immersed part of an object.

Now, moving back to *Vρg*. Since *V* is the volume of fluid displaced, then the product of *V*,

*ρ* and *g* is the weight of the fluid displaced. So, we can say that

Upthrust = Weight of the fluid displaced

Compare this conclusion with the statement above summarising Archimedes’ principle. Are they the same? Well, not totally. The “apparent loss in weight” was not mentioned.

In the figure on the left, there are arrows on the top and bottom of the solid block. The downward arrow represent the weight of the block pulling it downwards and the upward arrow represent the upthrust pushing it upwards. If one were to measure the weight of the solid block when it is immersed in the fluid, he will find that the weight of the block is less than that in air. There is a so-called “apparent loss in weight”, because the buoyant force has supported some of the block’s weight.

**NB:** 1. When an object is wholly immersed, it displaces its volume of fluid. So up thrust = weight of fluid displaces. = Volume of fluid displaced x its density x g = volume of object x density of fluid x g

2 When the object is partially immersed e.g. if ¼ of its volume (v) is immersed then the up thrust is given by v/4 x density of liquid x g.

**Determination of Relative Density by Archimedes’ Principle**

1. **Relative density of solid**

The body is weighed in air w1, and then when completely immersed in water w2

Relative density of solid

**=** Weight of solid in air

Weight of equal volume in water

= w1

W1-W2

**Relative density of liquid**

A solid is weighed in air (w1), then in water (w2) and finally in the given liquid (w3) Relative density of liquid = apparent loss of weight of solid in liquid apparent loss of weight of solid in water.

= W1 – W3

**W**1 **– W**2

Example – Themass of a stone is 15g when completely immersed in water and 10g when completely immersed in liquid of relative density 2.0 . What is the mass of the stone in air?

**Solution:**

Relative density = upthrust in liquid upthrust in water let W represents the mass of the stone in air

2 = w – 10 w – 15

2(w – 15) = w –10

2w – 30 = w – 10 2 w – w = -10 + 30 w = 20g

**Law of Floatation**

A floating object displaces its own weight of the fluid in which it floats or an object floats when the upthrust exerted upon it by the fluid is equal to the weight of the body. When an object is floating freely (i.e. neither sinking nor moving vertically upwards), then the upthrust must be fully supporting the object’s weight. We can say

Upthrust on body = Weight of floating body. By Archimedes’ principle,

Upthrust on body = Weight of fluid displaced. Therefore, Weight of floating body = Weight of fluid displaced

This result, sometimes called the “principle of floatation”, is a special case of Archimedes’ principle

**EVALUATION**

1. State the law of floatation.

1. State Archimedes’ principle.

**WEEKEND ASSIGNMENT**

1. A force of 40N acts on an area of 10m2. What is the pressure exerted on the surface? (a) 8pa (b) 4pa (c) 400pa (d) 10pa
2. What is the height of a cylindrical iron if the density is 7900kglm3  the mass is 700kg and the radius is 0.1m [a) 2.918cm [b] 2.819m © 3.418m
3. Density is defined as the ratio of mass to (a) pressure (b) area (c) volume
4. Relative density is the ratio of mass of a substance to ———— (A) mass of equal volume of water (b) volume of a substance (c) density
5. Pressure can be measured in the following except (a) bar (b) N/m2 (c) pascal (d)

Nm2

**THEORY**

1. Differentiate between force & pressure.
2. What is the pressure due to water at the bottom of a tank which is 20cm deep and is half of water? (Density of water = 103kg/m3 and g = 1om/s2 )

**WEEK 9**

**TOPIC: WORK, ENERGY AND POWER**

**CONTENT**

Work

Work Done in Lifting a Body & Falling Bodies

Conservation & Transformation of Energy World Energy Resources

**WORK**

Work is said to be done whenever a force moves a body through a certain distance in the direction of force. Work done can be defined mathematically as the product of the force and the displacement. It is a scalar quantity & measured in Joules

W = F X d ……………………………………….1.

W = mgh ……………………………………….2.

If a force is applied on a body at an angle Ø to the horizontal

Work done to move the body on the horizontal plane = Fcos Ø x d

……………………………..3.

Work done to raise the body to an appreciable height = Fcos Ø x d ………………………4.

Examples- A boy of mass 50kg runs up a set of steps of total height 3.0m. Find the work done against gravity Solution m = 50kg, h = 3m, g = 10m/s2 Work done = mgh

= 50 x 10 x 3

= 1500 Joules

**Energy**

Energy is defined as the ability to do work. It is a scalar quantity & measured in Joules.

There are many forms of energy. These include:

i. Mechanical energy

1. Thermal energy

1. Chemical energy

1. Electrical energy

1. Nuclear/Atomic Energy

1. Solar/Light energy

1. Sound Energy

## Types of Mechanical Energy

Mechanical energy is classified as

1. Potential energy

1. Kinetic energy

**POTENTIAL ENERGY:-** is simply “stored energy” i.e. energy possessed by a body by virtue of its states:

P.E = mgh …………………………………………….5.

**KINETIC ENERGY:** is the energy possessed by a body by virtue of its motion. Examples area student running a race, wind or air motion, electrical charges in motion, a moving bullet

K.E = ½ mv2 ……………………………………………………6.

Example – An object of mass 5kg is moving at a constant velocity of 15mls. Calculate its kinetic energy.

Solution:

K.E = ½ mv2  = ½ x 5 x 15 x 15 = 562.5 J

Example – Find the potential energy of a boy of mass 10kg standing on a building floor 10m above the ground level. g = 10m/s2

Solution:

P.E =mgh = 10 x 10 x10 =1000 J

**POWER**

Power is defined as the rate of doing work or the rate of transfer of energy. It is a scalar quantity & measured in watt

Power = work done

Time …………………………………………..7

P = (F X d)/t = F X d/t = FV ……………………………………8

Example: – : A boy of mass 10kg climbs up 10 steps each of height 0.2m in 20 seconds. Calculate the power of the boy.

Solution

Height climbed = 10 x 0.2 = 2m

Work done = mgh = 10 x 10 x 2 = 200 Joules

POWER = work = 10 x 10 x 2 = 10watts

Time 20

**EVALUATION**

1. Define power.
2. A boy of mass 960g climbs up to 12 steps each of height 20cm in 20 seconds.

Calculate the power of the boy.

**WORK DONE IN A FORCE FIELD** **& ENERGY CONVERSION**

**Work done in Lifting a Body & Falling Bodies**

The magnitude of work done in lifting a body is given by

Work = force x distance = mg x h = mgh

Also, the work done on falling bodies is given by

Work = force x distance = mg x h = mgh

**EVALUATION**

1. Explain three types of force field.

1. A loaded sack of total mass 100kg falls down from the floor of a lorry 2m high.

Calculate the work done by gravity on the load.

**Conservation & Transformation of Energy**

Energy can be converted from one form to another in a closed system. The law of conservation of energy states that in an enclosed system, energy can neither be created nor destroyed during transformation. Examples of such conversions include (a) Motor converts electrical to mechanical energy (b) Generator converts mechanical to electrical energy (c) Electric pressing iron convert electrical to heat energy

**World Energy Resources**

World energy resources can be classified as

1. Renewable Energy Resources: They are energy that can be replaced as they are used

e.g. solar energy, wind energy, water energy & biomass

1. Non-renewable Energy Resources: Energy that cannot be replaced after use e.g.nuclear energy, petroleum & natural gas

**EVALUATION**

* + 1. State the law of conservation of energy.
    2. Differentiate between renewable & non-renewable energy.

**GENERAL EVALUATION**

* + 1. When is work said to be done?
    2. State the difference between work, energy and power.
    3. Differentiate between kinetic and potential energy.
    4. State the energy transformation that take place during electricity generation at kanji dam.

**WEEKEND ASSIGNMENT**

* + 1. The following are example of force field except (a) electric force (b) magnetic force (c) frictional force (d) gravitational force
    2. Electric cell convert ……… to electrical energy (a) nuclear (b) chemical (c)mechanical (d) heat
    3. The following are examples of renewable energy except (a) biomass (b) solar (c) wind (d) nuclear
    4. A boy of mass 50kg runs up a set of steps of total height 3.0m. Find the work doneagainst gravity (a) 1200J (b) 1500J (c) 1000J (d) 1300J
    5. The SI unit of power is (a) joules (b) kilogram (c) watt (d) pascal
    6. A bob of a simple pendulum has a mass of 0.02kg. Determine the weight of the bob (a) 0.2w (b) 0.52w (c) 0.25w (d) 2N
    7. An object of mass 0.5kg has K.E of 25J. calculate the speed of the object (a) 50ms1 (b) 25ms-1  (c) 2.ms-1 (d)10ml-1
    8. An object of mass 0.5kg has a velocity of 4ms-1 Calculate the K.E (a) 4.0J (b) 40J (c) 0.4J (d) 400J
    9. Which of the following fundamental quantities is not correctly paired with its unit of measurement? (a) Electricity current – Ampere (b) Amount of substance – kilogram

(c) Temperature – Kelvin (c) length – meter

10. A diver is 5.2m below the surface of water of density 103 kg/m3. If the atmospheric pressure is 1.02 x 105 pa. Calculate the pressure on the diver. [g=10mls2 ) (a) 6.02 x 104 pa (b) 1.02 x 105 pa (c) 1.54 x 105 pa (d) 5.20 x 105 pa

**THEORY**

* + 1. Explain work done.
    2. A boy of mass 960g climbs up to 12 steps each of height 20cm in 20 seconds. Calculate the power of the boy.
    3. A loaded sack of total mass 100kg falls down from the floor of a lorry 2m high.

Calculate the work done by gravity on the load.

* + 1. State the law of conservation of energy.

**WEEK TEN**

**TOPIC: VISCOSITY**

**CONTENT**

**Meaning of Viscosity**

**Experiment to Determine the Terminal Velocity of a Steel Ball Falling in a**

**Fluid**

**Factors Affecting Viscosity**

**Effect of Viscosity**

**Application of Viscosity**

**MEANING OF VISCOSITY**

Viscosity is the internal friction which exists between layers of the molecules of a fluid (liquid or gas) in motion. The viscosity of a fluid can also be defined as the measure of how resistive the fluid is to flow. It is a vector quantity & measured in pascalseconds(pa.s). It can be defined mathematically as the ratio of the shearing stress to the velocity gradient in a fluid

Viscosity (ŋ) = Force

Area x Velocity gradient ……………………………………….1.

Velocity gradient = velocity

Length …………………………………………………2 W = U + V

W – U- V = 0 ……………………………………………………………3.

V = W – U (apparent or effective weight) where V-viscous force, W- weight, U- upthrust NB : Substances with low viscosity include water, kerosene, petrol, ethanol. Those with high viscosity are glue, syrup, grease, glycerine etc

**Experiment to Determine the Terminal Velocity of a Steel Ball Falling Through a Fluid**

**Aim**: To determine the terminal velocity of a steel ball falling in through a jar of glycerin

**Apparatus**: steel ball, cylindrical calibrated jar, glycerine

**Diagram**:

**Procedure**: Set-up the apparatus as shown above & gently drop the steel ball in the jar of glycerin

**Observation**: It will be observed that the ball is accelerating in the liquid. Also the time taken for the ball to move from A-B will be different from B-C and so on. A time will be reached when the ball will be moving at a constant speed or velocity. It is that point that terminal velocity is experience.

Graph :

**Conclusion**: Terminal velocity is attained when W = V + U. At a point when the ball is moving at a constant speed through the glycerine.

**Precaution**: 1. The steel ball should be dropped gently on the liquid 2. Experiment should be done under constant temperature 3. Avoid error of measurement when taken the reading.

NB: **Terminal velocity** is the maximum velocity of an object when the viscous force due to motion of the object equals the apparent (effective) weight of the object in the fluid where there is no longer net force on the object.

**Drag force** is the force that keeps the object continuously moving after the terminal velocity has been attained.

**Stokes’ Law** state that at the terminal velocity, the upward frictional force (F) = 6Π ŋrV

Where F- Frictional/Drag force, ŋ- viscosity, r- radius of sphere, Vt– Terminal velocity

**EVALUATION**

1. Derive the dimension of viscosity.
2. Describe an experiment to determine the terminal velocity of a steel ball falling ina fluid.

**Factors Affecting Viscosity**

1. Viscosity varies with material (viscosity is a property of material)
2. The viscosity of simple liquids (a) decreases with increasing temperature (b) increases under very high pressure
3. The viscosity of gases (a) increases with increasing temperature (b) is independent of pressure & density

**Effect of Viscosity**

1. Viscosity is responsible for different rate of fluid flow.
2. Viscosity affect motion of body in fluid.

**Application of Viscosity**

1. It is use as a lubricant.
2. The knowledge of viscous drag/drag force is applied in the design of ship & aircraft.
3. Use to estimate the enlarge size of particles.

**EVALUATION**

1. State two effects of viscosity.
2. State two applications of viscosity.

**GENERAL EVALUATION**

1. **Wh**at is viscosity?
2. What is terminal velocity?
3. State two(2) substances with high viscosity.
4. State Stoke’s law.
5. What is a viscostatic substance?

**READING ASSIGNMENT**

New school physics by M.W.Anyakoha,Phd.Pg 105 – 107

**WEEKEND ASSIGNMENT**

1. Viscosity opposes motion of an object in (a) solid (b) liquid only(c) gas only (d) liquid & gas
2. The SI unit of velocity gradient is (a) m/s (b) s-1 (c) m/s2 (d) ms
3. Terminal velocity is attained when (a) w + v = u (b) w = v – u (c) w + u = v (d) w = v + u
4. The following are vector quantities except (a) friction (b) viscosity (c) upthrust (d) pressure
5. Friction and viscosity are similar but not the same. True/False

**THEORY**

1. Explain viscosity.
2. Describe an experiment to determine the terminal velocity of a steel ball falling in a fluid.

NB: A liquid is said to be **VISCOSTATIC** if its viscosity does not change (appreciably) with change in temperature