FIRST TERM Physics E-LEARNING NOTE

Name____ Date__________________

FIRST TERM E-LEARNING NOTE

SUBJECT: PHYSICS **CLASS: SS2**

SCHEME OF WORK

WEEK	TOPIC
1.	Position, Distance and Displacement.
2.	Scalar and Vector Quantities-Concept of Scalar and Vector Quantities,Vector Representation etc
3.	Derivation of Equation of Linear Motion, Motion under Gravity, Calculation using theseEquations.
4.	Projectiles and Falling bodies.
5.	Newton Laws of Motion-Conservation of Linear Momentum and Energy.
6 & 7	Equilibrium of Forces-Principle of Moment, Conditions for Equilibrium of a Rigid Bodies etc.Centre of Gravity and Stability, Couple.
8.	Simple Harmonic Motion-Definition, Speed, Amplitude, Displacement, Acceleration,etc.
9 & 10	Machines – Types and Examples, Calculations.
11.	Laboratory Exercises

REFERENCE TEXT

- New School Physics by M.W Anyakoha
- SSCE WAEC Past Questions
- UTME Past Questions

WEEK ONE

POSITION,DISTANCE AND DISPLACEMENT

CONTENT

- ✔ Position
- ✔ Coordinates System
- ✔ Distance
- ✔ Displacement

POSITION

The position of an object in space or on a plane is the point at which the object can be located with reference to a given point (the origin).

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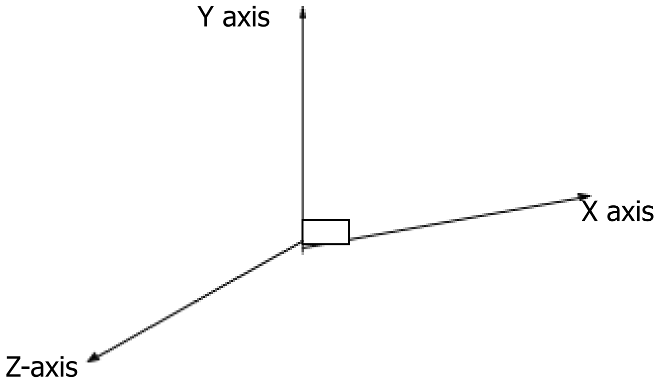
COORDINATES SYSTEM

1. RECTANGULAR CARTESIAN COORDINATE SYSTEM

This is a system that consists of two or three intersecting lines mutually perpendicular and which serves as a reference frame that guides one in locating the position of a point in a plane or in space.

This system also assigns direction(with arrow head) to these reference lines(called the coordinate axes) and make the distances measured from the point of intersection(known as the origin)positive along OX, OY and OZ and that measured on the opposite direction, negative.



3:Dimensional coordinate system diagram.

PLANE

A plane is a geometric figure defined by two reference frame or 2-dimensional coordinate system.

SPACE

A space is defined by three reference frames or 3-dimensional coordinate system.

EVALUATION

1. With the aid of a diagram, explain the term "plane" and "space".
2. Briefly describe how the position of a point can be located in space using rectangular Cartesian coordinate system

DISTANCE

This is a measure of the separation between two points. It has magnitude but no direction.Hence, it is a scalar quantity

DETERMINATION OF DISTANCE BETWEEN TWO POINTS

If two points A and B located in a plane are defined by two ordered pair of values(x_1 y_1) and (x_2 y_2) or assumed to be in space where they are defined by (x_1 y_1 z_1) and (X_2, Y_2 Z_2) the distance between them can be determined by applying the relation.

$AB = [(x2 – x1)^2 + (y2- y1)^2]^{1/2}$

EVALUATION

1. Calculate the distance between points A(2,3) and B(-5,1).
2. Calculate the distance between points J(-2,-4) and K(-5,-10) in space.

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DISPLACEMENT

Displacement is the distance covered in a specified direction. It is a vector quantity, that has the same unit as distance.

EVALUATION

1. Why is displacement regarded as vector quantity?.
2. Differentiate between distance and displacement.

READING ASSIGNMENT

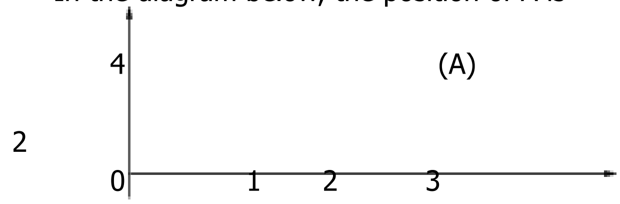
New School Physics for S S S-M W ANYAKOHA.Pages 121-126.

GENERAL EVALUATION

1. State 7 fundamental quantities.
2.for the fundamental quantities stated above give their respective units.

WEEKEND ASSIGNMENT

1. In the diagram below, the position of A is



(A)2,3 (B)3,3 (c)3,4 (D)4,3.

2, To locate a point in a plane or space, we can use.

(A)Bearing system. (B) Centrifugal (C) Centripetal. (D) None of the above

3.Displacement can be classified as

(A) Scalar quantity (B)Vector quantity (C)Both scalar and vector quantities. (D)All of the above.

4. Determine the distance between S(3,4,-5)and T(2,1,0). (A)5.8 (B) 5.9 (C) 6.0 (D) 6.2.

5. Distance can be measured by.

(A) Tape rule (B) Eureka can (C) Lever balance. (D) Stop watch.

THEORY

(1) Sketch clearly using scale indicators, the position of a point P (4,-5) and Q(-4, 10)with reference to a point Q(O,0). Determine the distance between P and Q.

(2) Distinguish between distance and displacement. Which of the terms is a vector and why?

WEEK TWO

SCALAR AND VECTOR QUANTITIES

CONTENT

- ✔ Concept of scalar and vector quantities.
- ✔ Vector representation, addition of vectors.
- ✔ Resolution of vectors and resultant.

CONCEPT OF SCALAR AND VECTOR QUANTITIES

Physical quantities are divided into two types

i Scalar quantity

ii Vector quantity

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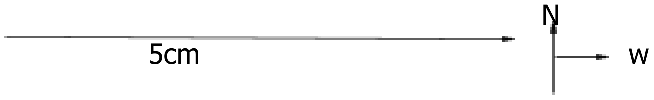
A scalar is one which has only magnitude (size) but no direction e.g. distance, speed , temperature , volume , work , energy, power , mass ,electric potential , gravitational potential electric charge .

A vector quantity has both magnitude (size) and direction e.g. force, weight, velocity, acceleration, momentum displacement, magnetic flux, electric fields and gravitational fields.

Scalar quantities are added according to the ordinary rules of arithmetic. For example , a mark of 50 added to a mark of 40 produces a mark of 90 –no directional property .But a force of 50N combined with a force of 40N may produce 90N if they are acting in same direction. But they are acting in opposite direction it would produce a different result. These vectors are combined or added by a special law the parallelogram law of addition of vectors.

VECTOR REPRESENTATION

A vector quantity can be graphically represented by a line drawn so that the length of the line denotes the magnitude of the quantity . The direction of the line indicates the direction in which the vector quantity act and it is shown by an arrow head . E.g a distance of 5km west represented by 5cm length of line where 1km = 1cm



ADDITION AND SUBTRACTION OF VECTORS

Two or more vectors acting on a body in a specified direction can be combined to produce a single vector having the same effect .The single vector is called the resultant.

For example:

(a) Two forces Y and X with magnitude of 3N and 4N respectively acting along the same direction will produce a resultant of 7N (algebraic sum of the two vectors).

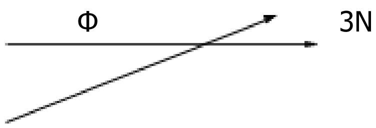
3N + 4N = 7N

(b) If Y and X act in opposite direction, the resultant will be 1N.

4N _ 3N 1N

-

(c) If the two vectors are inclined at an angle less than 90^0 or more than 90^0 , the resultant cannot be obtained by Pythagoras theorem but by vector addition,. Parallelogram law of vector, trigonometric or scale drawings can be used to calculate the magnitude and direction of the resultant 4N



$\varphi < 90^0$

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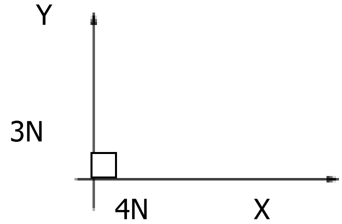
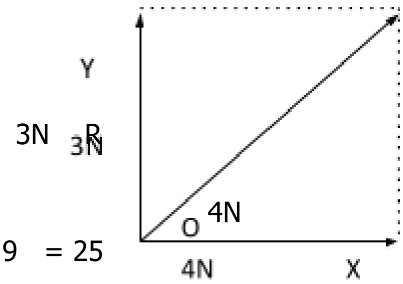
VECTORS AT RIGHT ANGLES

i. Parallelogram law of vectors states that if two vectors are represented in magnitude and direction by adjacent sides of a parallelogram , the resultant is represented in magnitude and direction by the diagonal of the parallelogram drawn from the common point





$R^2 = X^2 + Y^2 = 4^2 + 3^2 = 16 + 9 = 25$

$R = \sqrt{25} = 5N$

$\tan\theta = Y/X$

$\theta = \tan^{-1}(Y/X) = \tan^{-1}(3/4)$

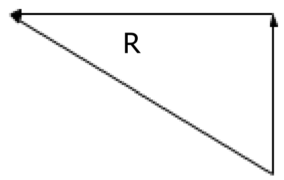
$\theta = \tan^{-1}(0.75)$

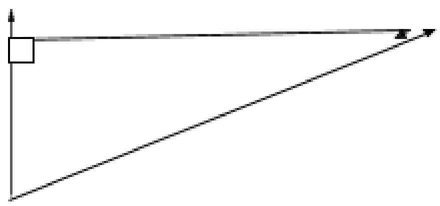
$\theta = 36.9^0$

ii. If the two vectors are inclined at an angle less than 90^0 , the scale drawing or trigonometric method can used . In using scale drawing (graphical) methods, a convenient scale is chosen (if the magnitude of the forces given is large) and then draw the lengths corresponding to the magnitude of the forces . A Protractor is used to draw the angle in between the forces. The parallelogram is completed and the resultant and its fraction obtained

A

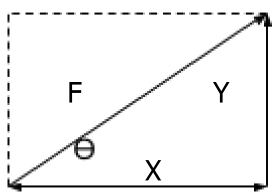
R





RESOLUTION OF VECTORS

A single vector can be resolved into two vectors called components. A vector F represented as the diagonalof the parallelogram can be resolved into its component later taken as the adjacent sides of the parallelogram.



$\sin\theta = Y/F$

$Y = F\sin\theta$ (vertical component)

$\cos\theta = X/F$

$X = F\cos\theta$ (horizontal component)

The direction of F is given by

$\tan\theta = Y/X$

$\Theta = \tan^{-1}(Y/X)$

THE RESULATNT OF MORE THAN TWO VECTORS

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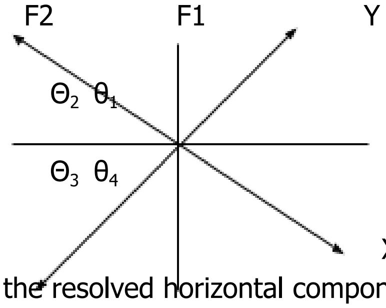
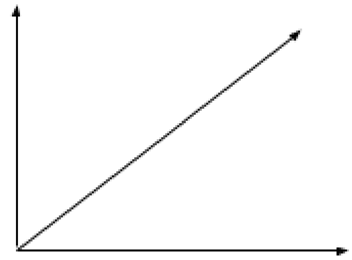
To find the resultant of more than two vectors, we resolve each vector in two perpendicular direction s add all the horizontal components X, and all the vertical components, Y.

For example, consider four forces acting on a body as shown below





Add all the resolved horizontal components

X = F1 cos θ1 + (-F2 cosθ2) + (-F3 cos θ3) + F4 cos θ4

Y= F1 sin θ1 + F2 sinθ2 + (-F3 sinθ3) + (-F4 sinθ4)

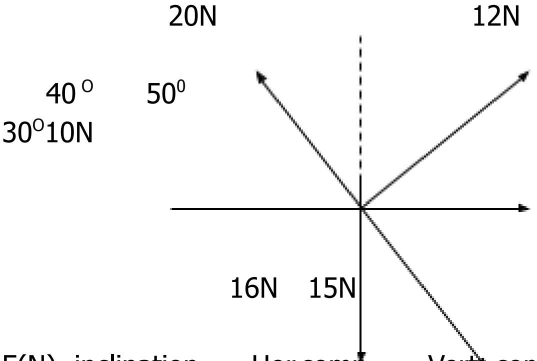
R = $\sqrt{X^2 + Y^2}$

And the direction ∞ is given by

Tan ∞ = y/x

EVALUATION

1 Calculate the resultant of five coplanar forces of values10N, 12N , 16N , 20N , 15N on an object as shown below



F(N)	inclination	Hor.comp.	Vert. comp.
10	0	10cos θ=10.00	10 sin θ= 0
12	50	12 cos 50 =7.71	12 sin50= 9.19
20	40	-20 cos 40 =-15.32	20sin40= 12.85
16	90	16 cos 90 = 0	-16 sin 90= -16.00
15	60	15cos60 =7.50	-15 sin60 =-12.99
		9.89	-6.95

R = √(19.89^2 + (6.95^2

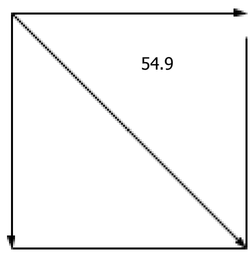
R = 12.09

Tan ∞ = 6.95/9.89

∞ = -35.1^0

90 – 35.1

=54.9



The direction of the resultant is S 54.9^0

GENERAL EVALAUTION

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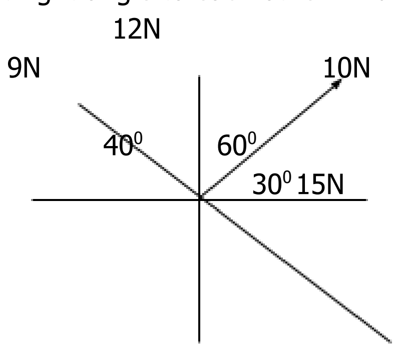
1. A body of mass 3.0Kg is acted upon by a force of 24N, if the frictional force on the body is 13N.Calculate the acceleration of the body.
2. For the body in question 1 above, what distance would it move if the force was applied for a period of 7s?

WEEKEND ASSIGNMENT

1. Which of the following is not a vector quantity (a) speed (b) velocity (c) force (d) acceleration (e) Electric field
2. Which of the following is not a scalar quantity (a) density (b) weight (c) speed (d) mass (e) temperature
3. Two forces , whose resultant is 100N are perpendicular to each other.If one of the makes an angle of 60 with the resultant , calculate its magnitude (sin60 = 0.8660 ,cos 60 = 0.500) (a) 200N (b) 173.2N (c) 115 .5N (d) 86.6 N
4. A boy pulls his toy on a smooth horizontal surface with a rope inclined at 60 to the horizontal .If the effective force pulling the toy along the tension in rope (a) 2.5 N (b) 4.33N (c) 5.0 N (d) 8.66N (e) 10.0N
5. A boy is pulling a load of 150N with a string inclined at an angle of 30 to the horizontal. If the tension in the lift the load off the ground is (sin 30 = ½ , cos 30 = √3/2 and tan30 = 1/√3) (a) 255N (b) 202.5N (c) 105 √3/2 N (d) 75N (e) 52.5N

THEORY

1. Two forces of magnitude 12N and 9N act at right angle to each other f ind the resulrant?
2. Four forces act as shown below.



Calculate their resultant

READING ASSIGNMENT

New Sch. Physics for Senior Sec. Schls. Pages 346---356

WEEK THREE

DERIVATION OF EQUATONS OF LINEAR MOTION

CONTENT

- ✔ Basic definitions
- ✔ Derivation of equations of linear motion
- ✔ Motion under gravity

Basic definitions

There are four major terms associated with motion in a straight line . These are speed (v) or velocity (v), distance (s) or displacement (s), acceleration (a) and time (t).

DISPLACEMENT: This is the distance traveled in a specified direction. For example, if a body moves a distance of 50m northwards, it is a vector quantity while distance is a scalar quantity. Distance indicates how far an object has moved. It's a scalar quantity.

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The rate at which a body covers a distance is called the SPEED of the body.

Thus, speed = $\frac{\text{distance}}{\text{Time}}$ (m/s , km/hr)

VELOCITY is the rate of change of displacement with time. When a body moves with equal displacement in equal interval of time, no matter how small the time intervals may be, the velocity is said to beuniform or constant.

ACCELERATION: is the rate of change of velocity with time . When the velocity increases in time , the rate of change of velocity is termed acceleration but when the velocity decreases with time ,it is called RETARDATION .Retardation is a negative acceleration.
When the rate of change of velocity with time is constant, we have uniform acceleration

EVALUATION

Sketch the velocity—time graph for a body that starts from rest and accelerates uniformly to a certain velocity If it maintains this for a given period before its eventual deceleration. Indicate the following:

1 Uniform acceleration, retardation
2 Total distance travelled

DERIVATION OF EQUATIONS OF LINEAR MOTION

v= Final velocity
u = Initial velocity
a = Acceleration
t = Time
s = Distance

$v = u + at$ --------------------- (i)

Average speed = $\frac{\text{total distance}}{\text{Time}}$

$\frac{s}{t} = \frac{u+v}{2}$

$\frac{s}{t} = \frac{u+u+at}{2}$

$\frac{s}{t} = \frac{2u+at}{2}$

$\frac{s}{t} = u + \frac{1}{2}at$

$s = ut + \frac{1}{2}at^2$ ———————(2)

$v^2 = (u + at)^2$

$v^2 = (u + at)(u + at)$

$v^2 = u^2 + 2uat + at^2$

$= u^2 + 2a(ut + \frac{1}{2}at^2)$

therefore $v^2 = u^2 + 2as$---------------(3)

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$$s = \left(\frac{u + v}{2}\right) t \text{ --------------(4)}$$

CALCULATIONS USING THE EQUATION OF MOTION

A car moves from rest with an acceleration of 0.2 m/s2. Find its velocity when it has covered distance of 50m

u= 0m/s

a= 0.2m/s2

s= 50m

v = ?

$v^2 = u^2 + 2as$ = (0)2 + 2 (0.2 x 50) = 20

v= √20= 2√5m/s

A car travels with a uniform velocity of 108km/hr .How far does it travels in ½ minutes?

Solution

v=108km/hr t= ½ minutes distance = ?

$v = 108 \text{ km/hr} = \frac{108 \times 1000}{3600}$

v= 30m/s t= ½ 60 = 30secs

$\text{speed} = \frac{\text{distance}}{\text{time}}$

Distance = speed x time = 30 x 30 = 900 m

CLASS ACTIVITIES

(1) A train slopes from 108 km/hr with a uniform retardation of 5 m/s^2 . How long will it take to reach 18 km/hr and what is the distance covered ?

(2) An orange fruit drops to the ground from the top of a tree 45m tall .How long does it take to reach the ground (g= $10m/s^2$)?

(3) A car moving with a speed of 90 km/h was brought uniformly to rest by the application of brake in 10s. How far did the car travel after the far did the car travel after the brakes were applied.Calculate the distance it covers in the last one second its motion.

FURTHER ACTIVITIES

A car starts from rest and accelerates uniformly until it reaches a velocity of 30m/s after 5secs . It travels with this uniform velocity for 15secs and it is then brought to rest in 10 secs with a uniform acceleration. Determine

(a) the acceleration of the car

(b) the retardation

(c) the distance covered after 5 secs

(d) the total distance covered.

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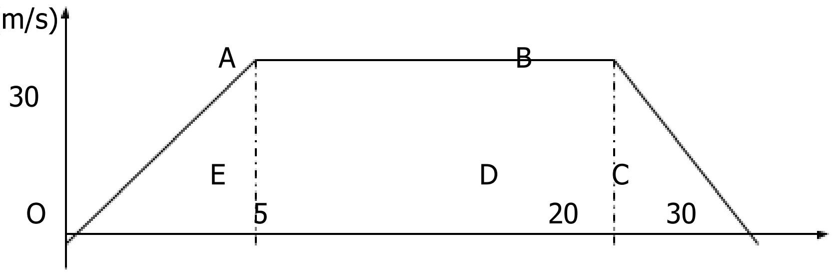
SOLUTION



ACCELERATION = $\frac{AE}{EO} = \frac{30}{5} = 6 m/s^2$

RETARDATION = $\frac{CB}{DC} = \frac{0 - 30}{10} = - 3 m/s^2$

II The distance covered after 5sesc

The area is given by area of the triangle

= ½ b h

= ½ (5) 30

= 75m

iv The total distance covered = area of the trapezium OABC

= ½ (AB + OC) X h

= ½ (15 + 30) 30

= 45 x 15

= 675 m

CLASS WORK

A lorry starts from rest and accelerates uniformly until it reaches a velocity of 50 m/s after 10 secs . It travels with uniform velocity for 15 secs and is brought to rest I 5secs with a uniform retardation .

Calculate :

a) The acceleration of the lorry
b) The retardation
c) The total distance covered
d) The average speed of the lorry

MOTION UNDER GRAVITY

A body moving with a uniform acceleration in space does so under the influence of gravity with a constant acceleration . ($g = 10 m/s^2$). In dealing with vertical motion under gravity , the following points must be noted

- ✔ All objects dropped near the surface of the Earth in the absence of air resistance fall toward the Earth with the same nearly constant accelerationWe denote the magnitude of free-fall acceleration as g.
- ✔ The magnitude of free-fall acceleration decreases with increasing altitude. Furthermore, slight variations occur with latitude. At the surface of the Earth the magnitude is approximately $9.8 m/s^2$. The vector is directed downward toward the centre of the Earth.
- ✔ Free-fall acceleration is an important example of straight-line motion with constant acceleration.
- ✔ When air resistance is negligible, even a feather and an apple fall with the same acceleration, regardless of their masses.

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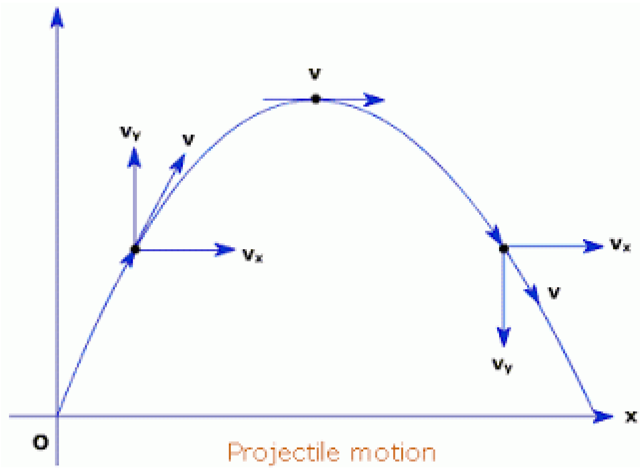


- ✔ a= +g is positive for a downward motion but (-g) negative for an upward motion
- ✔ The velocity v = 0 at maximum height for a vertically projected object
- ✔ The initial velocity u = 0 for a body dropped from rest above the ground .
- ✔ For a rebounding body the height h above the ground is zero

The time of fall of two objects of different masses has nothing to do with their masses but is dependent on the distance and acceleration due to gravity as shown below

S= ut + ½ gt2

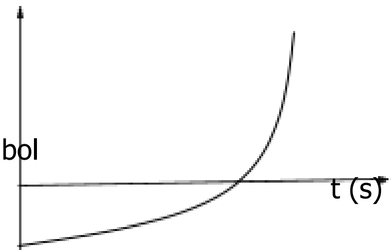
S = ½ gt2 (u=0)

t= √2s/g

The above relationship can also be used to determine the value of acceleration due to gravity. If we plot s against t, it will give us a parabolic curve.

S(m)

parabol



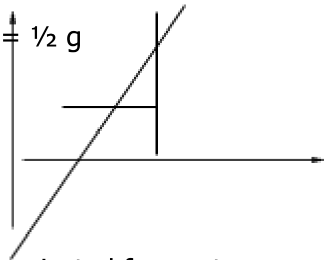
t (s)

A graph of s against t^2 will give us a straight line through the origin with slope ½ g from which g can be computed

S(m)

Slope = ½ g

(O,0)



t^2 (s^2)

Case One. For a body projected from a tower or plane of height h.

1. The body covers both horizontal Sx(also known as the range , R) and vertical Sy (height) distance.

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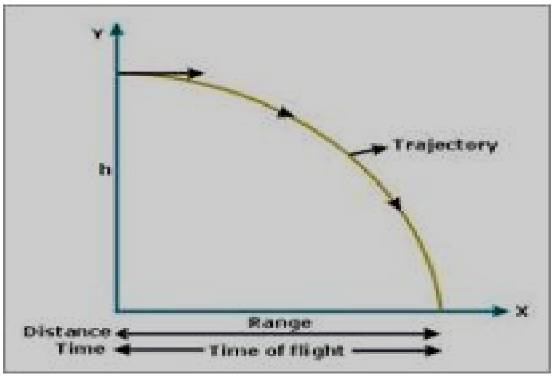


Gravity has no effect on the horizontal distance covered but on the vertical distance, hence

$S_x = R = ut$…………………… #

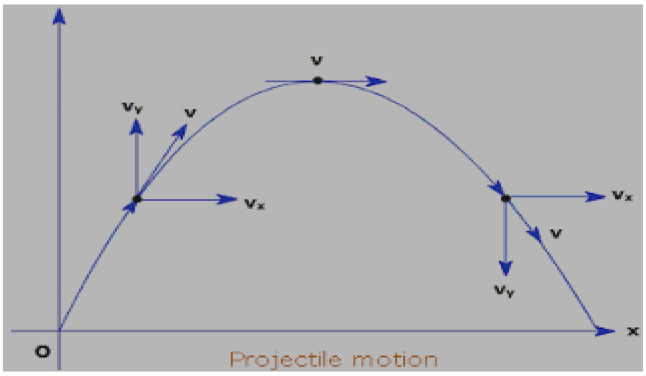
$S_y = ut + 1/2gt^2$ but u = 0

$S_y = ½ gt^2$ …………………….. #

Case two: For a body thrown vertically upward from the ground to a maximum height h and back to the ground.

At maximum height v = 0

Time taken to maximum height is same time taken from maximum height to the ground.



Time to maximum height (t)

V = u – gt

0 = u – gt

u = gt…………….. #

Maximum height attained

$V^2 = u^2 - 2gh_{max}$

$0 = u^2 - 2gh_{max}$

$u^2 = 2gh_{max}$ ………………… #

Case three for a body projected from the top of a tower to a maximum height h

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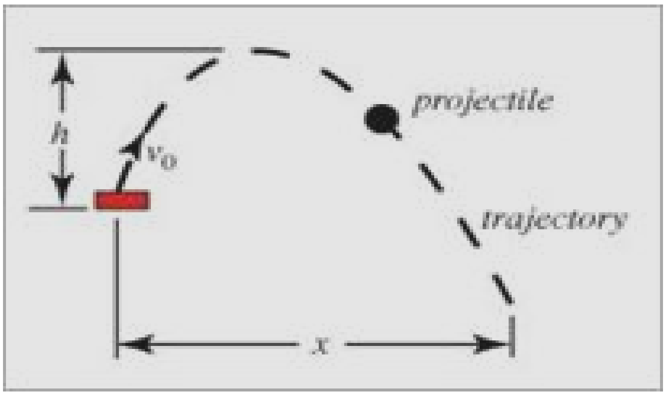

At maximum height h, v=0

Time (t) to maximum height

V = u - gt

0 = u –gt

U = gt

Time from maximum height h to the ground

Total distance travelled = h + h1

h + h1 = ut + 1/2gt^2

CALCULATIONS

1. A ball is thrown vertically into the air with an initial velocity, u. What is the greatest height reached?

Solution

$V^2 = u^2 + 2as$

U= u , a = -g , v = 0

02 = u2 + 2 (-g) s

$2gs = u^2$

$s = u^2 /2g$

2. A ball is released from a height of 20m .Calculate

(i) the time it takes to fall

(ii) the velocity with which it hits the ground

a= +g u=0 s =20m t = ?

t = √2s/g

t = √ 2 x20 /10

t = 2 secs

v = u + gt

v= gt

v = 10 x2

v = 20 m/s

GENERAL EVALUATION

1. List five apparatus for measuring the mass of a body.
2. List five apparatus for measuring the length of a body.

WEEKEND ASSIGNMENT

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1. A body starts from rest and accelerate uniformly at $5m/s^2$ until it attain a velocity of 25m/s.Calculate the time taken to attain this velocity (A) 2S (b) 3s (c) 5s (d) 6s.
2. A particle accelerates uniformly from rest at $6m/s^2$ for 8secs and then decelerates uniformly to rest in the next 5 secs. Determine magnitude of the deceleration (a) 9.6 m/s^2 (b) -9.6 m/s^2 (c) 6.9 m/s^2 (d) – 6.9 m/s^2
3. A car takes off from rest and covers a distance of 80m on a straight road in10secs Calculate its acceleration (a) 160 m/s^2 (b) 16 m/s^2 (c) 1.6 m/s^2 (d) 0.16 m/s^2
4. An object is released from rest at a height of 20m. Calculate the time it takes to fall to the ground (g= $10m/s^2$) (a) 1s (b) 2s (c) 3s (d) 4s.
5. A body accelerates uniformly rest at the rate of $3m/s^2$ for 8 secs. Calculate the distance it covers. (a) 24m (b) 48m (c) 72m (d) 96m.

THEORY

1. A particle start from rest and moves with constant acceleration of $0.5m/s^2$ .Calculate the time taken by the particle to cover a distance of 25m .
2. A particle accelerate uniformly from rest at $6m/s^2$ for 8secs and then decelerates uniformly to rest in the next 7secs .Determine the magnitude of the deceleration.

READING ASSIGNMENT

New Sch. Physics for Senior Sec. Schls. Pages 130-134.

WEEK FOUR
PROJECTILES AND FALLING BODIES

CONTENT

- ✔ Terms associated with projectiles
- ✔ Equation of projectile motion
- ✔ Uses of projectile

A **PROJECTILE** is an object or body launched into the air and allowed to move on its own or move freely under gravity.

A projectile motion is one that follows a curved or parabolic path .It is due to two independent motions at right angle to each other These motions are

i. a horizontal constant velocity
ii. a vertical free fall due to gravity

Projectile is a two dimensional motion of an object thrown obliquely into the air, the part followed by a projectile is called a trajectory

The following are examples of projectile motion

i. A throw rubber ball rebouncing from a wall.
ii. An athlete doing the high jump.
iii. A stone released from a catapult.
iv. A bullet fired from a gum.
v. A cricket ball thrown against a vertical wall.

TERMS ASSOCIATED WITH PROJECTILE

1. Time of flight (T):The time of flight of a projectile is the time required for the projectile to get to maximum height and return to the same level from which it projected.
2. The maximum height (H):is defined as the highest vertical distance reached and is measured from the horizontal projection plane.

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3. The range (R): is the horizontal distance from the point of projection of a particle to the point where the particle hit the projection plane again.

$U_y = U \sin \theta$ (vertical component)

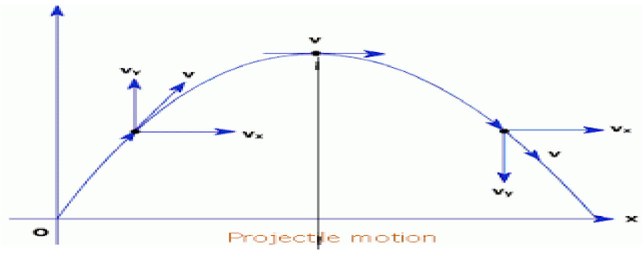
$U_x = U \cos \theta$ (Horizontal component)

t = time to reach the greatest height (s)

V = u + at v =o, a = -g

θ= u sin – gt

$t = \frac{U \sin \theta}{g}$ 1



T = Time of flight (s)

DETERMINATION OF TIME OF FLIGHT (T), RANGE (R) AND MAXTMUM HEIGHT

Assuming that Q is the point where the particles meet the target. Let T be the time of flight at Q, the vertical displacement is zero

Vertically $S = U \sin \theta \, t - 1/2 \, gt^2$

$0 = U \sin \theta - ½ \, gt^2$

$½ \, gt^2 = U \sin \theta \, t$

$T = \frac{2 U \sin \theta}{g}$ 2

Horizontally, considering the range covered

$R = \frac{U^2 \sin 2\theta}{g}$ 3

For max .range $\theta = 45^0$

$\sin 2\theta = \sin 2 (45) = \sin 90^0 = 1$

$R = \frac{U^2}{g}$

$R \max = \frac{U^2}{g}$ 4

For maximum height H ,

$V^2 = U^2 \sin^2\theta - 2g H$

At max height H, V=0

$H = \frac{U^2 \sin^2\theta}{2g}$ 5

APPLICATION OF PROJECTILES

1. To launch missiles in modern warfare
2. To give athletes maximum takeoff speed at meets

In artillery warfare, in order to strike a specified target, the bomb must be released when the target appears at the angle of depression p given by :

Tan φ =1/u √gh/2

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EXAMPLES

1. A bomber on a military mission is flying horizontally at a height of zoom above the ground at
60kmmin-1

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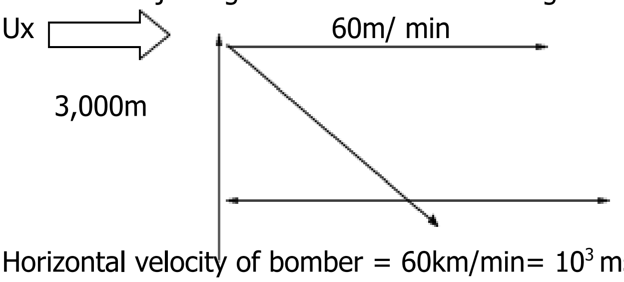
2. It drops a bomb on a target on the ground. determine the acute angle between the vertical and the line joining the bomber and the tangent at the instant. the bomb is released



Horizontal velocity of bomber = 60km/min= 10^3 ms^{-1}

Bomb falls with a vertical acceleration of g = 10m/s

At the release of the bomb, it moves with a horizontal velocity equals that of the aircraft i.e. 1000m/s

Considering the vertical motion of the bomb we have

$h = ut + 1/2\ gt^2 (u=o)$

$h = 1/2 gt^2$

wheret is the time the bomb takes to reach the ground :. $300 = 1/2gt^2$

$t^2 = 600$

t=10 √6 sec, considering the horizontal motion we have that horizontal distance moved by the bomb in time t is given by

s =horizontal velocity x time

= 1000 x10√6 = 2.449×10^4 m

buttanθ = $\frac{s}{3,000}$ = $\frac{2.449 \times 10^4}{3,000}$

θ =83.02$^{\theta}$

2. A stone is shot out from a catapult with an initial velocity of 30m at an elevation of 60,find

a. the time of flight

b. the maximum height attained

c the range

$T = \frac{2U \sin\theta}{g}$

$T = \frac{2 \times 30 \sin 60^o}{10}$

T= 5.2s

The maximum height,

$H = U^2 \sin^2\theta$

$H = \frac{30^2 \sin^2 (60)}{20} = 33.75$ m

The range ,$R = \frac{U^2 \sin 2\theta}{g}$

$R = \frac{30^2 \sin^2 (60)}{10}$

= 90 sin 120

= 77.9 m

3. A body is projected horizontally with a velocity of 60m/s from the top of a mast 120m above the grand, calculate

(i) Time of flight, and

(ii) Range

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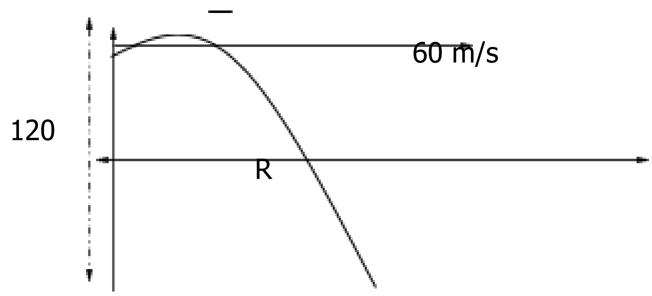

a. $s = ut + 1/2gt^2$
a=g, u=o
$120 = ½ (10)t^2$
t2 = 24
t = 24
t =4.9s
(b) Range =u cosθ x T.
but in this case θ =o
cos o =1
R =ut
= 60x 4.9
=294m
$s = ut + 1/2gt^2$
a=g, u=o
$120 = ½ (10)t^2$
$t^2 = 24$
t = 24
t =4.9s

4 A stone is projected horizontally with a speed of 10m/s from the top of a tower. With what speed does the stone strike the ground?

T = √ 2H/g =√2x50/10 =10
R = ut = 10√10 m
$V^2 = u^2 + 2gh$
$=0^2+2x10x50$ (U= 0 when it strikes the ground)
=0+1000
V =$\sqrt{1000}$
V =33.33m/s

5. A projectile is fired at an angle of 60 with the horizontal with an initial velocity of 80m/s. Calculate:

i the time of flight
ii. the maximum height attained and the time taken to reach the height
iii. the velocity of projection 2 seconds after being fired (g = 10m/s)

O=60
u =80m/s
T =? H =? T =? R=?

$T = \frac{2 U \sin \theta}{g}$

$T = \frac{2x80 \sin 60}{10} =$ 13 .86 s

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$H = \frac{u^2 \sin 2\theta}{2g}$

$H = \frac{80 \times 80 \times \sin 60}{20} = 240$ m

$t = \frac{U \sin \theta}{g} = \frac{80 \sin 60}{10} = 6.93$ s

$R = \frac{U^2 \sin 2\theta}{g} = \frac{80^2 \sin 2(60)}{10}$

$R = 640 \sin 120 = 554.3$m

(iii) $V_y = U \sin \theta - gt$

$V_y = 80 \sin 60 - 20 = \underline{49.28\text{m/s}}$

$U_x = U \cos \theta$

$U_x = 80 \cos 60 = 40$ m/s

$U^2 = U^2y + U^2x$

$= 49.28^2 + 40^2 = \sqrt{1600 + 2420} = 63.41$ m/s

GENERAL EVALUATION

A stone of mass 0.4Kg is attached to a string of length 2.5m and its is spin around by a boy at 5rad/s. calculate

1. The force necessary for this motion.
2. The linear velocity with the stone moves.

WEEKEND ASSIGNMENT

1. A ball is projected horizontally from the top of a hill with a velocity of 30m/s. if it reaches the ground 5 seconds later, the height of the hill is: (a) 200m (b) 65m (c) 250m (d) 100m.
2. The maximum height of a projectile projected with an angle of to the horizontal and an initial velocity of U is given by
   (a) $\frac{U \sin^2 \theta}{g}$ (b) $\frac{U^2 \sin \theta}{2g}$ (c) $\frac{U^2 \sin \theta}{g}$ (d) $\frac{2U^2 \sin^2 \theta}{g}$ (e) $\frac{2U \sin 2\theta}{g}$
3. A stone is projected at an angle 60 and an initial velocity of 20m/s determine the time of flight(a) 34.6s (b) 3.46s (c) 1.73s (d) 17.3s (e) 6.92s
4. The range of a projectile projected at θ to the horizontal with a velocity U is given by
   a) $\frac{U^2 \sin 2\theta}{g}$ (b) $\frac{U^2 \sin^2 \theta}{2g}$ (c) $\frac{2U^2 \sin^2 \theta}{g}$ (d) $\frac{2U^2 \sin^2 \theta}{g}$ (e) $\frac{U^2 \sin 2\theta}{g}$
5. For a projectile the maximum range is obtained when the angle of projection is;
   a) 60 b) 30 c) 45 d) 75 e) 90

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THEORY

1. A gun fires a shell at an angle of elevation of 30 with a velocity of 2x10m what are the horizontal and vertical components of the velocity? What is the range of the shell? How high will it rise?
2. A stone propelled from a catapult with a speed of 50m/s attains a height of 100m. Calculate. (a)the time of flight (b). the angle of projection (c). the range attained.

READING ASSIGNMENT

New Sch. Physics for Senior Sec. Schls. Pages 137-144.

WEEK FIVE

NEWTON'S LAWS OF MOTION

CONTENT

✔ Newton's laws motion

✔ Conservation of linear momentum

NEWTON'S FIRST LAW OF MOTION states "that everybody continues in its state of rest or of uniform motion in straight line unless it is acted upon by a force."

This simply means that a body at rest will remain permanently there or a body moving with uniform velocity on a straight line will continue moving forever if it were possible for all the external opposing forces to be eliminated.

The tendency of a body to remain at rest or, if moving, to continue its motion in a straight line is called the inertia of the body. That is why Newton's first law is otherwise referred to as the law of inertia

There are consequences of this law. For example, when a car had a head on collision with another car or the driver suddenly applies the brake, the passengers are likely to be injured when they hit the windscreen.

The reason is that an external force will only stop the car but not the passengers who tend to continue their linear motion. This necessitated, the use of safety precautions e.g seat belt
Also, if a stationary car is knocked forward from behind, the passengers may sustain neck injuries as their bodies tend to move forward in relation to the car while their neck move backward. Modern cars have rests to prevent this incident

NEWTON'S SECOND LAW OF MOTION states "that the rate of change of momentum of a body is directly proportional to the applied force and takes place in the direction in which the force acts." This implies that when a heavy body and a light one are acted upon by the same force for the same time, the light body will build up a grater velocity than the heavy one. But they gain the same momentum

$$F \propto \frac{mv - mu}{t}$$

$$F \propto \frac{m(v - u)}{t}$$

$$F = \frac{K\,m(v - u)}{t}$$

where k is a constant, if v = 1, u = 0, t= 1, m =1 and F=1 ,then k=1

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but $a = \frac{v - u}{t}$

F= kma but k= 1

F =ma 1

Momentum of a body is the product of the mass and velocity of the body.
The S.I unit of momentum is kgm/s.

IMPULSE

The impulse of a force and time. This impulse is also equal to the change in momentum and they therefore share the same unit (Ns)

$F = \frac{m(v-u)}{t}$

Ft = mv – mu 2

F x t = I (Ns) 3

mv- mu = change in momentum 4

NEWTON'S THIRD LAW OF MOTION states that to every action, there is an equal but opposite reaction. when a book is placed on a table, the downwards weight (force) of the book on the table is balanced by the upwards reaction of the table on the book.

Another practical demonstration of this law can be observed when a bullet is fired from a gun, the person holding it experiences the backward recoil force of the gun (reaction) which is equal to the propulsive force (action) acting on the bullet.

According to Newton second law of motion, force is proportional to change in momentum,therefore the momentum of the bullet is equal and opposite to the momentum of the gun i.e.

mass of bullet x muzzle velocity = mass of gun x recoil velocity,

hence, for a bullet of mass in and muzzle velocity , v the velocity v of the recoil of the gun is given by

$M_gV_g = m_bv_b$ 5

$Vg = m_bv_b / M_g$

EVALUATION

1. State Newtons laws of motion
2. Mention and explain the consequencies of each law stated above

CONSERVATION OF LINEAR MOMENTUM

The principle of conservation of linear momentum states that when two or more bodies collide, their momentum remain constant provided there is no external force acting on the system. This implies that in a closed or isolated system where there is no external forces , the total momentum after collision remains constant.

The principle is true for both elastic and inelastic collision.

TYPES OF COLLISION

There are two types of (a) collision- elastic and (b) inelastic.

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IN ELASTIC COLLISION where the two bodies and then move with different velocities , both momentum and kinetic energy are conserved eg collision between gaseous particles , a ball which rebounds to its original height etc .If the two colliding bodies have masses $m_1$and m_2 initial velocities u_1 and u_2 and final velocities v_1 and v_2 , , the conservation principle can be mathematically expressed as

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$ 6

IN AN INELASTIC COLLISION , the two bodies join together after the collision and with the same velocity momentum is conserved but kinetic energy is not conversed because part of it has been converted to heat or sound energy, leading to deformation

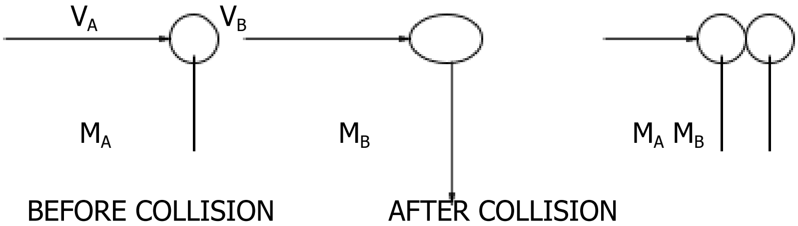
Thus, the conversation principle can be re-written as

$m_1U_1 + m_2U_2 = V_{12}(m_1 +m_2)$ 7

$V_{12} =$ common velocity

Since momentum is a vector quantity, all the velocities must be measured in the same direction , assigning positive signs to the forward velocities and negative signs to the backward or opposite velocities .

TWO BODIES MOVING IN THE SAME DIRECTION BEFORE COLLISION



BEFORE COLLISION AFTER COLLISION

$M_AV_A + M_BV_B = V_{AB} (M_A + M_B)$.............................. 8

V_{AB}= COMMON VELOCITY

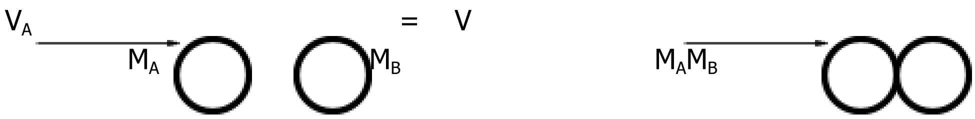
$$V= \frac{M_AV_A + M_BV_B}{M_A+ M_B}$$

TWO BODIES TRAVELLING IN OPPOSITE DIRECTION

$M_AV_A – M_BV_B = V_{AB}(M_A+ M_B)$ 9

$$V_{AB}= \frac{M_AV_A – M_BV_B}{M_A + M_B}$$

COLLISION BETWEEN A STATIONARY AND MOVING BODY



The momentum of a stationary body is zero

$M_AV_A + 0 = M_AV_A / M_A + M_B$.

Worked example.

1 Two moving toys of masses 50kg and 30 kg are traveling on the same plane with speeds of 5 m/s and 3 m/s respectively in the same direction .If they collide and stick together , calculate their common velocity.

$M_AV_A + M_BV_B = V(M_A +M_B)$

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$V = \frac{M_A V_A + M_B V_B}{M_A + M_B}$

$= \frac{50 \times 5 + 30 \times 3}{50 + 30}$

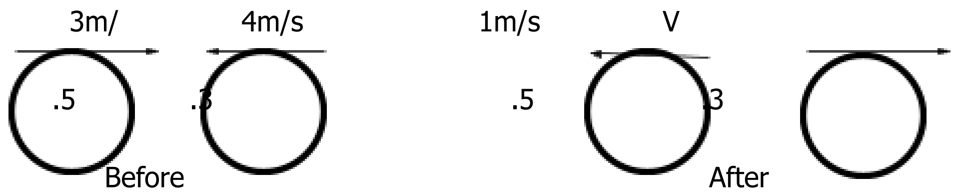
$= \frac{250 + 90}{80}$

$= \frac{340}{80}$

= 4.05 m/s

2 Two balls of masses 0.5 kg and 0.3kg move towards each other in the same line at speeds of 3 m/s and 4 m/s respectively .After the collision , the first balls has a speed of 1m/s in the opposite direction

What is the speed of the second ball after collision?



$3 \times 0.5 + (0.3 \times -4) = 0.5(-1) + 0.3v$

$1.5 - 1.2 = -0.5 + 0.3v$

$0.8 / 0.3 = V$, $V = 2.7 m/s$

3 A gun of mass 100kg fires a bullet of mass 20g at a speed of 400m/s .What is the recoil velocity of the gun ?

Momentum gun = momentum of bullet

$M V = m v$

$10 \times V = 0.002 \times 400$

$V = \frac{0.002 \times 400}{10}$

V= 0.8 m/s.

EVALUATION

1. State the principle of conservation of linear momentum.
2. Explain elastic and inelastic collision, and give two example of each

GENERAL EVALUATION

1. State Archimedes principle.
2. A 15kg monkey hangs from a cord suspended from the ceiling of an elevator. The cord can withstand a tension of 200N and breaks as the elevator accelerates. What was the elevators minimum acceleration ($g=10m/s^2$).

WEEKEND ASSIGNMENT

1 A ball of mass 0.5kg moving at 10m/s collides with another ball of equal mass at rest. If the two balls move off together after the impact, calculate their common velocity (A) 0,2m/s (B)0.5m/s (C) 5m/s (D) 10m/s.

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2 A ball of mass 6kg moving with a velocity of 10m/s collides with a 2kg ball moving in the opposite direction with a velocity of 5m/s. After the collision the two balls coalesce and move in the same direction. Calculate the velocity of the composite body.
(A) 5m/s (B) 6.25m/s (C) 8.75m/s (D) 12m/s

3 A constant force of 5N acts for 5 seconds on a mass of 5kg initially at rest. Calculate the final momentum. (A) 125kgm/s (B) 25kgm/s (C) 15kgm/s (D) 5kgm/s.

4 When taking a penalty kick, a footballer applies a force of 30N for a periods of 0.05S. If the mass of the ball is 0.075kg, calculate the speed with which the ball moves off. (A) 4.5m/s (B) 11.25m/s (C) 20m/s (D) 45m/s.

5 A body of mass 40kg changes its velocity from 10m/s to 80m/s in 10 seconds. Calculate the force acting on the body. (A) 480N (B) 380N (C) 280N (D) 180N.

THEORY

1. State the law of conservation of linear momentum. A 3kg rifle lays on a smooth table when it suddenly discharges, firing a bullet of 0.02kg with a speed of 500m/s. Calculate the recoil speed of the gun.
2. Distinguish between:
   (a) elastic and inelastic collisions (b) Inertial mass and weight
   (c) Derive from Newtons law the relationship between Force, mass and acceleration.

READING ASSIGNMENT

New Sch Physics FOR SSS-ANYAKOHA PAGES-161—165.

WEEK SIX AND SEVEN

EQUILIBRIUM OF FORCES

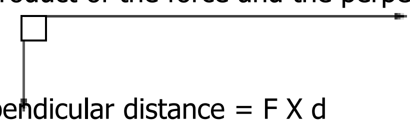
CONTENT

✔ Principles of moment
✔ Conditions for equilibrium of a rigid body
✔ Centre of gravity and stability
✔ Couple

A body is said to be in equilibrium if under the action of several forces, it does accelerate uniformly, rotate with uniform angular velocity or remain at rest. Example a stone at rest, the earth rotating round the sun, a body moving along a path at uniform velocity.

MOMENT OF A FORCE

The moment of a force is the product of the force and the perpendicular distance



d

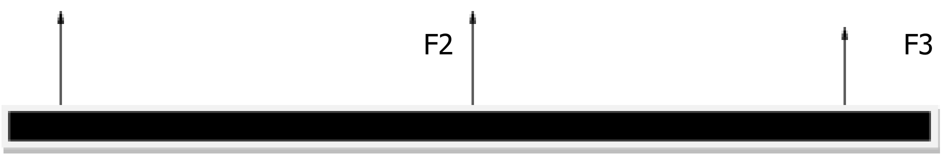
F

Moment = Force x perpendicular distance = F X d Unit =Nm

CONDITIONS FOR EQUILIBRIUM

1.The sum of the upward forces must be equal to the sum of the downward forces.
2.The sum of the clockwise moment above a point must be equal to the sum of anticlockwise moment about the same point

F1



F3

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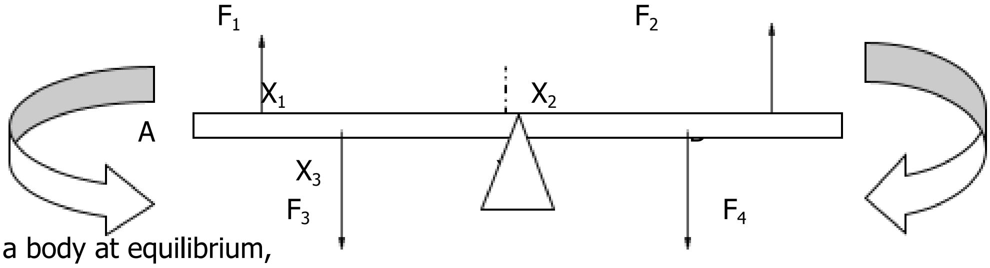
Upward forces [U_F] = F1 + F2 + F3
Downward forces [D_F] = F4 + F5
For a body at equilibrium,
$U_F = D_F$
F1 + F2 + F3 = F4 + F5



For a body at equilibrium,
Upward forces = downward force,
$F_1 + F_2 = F_3 + F_4$
$(F_1+F_2) – (F_3+F_4)=0$
Clockwise moment = $F_2 X_2 + F_4X_4$
Anticlockwise moment = $F1X_1+ F_3X_3$
$(F_1X_1+ F_3X_3) –(F_2X_2 + F_4X_4)= 0$
sum of clockwise moment =sum of anticlockwise moment

COUPLE
A couple is a system of two parallel, equal and opposite forces acting along the same line. The effect of a couple is to rotate the body.

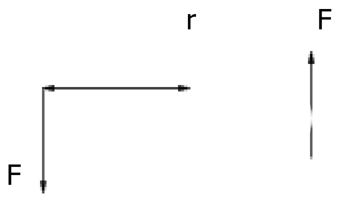


Fig I
d F

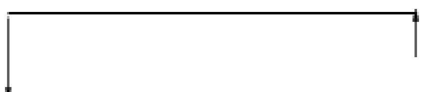


fig ii
The moment of a couple is the product of one of the forces and the perpendicular distance between the lines of action of the two forces
In fig (i), M = f x 2r
In fig (ii), M = f x d
The distance between the two equal forces is called the arm of the couple, the moment of a couple is also called a torque

APPLICATION OF THE EFFECT OF COUPLES
1. It is easier to turn a tap on or off by applying couple
2. It is easier to turn a steering wheel of a vehicle by applying a couple with our two hands instead of a single force with one arm.

EXAMPLES 1: A light beam AB sits on two pivots C and D . A load of 1ON hangs at O,2m from the support at c. Find the value of the reaction forces P and Q at C and D.

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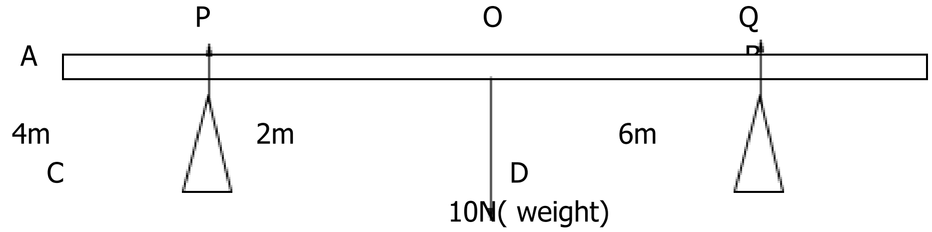


P + Q = 10N

X 2 = Q (2 + 6)

20 = 8Q

Q = 20/8 =2.5 N

Taking moment about D

P x8 = 10 x6

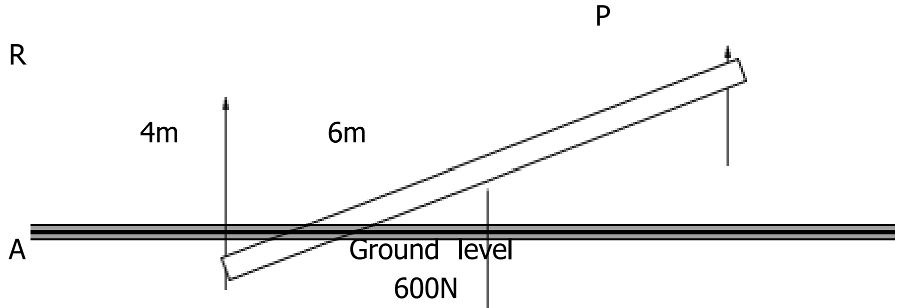
P = 60/8

=7.5N

Q = 10 -7.5

= 2.5 N

EXAMPLE 2: A pole AB of length 10m and weight 600N has its centre of gravity 4m from the end A, and lies on horizontal ground. Draw a diagram to show the the forces acting on the pole when the end B is lift this end. prove that this force applied at the end A will not be sufficient to lift the end A from the ground.



Clockwise moment =600 x 4 =2400Nm

Anticlockwise moment =p x 10 = 10pNm

P =240Nm

If this force of 240Nm is applied at A, we have

P= 240Nm

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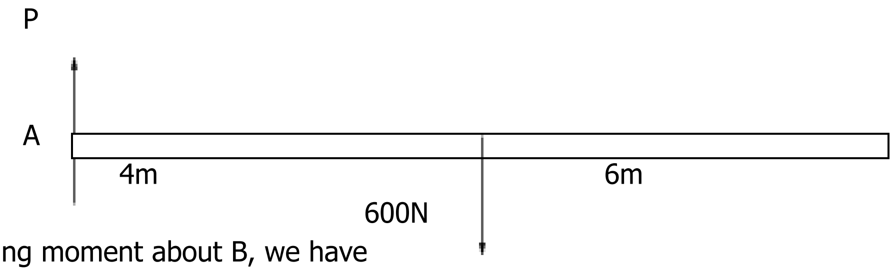
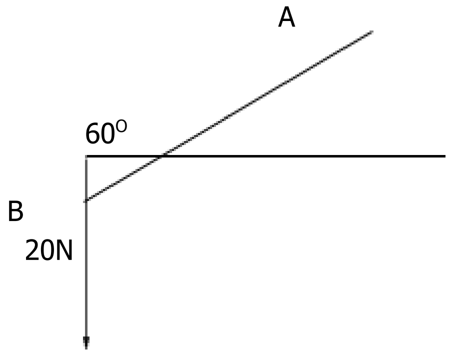


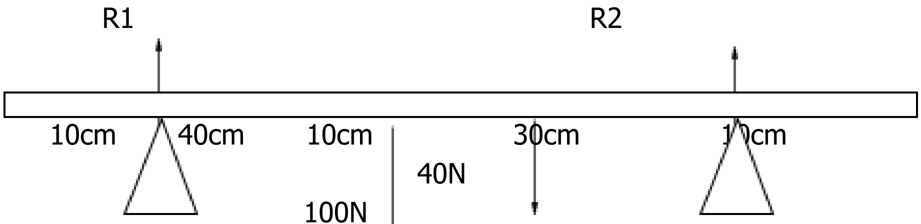
Taking moment about B, we have
clockwise moment =240 x 10 =2400Nm
Anticlockwise moment =600 x 6 =3600 Nm
The anticlockwise moment is greater than the clockwise moment .
Therefore , the 240N force A will not be sufficient to lift the end A because the turning effect due to the 600N force far exceeds that due to the 240N force

EXAMPLE 3:
3m



Find the moment of the force of 20N in the diagram above about A and B
Taking moment about A
Cos 60 =d/3m
D= 3 cos 60
D = 1.5m
Moment about A =F x d
M = 20 x 1.5= 30 Nm
The Moment about B= 0

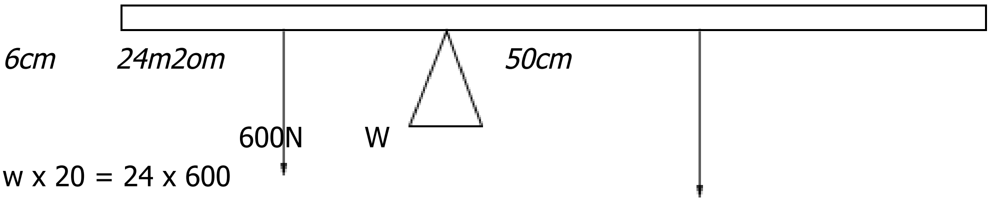
EXAMPLE 4: A uniform rod lm long weighing 100N is supported horizontally on two knife edges placed 10cm from its ends. What will be the reaction at the support when a 40N load is suspended 10cm from the midpoint of the rod.



R1 + R2 = 140N
Taking moment about R1
R2 x 80 = (100 x 40) + (40 x 50)
80R2 = 4000 + 2000
R2 = 6000/80
R2=75N
R1 = 140 – 75 =65N

Name____ Date___________________

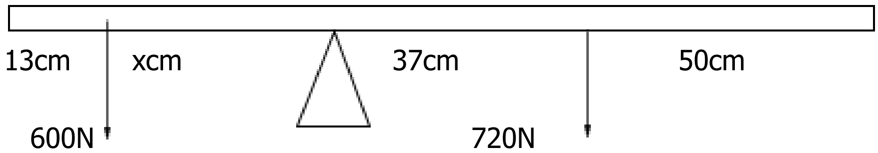
EXAMPLE 5. A metre rule is found to balance horizontally at the 50cm mark, When a body of mass 60kg is suspended at the 6cm mark, the balance point is found to be at the 30cm mark, calculate. The weight of the metre rulethe distances of the balance point to the 60kg mass if the mass is moved to the 13cm mark



w x 20 = 24 x 600

w = 14400/20

= 720N



600x(X)=720(37-X)

600x = 6640 – 720x

600x+ 720x = 6640

x = 6640/1320

x = 20. 18cm

CENTRE OF GRAVITY

The centre of gravity of a body is the point through which the line of action of the weight of the body always passes irrespective of the position of the body. It is also the point at which the entire weight of the body appears to be concentrated.

The centre of mass of a body is the point at which the total mass of the body appears to be concentrated. Sometimes, the center of mass may coincides with the centre of gravity for small objects.

EVALUATION

1. With the aid of diagrams, explain how you can determine the centre of gravity of four named regular uniform bodies.
2. Describe an experiment to determine the centre of gravity of an irregular lamina.

STABILITY OF OBJECTS

There are three types of equilibrium- stable equilibrium, unstable equilibrium, and neutral equilibrium.

1. Stable equilibrium: a body is said to be in stable equilibrium if it tends to return to its original position when slightly displaced. A low centre of gravity and wide base will put objects in stable equilibrium e.g. a cone resting on its base ; a racing car with low C.G and wide base; a ball or a sphere in the middle of a bowl.
2. Unstable equilibrium: a body is said to be in an unstable equilibrium if when slightly displaced it tends to move further away from its original position e.g. a cone or an egg resting on its apex. High C.G. and a narrow base usally causes unstable equilibrium.
3. Neutral equilibrium: a body is said to be in neutral equilibrium if when slightly displaced, it tends to come to rest in its new position e.g a cone or cylinder or an egg resting on its side.

EVALUATION

Name____ Date_________________

Students project.

Each student will make paper model of the three types of equilibrium.

GENERAL EVALUATION

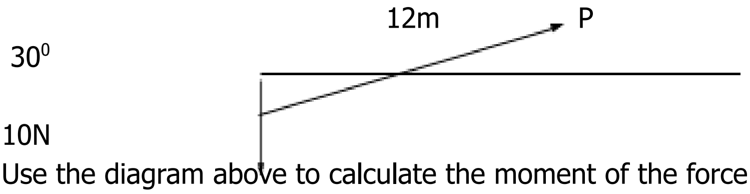
1. A uniform beam AB of length 6m and mass 20kg rests on support P and Q placed 1m from each end of the beam. Masses of 10kg and 8kg are placed at A and B respectively. Calculate the reactions at P and Q ($g = 9.8ms^{-2}$)
2. A box is pushed along a horizontal floor by a horizontal force of 60 N. There is a frictional force between the box and the floor of 50 N.What is the gain in kinetic energy of the box when it moves a distance of 4.0 m?

WEEKEND ASSIGNMENT

1. The S.I unit of moment is (a) Jm (b)Wm (c)Nm
2. A uniform metre rule of mass 100g balances at the 40cm mark when a mass X is placed at the 10cm mark.What is the value of X? (a)33.33g (b)43.33g (C) 53.33g.
3. Two forces each of magnitude 10N act jn opposite directions at the end of a table.If the length of the table is 50cm.Find the moment of the couple on the tab le.(a)0.5Nm (b)5Nm (c) 50Nm.
4. A pole AB of length 5M and weigh 300N has its centre of gravity 2.0M from the end A,and lies on horizontal ground.Calculate the force required to begin to lift this end (a) 60N (b)120N (c) 240N.
5. When a body is acted upon by several forces and it does not accelerates or rotates, the body is said to be in (a) space (b)equilibrium (C) motion.

THEORY

1. State the conditions necessary for a body to be in equilibrium, mention the three types of equilibrium)



Use the diagram above to calculate the moment of the force of 10N about the point p.

READING ASSIGNMENT

New Sch. Physics FOR SSS –M W ANYAKOHA PAGES 173-182.

WEEK EIGHT

SIMPLE HARMONIC MOTION

CONTENT

- ✔ Definition
- ✔ Velocity, acceleration and energy
- ✔ Forced vibration

DEFINITION

This is the periodic motion of a body or particle along a straight line such that the acceleration of the body is directed towards a fixed point .

FIRST TERM Physics E-LEARNING NOTE

Name____ Date___________________

A particle undergoing simple harmonic motion will move to and fro in a straight line under the influence of a force . This influential force is called a restoring force as it always directs the particle back to its equilibrium position.

Examples of simple harmonic motions are:

i. loaded test tube in a liquid

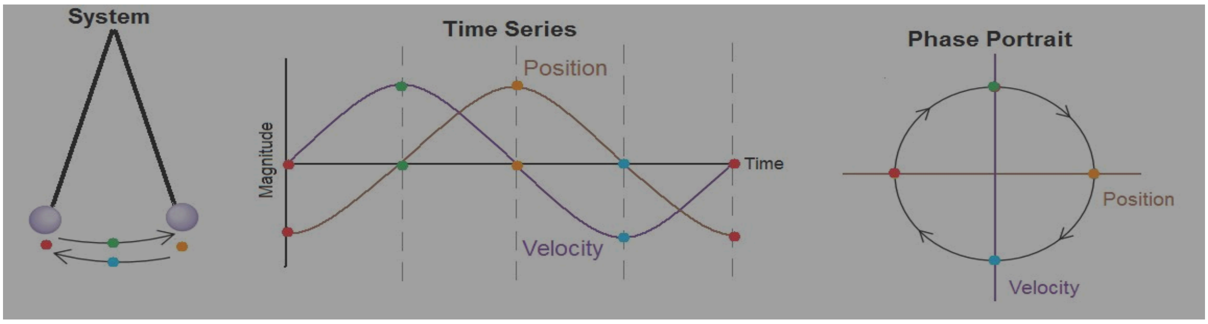
iimass on a string

iiithe simple pendulum

for a body performing simple harmonic motion, the general equation is given as

$y = A \sin [wt \pm kx]$

where k = phase constant, w = angular velocity, t = time , A = amplitude,



As the particle P moves round the circle once, it sweeps through an angle $\theta = 360^0$ (or 2п radian) in the time T the period of motion. The rate of change of the angle θ with time (t) is known as the angular velocity ω

Angular velocity (ω) is defined by

$\omega = \frac{\text{angle turned through by the body}}{\text{Time taken}}$

$\omega = \frac{\theta}{t}$ .... 1 (rad /sec)

$\theta = \omega t$

This is similar to the relation distance = uniform velocity x time (s= =vt) for motion in a straight line

A = r = radius of the circle

The linear velocity v at any point ,Q whose distance from C the central point is x is given by

$V = \omega \sqrt{A^2 - X^2}$ 2

The minimum velocity ,Vm corresponds to the point at X = 0 that is the velocity at the central point or centre of motion .

Hence

$V_m = \omega A = \omega r$ 3

Thus the maximum velocity of the SHM occurs at the centre of the motion (X=0) while the minimum velocity occurs at the extreme position of motion (x=A).

Name____ Date____________________

EVALUATION

1. A body of mass 0.2kg is executing simple harmonic motion with an amplitude of 20mm. The maximum force which acts upon it is 0.064N.Calculate (a) its maximum velocity (b) its period of oscillation.
2. A steel strip clamped at one end , vibrates with a frequency of $20H_Z$ and an amplitude of 5mm at the free end , where a small mass of 2g is positioned. Find the velocity of the end when passing through the zero position.

RELATIONSHIP BETWEEN LINEAR ACCELERATION AND ANGULAR VELOCITY

X = A COS θ

Θ = ωt

X = A cos ω t

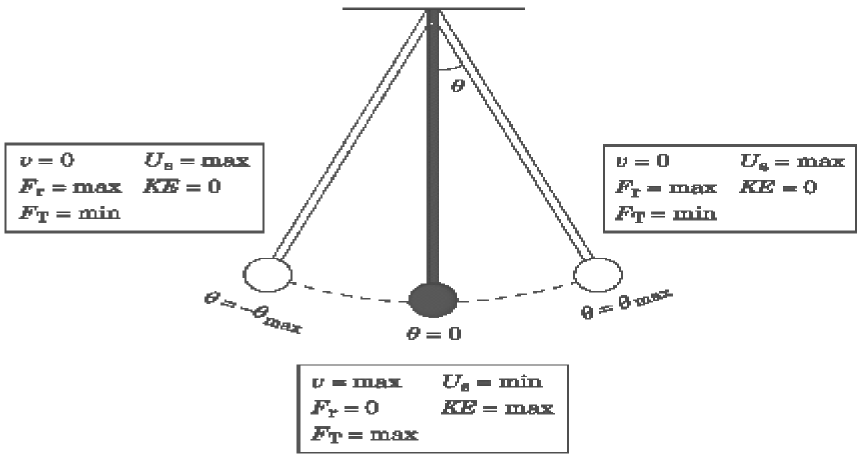
$\frac{dx}{dt} = -\omega A \sin \omega t$

$\frac{dv}{dt} = -\omega^2 A \cos \omega t$

$= -\omega^2 X = -\omega^2 A = -\omega^2 r$ ………………………………………….. 4

The negative sign indicates that the acceleration is always inwards towards C while the displacement is measured outwards from C.

ENERGY OF SIMPLE HARMONIC MOTION



Since force and displacement are involved, it follows that work and energy are involved in simple harmonic motion.

At any instant of the motion , the system may contain some energy as kinetic energy (KE) or potential energy(PE) .The total energy (KE + PE) for a body performing SHM is always conserved although it may change form between PE and KE .

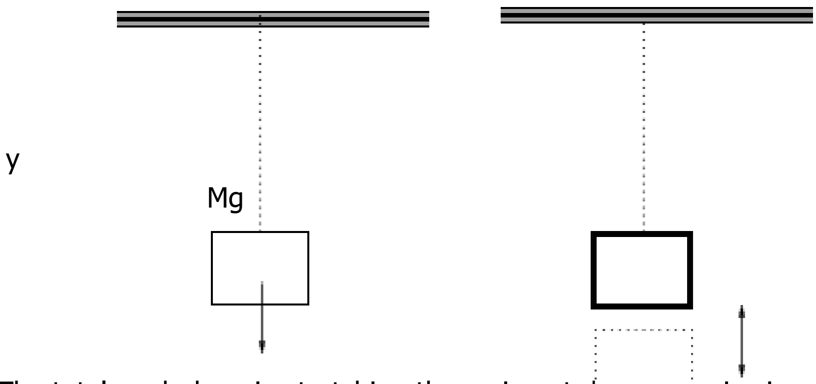
When a mass is suspended from the end of a spring stretched vertically downwards and released , it oscillates in a simple harmonic motion .During this motion , the force tending to restore the spring to its elastic restoring force is simply the elastic restoring force which is given by

Name____ Date__________________

$F = -ky$ 5

K is the force constant of the spring , but F = ma

$a = \frac{ky}{m}$



The total work done in stretching the spring at d y is given by

W = average force x displacement

$W = \frac{1}{2} ky \times y = \frac{1}{2} ky^2$ 6

Thus the maximum energy total energy stored in the spring is given by

$W = \frac{1}{2} KA^2$ 7

A = amplitude (maximumdisplacement fromequilibrium position).

This maximum energy is conserved throughout the motion of the system.

At any stage of the oscillation, the total energy is

$W = \frac{1}{2} KA^2$

$W = \frac{1}{2} mv^2 + \frac{1}{2} ky^2$ 8

$\frac{1}{2} mv2 = \frac{1}{2} KA^2 - \frac{1}{2} ky^2$

$v2 = k/m (A^2 - y^2)$

$V = \sqrt{k/m(A^2 - y^2)}$

The constant K is obtained from

Hooke's law in which

F= mg = ke

Where e is the extension produced in the spring by a mass m

But $V = \omega\sqrt{A2-X2}$

Therefore $\omega = \sqrt{k/m}$

Hence the period $T = 2\pi/\omega$

$T = 2\pi\sqrt{\frac{m}{k}}$

EXAMPLE:

A body of mass 20g is suspended from the end of a spiral spring whose force constant is $0.4Nm^{-1}$

The body is set into a simple harmonic motion with amplitude 0.2m. Calculate :

a. The period of the motion
b. The frequency of the motion
c. The angular speed
d. The total energy

e. The maximum velocity of the motion

f. The maximum acceleration

SOLUTION

a $T = 2\pi \sqrt{m/k}$

$= 2\pi \sqrt{0.02/0.4}$

$= 0.447\ \pi$ sec

= 1.41 sec

b. f=1/T = 1/1.41 = 0.71Hz

c. $\omega = 2\pi f$

$= 2\pi \times 0.71$

= 4.46 rad. S^{-1}

d. Total energy = ½ KA^2

= ½ (0.4) $(0.2)^2$

= 0.008 J

e. ½ mv^2 = /12 KA^2

$Vm^2 = \frac{0.008 \times 2}{0.02}$

= 0.8

Vm= 0.89 m/s

Or V= ω A

$= 4.46^2 \times 0.2$

$= 3.98 m/s^2$.

EVALUATION

A body of mass 0.5kg is attached to the end of a spring and the mass pulled down a distance 0.01m. Calculate (i) the period of oscillation (ii) the maximum kinetic energy of mass (iii) kinetic and potential energy of the spring when the body is 0.04m below its centre of oscillation.(k=50Nm)

FORCED VIBRATION AND RESONANCE

Vibrations resulting from the action of an external periodic force on an oscillating body are called forced vibrations. Every vibrating object possesses a natural frequency ((f_o) of vibration. This is the frequency with which the object will oscillate when it is left undisturbed after being set into vibration. The principle of the sounding board of a piano or the diaphragm of a loudspeaker is based on the phenomenon of forced vibrations.

Whenever the frequency of a vibrating body acting on a system coincides with the natural frequency of the system, then the system is set into vibration with a relatively large amplitude. This phenomenon is called resonance.

EVALUATION

1. Explain the terms forced vibrations, resonance. Give two examples of forced vibrations and two examples of resonance.
2. Describe an experiment to demonstrate forced vibration and resonance..

GENERAL EVALUATION

Name____ Date_________________

1. State the principle of floatation
2. A stone of mass 2.0Kg is thrown vertically upward with a velocity of 20.0m/s. Calculate the initial kinetic energy of the stone.

WEEKEND ASSIGNMENT

1. Which of the following correctly gives the relationship between linear speed v and angular speed w of a body moving uniformly in a circle of radius r?
(A) v=wr (B) $v=w^2r$ (C) $v= wr^2$ (D) v=w/r.
2 The motion of a body is simple harmonic if the:
(A) acceleration is always directed towards a fixed point.
(B) path of motion is a straight line .
(c) acceleration is directed towards a fixed point and proportional to its distance from the point.
(D) acceleration is proportional to the square of the distance from a fixed point.
3. The maximum kinetic energy of a simple pendulum occurs when the bob is at position.
(a) 1 (b) 2 (c) 3 (d) 4 (e) 5
4 The vibration resulting from the action of an external periodic force on the motion of a body is called:(a) Forced vibration. (b) damped vibration. (c) natural vibration. (d) compound vibration.
5 The maximum potential energy of the swinging pendulum occurs positions
(A) 1and 5 (B) 2 and 4 (C) 3 only (D) 4 only (E) 5 and 3

THEORY

1. Define simple harmonic motion(SHM). A body moving with SHM has an amplitude of 10cm and a frequency of 100Hz. Find (a) the period of oscillation (b) the acceleration at the maximum displacement (c) the velocity at the centre of motion.
2. Define the following terms: frequency, period, amplitude of simple harmonic motion. What is the relation between period and frequency.

READING ASSIGNMENT

NEW SCH PHYSICS FOR SSS –ANYAKOHA.Pages 188-197

WEEK NINE AND TEN

CONTENT

✔ Definition
✔ Types of Machines
✔ Mechanical Advantage of Machines
✔ Velocity Ratio of Machines
✔ Efficiency of Machines

MACHINES

Machines make our work simpler .It is a force producing device by which a large force called load can be overcome by a small applied force called effort

Terminologies Used in Machines

1. Force ratio (mechanical advantage)
2. Velocity ratio
3. Efficiency

FIRST TERM Physics E-LEARNING NOTE

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MECHANICAL ADVANTAGE

We define effort as the force applied to a machine and load as the resistance overcome by the machine. The ability of a machine to overcome a large load through a small effort is known as its mechanical advantage .It is given by

M.A = Load/ Effort = L/E ………………………… 1

The mechanical advantage of a machine is influenced by friction in parts

VELOCITY RATIO (V.R)

The velocity ratio is the ratio of distance moved by the effort and load in the same interval

V.R = Distance moved by effort ……………………….. 2

Distance moved by the load

The velocity ratio depends on the geometry of the machine

EFFICIENCY (E)

The efficiency of a machine is defined as

Ef =Usefulwork done by the machine x 100 …………………………………… 3

Work put into the machine

Work = force x distance

Ef= load x distance moved by load x 100 ………………………………………….. 4

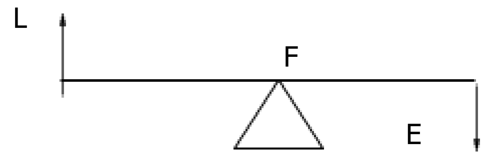
Effort x distance moved by effort

Then V.R =M.A

TYPES OF MACHINES

1 LEVER

This is the simplest form of machine . It consist of a rigid rod pivoted about a point called the fulcrum F with a small effort applied at one end of the lever to overcome a large load L at the other end . There are various types of lever depending on the relative positions of the load, effort and fulcrum.

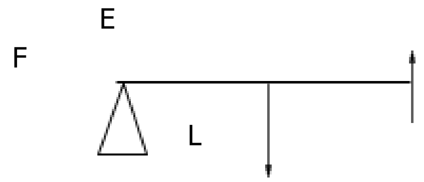


Examples of first class lever are the crowbar.pair of scissors or pincers, claw hammer , see-saw ,pliers etc

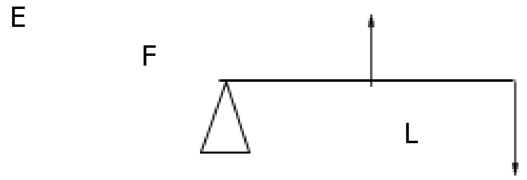
FIRST TERM Physics E-LEARNING NOTE

Name____ Date_________________

In second order lever , the load is between the fulcrum and effort

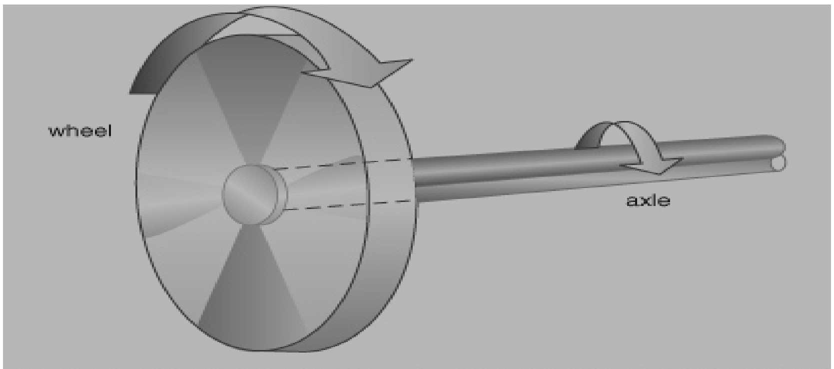


Examples are wheel barrow, nut cracker tarp door , an oar etc .
In the third order lever, the effort is between the fulcrum and the load .Human fore arm , laboratory tong etc.



WHEEL AND AXLE

It consists of a large wheel to which a rope or string is attached and an axle or small wheel with the rope or string wound round it in opposite direction . The load to be lifted is hung at the free end of the rope on the axle while the effort is applied at the end of the rope on the wheel . For each complete rotation the load and the effort move through distance equal to the circumference of the wheel and axle respectively.



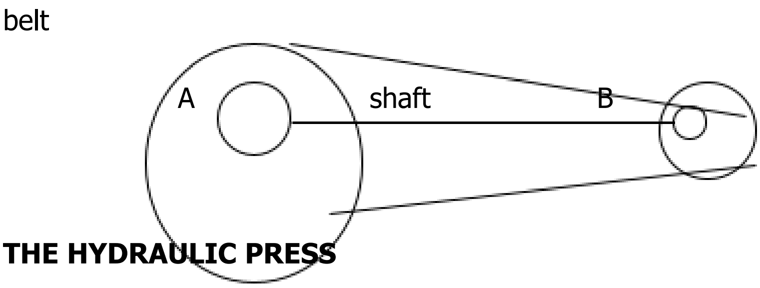
THE WHEEL AND AXLE IS A WHEEL CONNECTED TO A RIGID POLE.

V.R = R/r 5

The principle of wheel and axle is used in brace screw driver but spanner windless and gear-boxes

In gear boxes , there are toothed wheels of different diameter interlocked to give turning force at low speed depending on which gear is the driver and whih is the driven

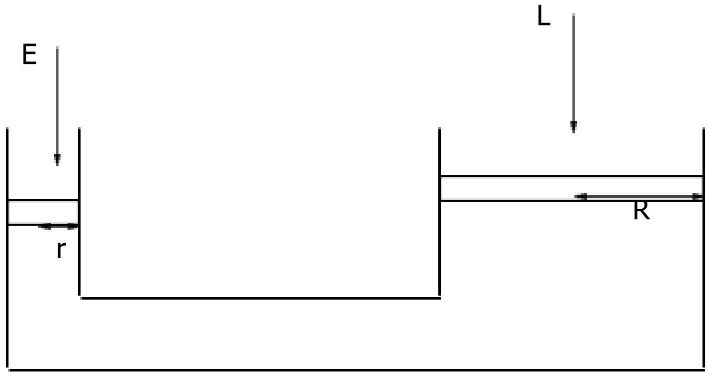
V.R = No of teeth on driven wheel (A) / No of teeth on driving wheel (B) 6



THE HYDRAULIC PRESS

Name____ Date___________________

The machine is widely used for compressing waste paper and cotton into compact bales forging different alloys into desirable shape etc .It s work is based on Pascal's principle which states that pressure is transmitted equally in fluid Oil is the liquid normally used in hydraulic press



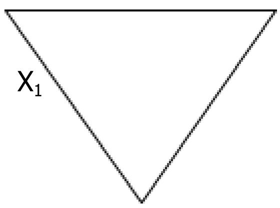
V.R = R^2/r^2 7

THE WEDGE

The wedge is a combination of two inclined planes >It is used to separate bodies which are held together by large force .Examples of wedge type of machines are axes chisels knives etc

X_o

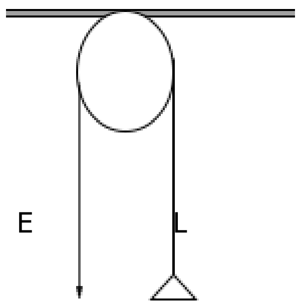
θ



$$M.A = \frac{X_1}{X_0} = \frac{\text{Slant height of wedge}}{\text{Thickness of wedge}}$$ 8

PULLEY

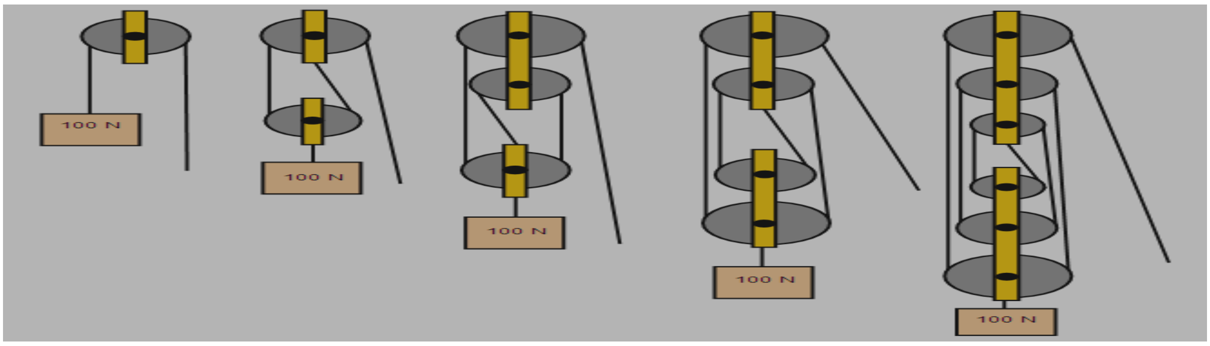
A simple pulley is a fixed wheel hung on a suitable support with a rope passing round its groove. For a set of pulley, the velocity ratio is the number of pulley in the system.



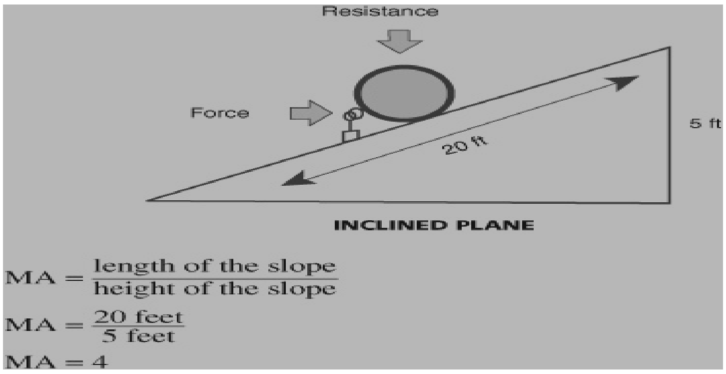
BLOCK AND TACKLE (PULLEY)

This is the more practical system of pulleys in which one or more pulley are mounted on the same axle with one continuous rope passing all-round the pulleys

Name____ Date____________________



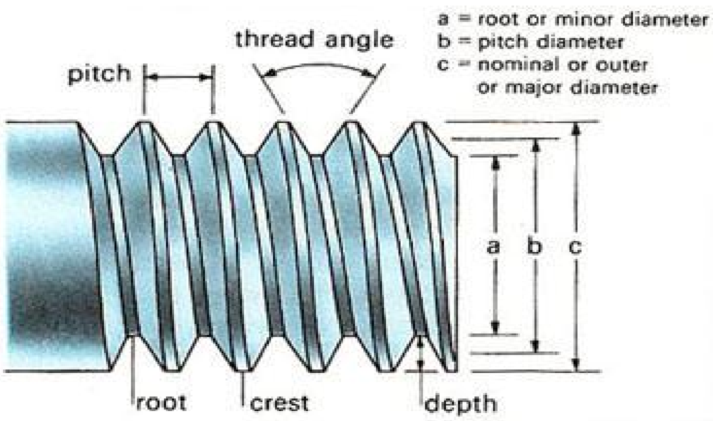
INCLINED PLANE : This is in form of a sloping plank commonly used to raise heavy load such as barrels of oil with little applied effort than by lifting it vertically .



V.R = Distance moved by force
Distance moved by load
= x /h
V.R = 1/ sin θ 9

THE SCREW

Geometrically speaking the screw is an inclined plane wrapped round a cylinder to form a thread . The distance between successive threads on a screw is called its pitch. For one complete revolution of screw through an effort , the load moves a distance equal to its pitch e.g screw jack nut and bolt



In a screw jack where length of the operating handle is a , the effort moved a distance equal to the pitch P. If frictional forces are negligible

Thus $V.R = \frac{2\pi a}{P} = \frac{2\pi r}{P}$ 10

EFFECTS OF FRICTION ON MACHINE

FIRST TERM Physics E-LEARNING NOTE

Name____ Date__________________

Work is always wasted in machines to overcome the frictional forces present between the moving parts and also to lift to part of the machine. The greater the friction , the greater the effort required and the smaller the M.A . M.A depends on friction but depends on the geometry of moving parts.

In practical machines the efficiency is usually less than 100% because of friction in the moving parts of the machine.

GENERAL EVALUATION QUESTION

1. A body travels from rest over a distance x in time t. if it has a uniform acceleration a, the value of t expressed in terms of a and x is?
2. A uniform meter rule of mass 0.42Kg is balanced at the 60cm mark when a mass of m is placed at the 90cm mark. Calculate the value of m.

WEEKEND ASSIGNMENT

1. A machine with a velocity ratio of 30 moves a load of 3000N when an effort of 200N is applied. The efficiency of the machine is (a) 30% (b) 50% (c) 60% (d) 75%.
2. The efficiency of a wheel and axle system is 80% and the ratio of radius of wheel to radius of the axle is 4 : 1, In order to lift a mass of 20kg,the effort required is (a) 60N (b) 62.5N (c) 32.5N (d) 250 (e) 50N.
3. The velocity ratio of an inclined plane whose angle of inclination is Ө is
   (a) sinӨ (b) cosӨ (c) tan Ө (d) 1/sin Ө (e) 1/cosӨ.
4. Which of the following is not an example of levers of the first order (a) crow bar (b) Nutcracker (c) scissors (d) pliers (e) claw hammer.
5. A plane inclined at 30^o to the horizontal has an efficiency of 50%. Calculate the force parallel to the plane required to push a load of 120N uniformly up the plane. (a) 50.0N (b) 120.0N (c) 200.0N (d) 240.0N

THEORY

1. Show that efficiency E, the force ration (MA) and the velocity ratio (VR) of a machine are related by the equation E = MA/VR X 100.
2. (a) What is meant by a machine?
   (b) Explain why a machine can never be 100% efficient.