Date: _____

# KINEMATICS

**speed** : distance travelled per unit time (m/s)

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

- average speed : total distance travelled in total time
- uniform speed : if the object is moving with constant speed
- non-uniform speed : if the speed of the object changes with time

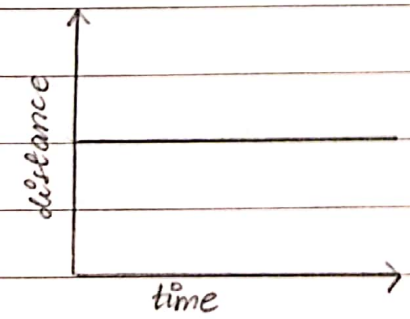
**acceleration** : increase in velocity per time ($m/s^2$)

$$\text{acceleration} = \frac{\text{change in velocity}}{\text{time}}$$

- uniform acceleration : velocity changes in equal amounts in equal time intervals
- non-uniform acceleration : velocity changes in unequally in equal time intervals

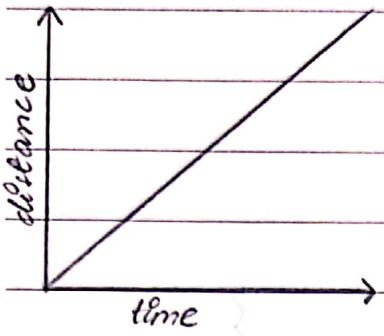
**deceleration** : decrease in velocity per unit time

## DISTANCE-TIME GRAPHS

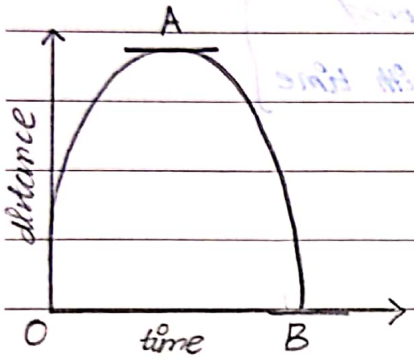



* a horizontal line indicates a zero speed as the body is not moving from its initial speed

Date: _____



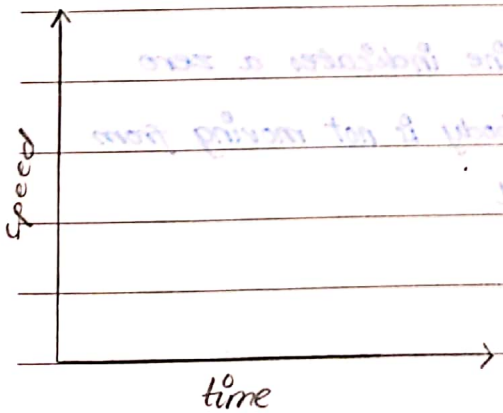

* a straight line shows uniform speed since distance increases uniformly with time




* non-uniform speed
* from O → A, speed decreases gradually to zero; from A → B, speed increases

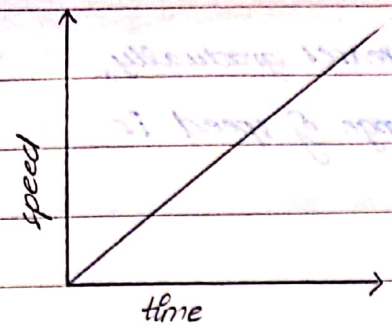
- the gradient of distance-time graph is zero
- gradient is zero, body is at rest
- if gradient is negative, body is moving in reverse or opposite direction

## SPEED-TIME GRAPHS

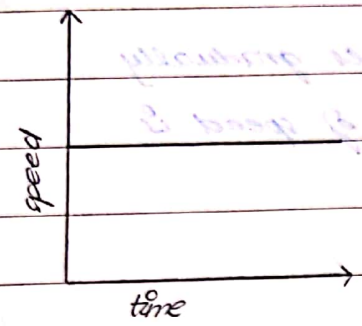



* object is at rest

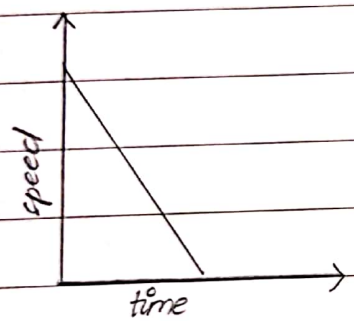
Date: _____



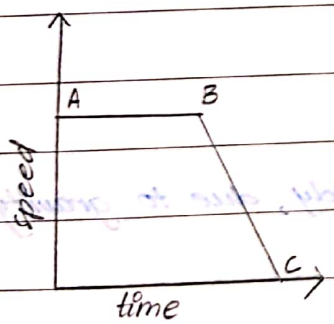

* speed of object is increasing uniformly with constant acceleration



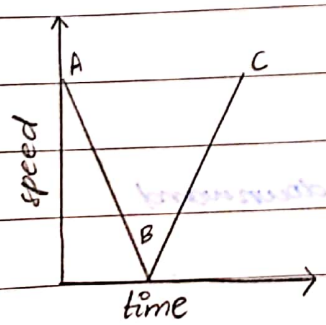

* speed of object is constant so acceleration is zero




* speed of object is decreasing uniformly with constant retardation

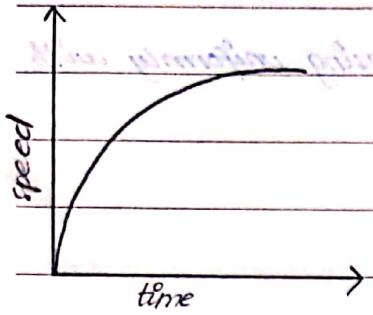



* from A → B, speed is constant with zero acceleration
* from B → C, speed decreases uniformly with constant retardation

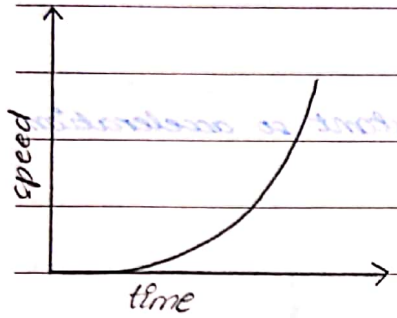



* from A → B, speed is decreasing uniformly with constant retardation
* At B, object is at rest
* from B → C, speed is increasing uniformly with constant acceleration

Date: _____




* the acceleration decreases gradually, because rate of change of speed is decreasing with time




* the acceleration increases gradually because rate of change of speed is increasing with time

» the gradient of speed-time graph is acceleration

» area under graph is the distance

acceleration of free fall or acceleration due to gravity :

→ the initial uniform acceleration produced by a free falling body, due to gravity

→ value is approximately $10 m/s^2$

→ it is directed towards the center of the earth

→ does not depend on mass of the falling bodies

→ in presence of air resistance, it decreases

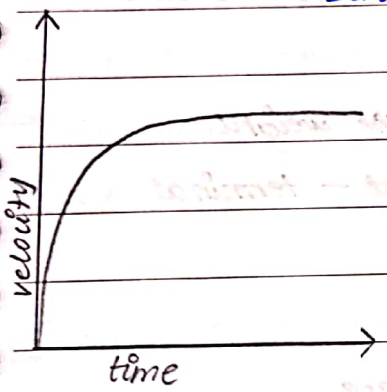
→ for upward motion, it is $= -10 m/s^2$ and for downward motion it is $= +10 m/s^2$

Date: _____

## Effects of air resistance:

1. it always opposes the motion of moving objects
2. increases with the increase of speed of the objects
3. increases with the size of the objects

**terminal velocity**: when air resistance on an object falling in gravitational field becomes equal to the weight of the object then object moves with constant velocity and the acceleration becomes zero




* object falls with initial acceleration of 10m/s² i.e. acceleration of gravity
* when air resistance and acceleration become equal then the velocity is zero

Date:

## FORCES ACTING ON A SKY DIVER

→ as soon as he jumps, the only force acting on it is weight and due to gravity it won't change throughout the journey

→ resultant force is downwards so they accelerate towards the ground

→ he starts to experience friction with air molecules — air resistance

→ continues to accelerate downwards b/c air resistance is less than weight

→ as the velocity of the skydiver increases, the air resistance also increases

→ at a certain point, the air resistance balances the weight

→ no resultant force now so velocity becomes constant — terminal velocity

→ now they can open the parachute

→ S.A increases and causes air resistance to increase

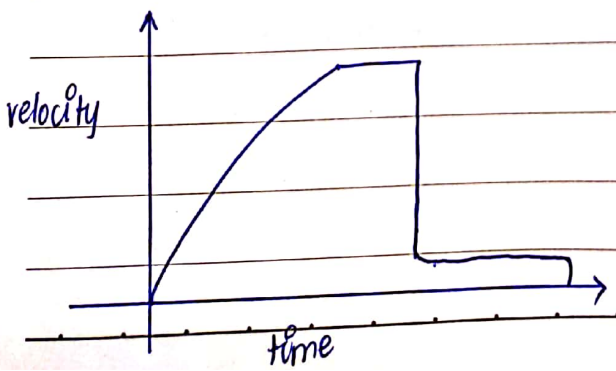
→ air resistance is greater than weight — resultant force is acting upwards

→ skydiver decelerates — velocity decreases

→ now air resistance also decreases ↑ b/c

→ at some point they will balance again and resultant force will be zero

→ now the skydiver is falling at a lower terminal velocity — safe for them to hit the ground.



Date: _____

# DYNAMICS

**force** : it is pull or push on an object that changes or tends to change the state of rest or uniform motion of that object

## Effect of force :

→ can change the shape of a body
→ can stop the moving body.
→ can set the body into motion
→ can accelerate the body
→ can decelerate the body
→ can change direction of a moving body

**friction** : constant force that slows down moving objects

## Negative effects of friction :

→ force of friction causes wear and tear in moving parts of the machine
→ force of friction reduces the engine power.

## Positive effects of friction :

→ helps in holding the objects walking on ground
→ in stopping the moving vehicles

## Methods of reducing friction :

→ using a highly polished surface for moving parts
→ using a layer of lubricants between moving parts

Date:

→ using ball bearings to enable surface to roll over

→ making the aerodynamic shapes of moving objects

## Effects of friction on the motion of a vehicle

1. Tyre surface

↳ if tyre surface is in good condition then there is more friction between the tyre and the road

↳ vehicle can be stopped easily within the stopping distance

2. Road condition

↳ if road is wet, the friction between the tyres and road reduces, resulting in increase to the stopping distance

↳ vehicle can also skid at turns

3. Braking force

↳ if braking pads/discs are in good condition, then braking force causes more friction and stopping distance reduces

braking distance: the distance traveled by a moving vehicle during the time that the brakes are applied

thinking distance: the distance traveled by moving vehicle during the reaction time of the driver, before applying the brakes

stopping distance: the total distance travelled by a moving vehicle between thinking the distance and stopping the vehicle

Date: _____

stopping distance = thinking distance + breaking distance

Q. Why can't they all be equal?

A. → the road condition → the speed of the moving vehicle
→ the tyre condition → the vehicle is loaded or unloaded
→ the brakes condition → the human reaction of driver

circular motion : if the distance of the object remains constant from a fixed point, throughout its motion, then object is in circular motion

→ resultant force on an object in circular motion is towards the centre
→ if the speed of object in circle is constant, its direction keeps changing so the velocity is not constant
→ the direction of velocity at any instant in circular motion is determined by the tangent to circle at that point
→ the force which keeps the object moving in a circular path is called centripetal force
↳ always directed towards centre of circle
→ e.g //
⇒ the electrostatic force exerted by the nucleus on electron, provides centripetal force to electrons
↳ electrons keep on orbitting around the nucleus in circular motion
⇒ the force of gravity of the earth provides centripetal force to the earth
↳ the satellite keeps on orbitting the earth in circular motion

Date: _____

⇒ the planets move around the sun due to gravitational force
↳ the gravitational force provides centripetal force to the planets
↳ each planet in the solar system is directed towards the sun, due to centripetal force and keeps on moving in fixed orbit

balanced forces: two equal forces acting in opposite directions cancel each other out
they produce two effects: ①. object is either at rest
②. moving at a steady speed

unbalanced forces: two forces of different values acting in directions on an object
they produce two effects. ①: either accelerate the object
②. decelerate the object

## NEWTON'S LAW OF MOTION:

First Law: a body continues its state of rest or uniform motion until an external force acts on it.

Second Law: when a force acts on a body, acceleration is produced such that:

- acceleration is directly proportional to the force applied.
- acceleration is inversely proportional to the mass of the body

Date: _____

Third Law: to every action there is equal and opposite reaction

Force = mass x acceleration

$F = ma$

→ forced is measured in Newtons

contact forces : the two objects are physically touching
e.g/ tension in a rope, friction, air resistance, lamp on a table (lamp exerts downward force and table exerts upward force)

non-contact forces : the two objects are physically separate
e.g/ gravitation force, electrostatic forces, magnetic force

*study vector diagrams

→ when speed of an object is constant, the resultant force is zero