WJEC England Physics AS-level

Section 1.2 - Kinematics

Flashcards

Define mean speed, the equation used to calculate mean speed, and the respective SI units.

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Mean speed is defined as the average rate of change of distance.

The equation used is:

mean speed = total distance / total time taken

The SI units are m s^{-1}.

What is meant by instantaneous speed?

What is meant by instantaneous speed?

The speed of an object at a given point in time.

Define displacement.

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The displacement of an object is the shortest distance between its initial and final position, together with the direction.

Define velocity, the equation used to calculate velocity, and the respective SI units.

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The velocity of an object is defined as the rate of change of displacement, or speed in a given direction, making velocity a vector.

The equation used is:

velocity = change in displacement / time

The SI units are ms^{-1}.

What is the difference between mean velocity and instantaneous velocity?

What is the difference between mean velocity and instantaneous velocity?

Mean velocity is the average velocity of an object over a specified period of time, whereas instantaneous velocity is the velocity of the object at a given point in time. (This difference between mean and instantaneous applies to speed and acceleration as well.)

Define acceleration, the equation used to calculate acceleration, and the respective SI units.

Define acceleration, the equation used to calculate acceleration, and the respective SI units.

Acceleration is defined as the rate of change of velocity, making it a vector.

The equation used is:

acceleration = change in velocity / time

The SI units are ms^{-2}.

What does a straight, horizontal line represent on a displacement-time graph?

What does a straight, horizontal line represent on a displacement-time graph?

A stationary object.

What does a line with a constant, non-zero gradient represent on a displacement-time graph?

What does a line with a constant, non-zero gradient represent on a displacement-time graph?

An object moving with constant velocity.

What does a curved line represent on a displacement-time graph?

What does a curved line represent on a displacement-time graph?

Acceleration (if gradient is increasing) or deceleration (if gradient is decreasing).

What does a straight, horizontal line represent on a velocity-time graph?

What does a straight, horizontal line represent on a velocity-time graph?

An object moving with constant velocity.

What does a line with a constant, non-zero gradient represent on a velocity-time graph?

What does a line with a constant, non-zero gradient represent on a velocity-time graph?

An object that is accelerating (positive gradient) or decelerating (negative gradient).

What does the area under a velocity-time graph represent?

What does the area under a velocity-time graph represent?

Displacement.

What does the area under an acceleration-time graph represent?

What does the area under an acceleration-time graph represent?

Velocity.

Derive v = u + at

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1. Rearrange $a = \Delta v/t$ to $\Delta \mathbf{v = at}$
2. Substitute $\Delta v = (v - u)$ to get $\mathbf{v - u = at}$
3. Rearrange to get $\mathbf{v = u + at}$

Derive $s = (u + v)\,t / 2$

Derive $s = (u + v)\,t / 2$

1. Average velocity is given by $\mathbf{v_{avg} = (v + u) / 2}$
2. Displacement is given by $\mathbf{s = s_0 + v_{avg}t}$
3. Substitute in the formula for v_{avg} to get
   $$\mathbf{s = s_0 + (v + u)\,t / 2}$$
4. If the initial displacement (s_0) is 0, the formula becomes $\mathbf{s = (v + u)\,t / 2}$

Derive $s = ut + \frac{1}{2}at^2$

Derive $s = ut + \frac{1}{2}at^2$

1. Substitute $v = u + at$ into $s = (u + v)\ t\ /\ 2$ to get $\mathbf{s = (u + (u + at))\ t\ /\ 2}$
2. Simplify to $\mathbf{s = (2u + at)\ t\ /\ 2}$
3. Expand and simplify to $\mathbf{s = ut + \frac{1}{2}at^2}$

Derive $v^2 = u^2 + 2as$

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1. Square ($v = u + at$) to get $\mathbf{v^2 = u^2 + 2uat + a^2t^2}$
2. Rearrange $s = ut + \frac{1}{2}at^2$ to get $\mathbf{at^2 = 2s - 2ut}$
3. Substitute at^2 into the first stage to get

$$\mathbf{v^2 = u^2 + 2uat + a\,(2s - 2ut)}$$

4. Simplify to get $\mathbf{v^2 = u^2 + 2uat + 2as - 2uat}$
5. Simplify further to get $\mathbf{v^2 = u^2 + 2as}$

What can be described as ‘the change in displacement per unit time’.

What can be described as ‘the change in displacement per unit time’.

Velocity.

Instantaneous velocity can be found by measuring the gradient of a tangent to a displacement-time graph.

What is the area under a velocity-time and acceleration-time graph?

What is the area under a velocity-time and acceleration-time graph?

The displacement and the velocity respectively.

As speed increases, air resistance ....

As speed increases, so air resistance ....

Increases (proportional to the square of the speed).

A ball is projected off a castle at 6m/s. How does its horizontal velocity change from its launch until it hits the ground?

A ball is projected off a castle at 6m/s. How does its horizontal velocity change from its launch until it hits the ground?

The horizontal velocity remains the same as there is no acceleration in that direction.

How do the SUVAT equations reflect that all objects fall at the same rate?

How do the SUVAT equations reflect that all objects fall at the same rate?

Mass is not included in the SUVAT equations, showing that the mass of an object does not affect its speed or acceleration. Therefore, all objects fall at the same rate regardless of their masses.

In projectile motion, what is the vertical acceleration?

In projectile motion, what is the vertical acceleration?

The vertical acceleration is equal to the gravitational field strength (g) towards the centre of the Earth.

What is meant by terminal velocity?

What is meant by terminal velocity?

When the forces acting on the falling object become balanced, the acceleration becomes zero and the object is moving at maximum velocity.

A ball is fired at a velocity of 10 m/s, at an angle of 30° to the horizontal. Find the vertical and horizontal components of velocity.

A ball is fired at a velocity of 10 m/s, at an angle of 30° to the horizontal, find the vertical and horizontal components of velocity.

$x = 10 \cos 30°$

$= 8.7$ m/s

$y = 10 \sin 30°$

$= 5$ m/s

Describe bodies falling in gravitational fields with air resistance.

Describe bodies falling in gravitational fields with air resistance.

- Air resistance increases with speed, so as a body accelerates, the resistance increases.
- Acceleration decreases as speed increases.
- When air resistance and weight are equal, the body is falling with its terminal velocity.
- Suvat does not account for air resistance.

Describe bodies falling in gravitational fields without air resistance.

Describe bodies falling in gravitational fields without air resistance.

- Resultant force is only weight.
  - Acceleration = g.
- The acceleration is constant, so suvat formulae can be applied.