LINEAR MOTION

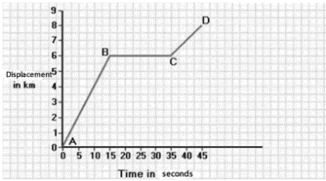
Definitions

Displacement is the change in the position of an object in a particular direction. Displacement may also be defined as the shortest distance between the initial and final position of a moving body.

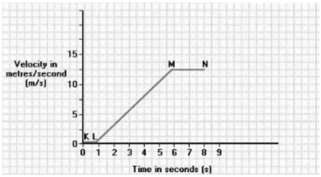
Velocity is the distance travelled by a body in a particular direction or displacement per unit time. Velocity can be positive or negative.

Acceleration is the rate of change of velocity of a moving object. This change in velocity can result from a change in speed, a change in direction, or a combination of changes in speed and direction.

Displacement-time graph
A horizontal line shows a constant displacement (i.e., at rest).
Gradient = velocity



Velocity-time graph
A horizontal line shows a constant velocity.
Gradient = acceleration
The area under a velocity-time graph represents the distance travelled.



Equations

There are a set of kinematic formulas used to describe motion mathematically.

$v_f = v_i + at$	final velocity	v_f	m s^{-1}
	initial velocity	v_i	m s^{-1}
	acceleration	a	m s^{-2}
	time	t	s
$d = v_i t + \frac{1}{2}at^2$	displacement	d	m
	initial velocity	v_i	m s^{-1}
	acceleration	a	m s^{-2}
	time	t	s
$d = \frac{v_i + v_f}{2}t$	displacement	d	m
	initial velocity	v_i	m s^{-1}
	final velocity	v_f	m s^{-1}
	time	t	s
$v_f^2 = v_i^2 + 2ad$	final velocity	v_f	m s^{-1}
	initial velocity	v_i	m s^{-1}
	acceleration	a	m s^{-2}
	displacement	d	m

You will be given 3 variables and asked to work out a fourth variable. Choose the equation that only has these four (or the equation without the fifth variable).

Questions

IN TOWN (2020;1)

Alex and Jo have decided to take a road trip. They start from rest on a straight road and accelerate at 4.2 m s^{-2}.

(a) Show their velocity after 0.60 seconds is 2.5 m s^{-1}.

(b) While travelling at 50 km h^{-1}, Jo sees a pothole in the road 15 m ahead. She must reduce her speed from 50 km h^{-1} to 20 km h^{-1} to avoid damaging the car. If the time needed for safe braking from 50 km h^{-1} to 20 km h^{-1} is 2.3 seconds, show by calculation whether there is enough time to complete braking before reaching the pothole. You should start by showing that 50 km h^{-1} = 13.89 m s^{-1}.

Motion (2013;1)

Jason spends a day at an amusement park.

(c) Jason goes for a ride on a go-kart. Towards the end of the ride, he decelerates at 2.5 m s^{-2} and comes to a stop in 4.2 seconds. By calculating Jason's initial velocity, determine the distance he travels while coming to a stop.

Terms

Kinematic equations of motion: Set of formulas used to describe motion mathematically.

Specific words that they may use in the examinations:

"From rest/Dropped": $v_i = 0$

"Falling": a = + 9.8 ms^{-2}

"Thrown upwards": a = - 9.8 ms^{-2}

Tips

- I suggest avoiding using:

$v = \frac{\Delta d}{\Delta t}$	(Average) velocity	v	m s^{-1}
	displacement	d	m
	time	t	s
$a = \frac{\Delta v}{\Delta t}$	(Average) acceleration	a	m s^{-2}
	velocity	v	m s^{-1}
	time	t	s

- Work in SI units so always convert km, cm and mm into m.
- Work in SI units so always convert hours and minutes into seconds.
- Watch out for negative values when putting the numbers into your calculator.

Answers

(a) You are not given d so use the equation without d
$v_f = v_i + at$ so $v_f = 0 + (4.2 \times 0.6) = 2.5$ m s^{-1} (it's a "show that" question)

(b) 50 km h^{-1} is 50/3.6 = 13.89 m s^{-1} and 20 km h^{-1} is 20/3.6 = 5.56 m s^{-1}.
Distance travelled in 2.3 s can be calculated by:
$d = (v_i + v_f)\, t / 2 = (13.89 + 5.56) \times 2.3 / 2 = 22.4$ m. This is more than 15 m so cannot slowdown in time.

(c) $v_f = v_i + at$ so $0 = v_i - 2.5 \times 4.2$ so $v_i = 10.5$ m s^{-1} (you do not know d) then
$d = v_i t + ½at^2$
$d = (10.5 \times 4.2) - (½ \times 2.5 \times 4.2^2)$
d = 22.05 m