Edexcel International A Level (IAL) Maths: Mechanics 1

Your notes

Constant Acceleration in 2D

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- suvat in 2D

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Your notes

suvat in 2D

Which suvat equations can be written in vector form?

- For **constant 2D acceleration**, four of the five suvat formulae can be used with vectors (remember time, t, is not a vector)

$$v = u + at$$

$$s = \frac{1}{2}(u + v)t$$

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

$$s = vt - \frac{1}{2}at^2$$

- The final formula $v^2 = u^2 + 2as$ can not be written in vector form
  - Instead you would use this formula for each component separately (one equation using only the **i** components and one equation using only the **j** components)
- You may also find the following formula useful

$$r = r_0 + s$$

  - r is the displacement from the origin
  - r_0 is the initial displacement from the origin
  - s is the displacement from the starting position

How do I use the 2D suvat equations?

- The skills involved are the same for **suvat in 1D**
- **Acceleration** must be **constant**
  - If acceleration **varies** with time then you need to use **calculus**
- All the **suvat** equations connect four of the five quantities
  - Knowing any **three** allows a **fourth** to be found
- Any vector quantity used within the suvat equations (**s**, **u**, **v** and **a**) are split into **i** and **j**-components, time is a scalar and is used as normal

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- You can use one vector equation and solve that or split into two equations (one for each component) and solve them separately

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How can 2D suvat problems be made harder?

- Sometimes they won't give you the velocity instead it could say "...a particle is travelling parallel to..."
  - This means its velocity is a **scalar multiple** of that vector
  - If the object is travelling parallel to the vector **i** then the component of velocity in the **j** direction must be zero and vice versa
- The question could ask for speeds and/or distances
  - You will need to find **magnitudes** of relevant vectors

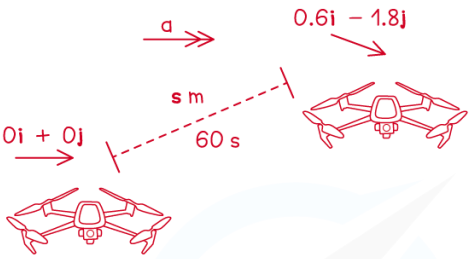
Worked Example

A drone flies parallel to the ground in a 2D-plane.
Starting from rest, the drone flies with constant acceleration. After one minute, the drone's velocity is $(0.6\mathbf{i} - 1.8\mathbf{j})$ m s^{-1}

(a) Find the acceleration of the drone, giving your answer in the form $(a\mathbf{i} + b\mathbf{j})$ m s^{-2}.

Answer:

a) Step 1: Draw a sketch



Step 2: Write down the values we know/want

$\mathbf{u} = 0\mathbf{i} + 0\mathbf{j}$ $\quad \mathbf{v} = 0.6\mathbf{i} - 1.8\mathbf{j}$ $\quad \underline{\mathbf{a} = \mathbf{a}}$ $\quad t = 60$

Step 3: Select the equation

$\mathbf{v} = \mathbf{u} + \mathbf{a}t$

Step 4: Solve

$0.6\mathbf{i} - 1.8\mathbf{j} = 0\mathbf{i} - 0\mathbf{j} + 60\mathbf{a}$

$60\mathbf{a} = 0.6\mathbf{i} - 1.8\mathbf{j}$

$\mathbf{a} = 0.01\mathbf{i} - 0.03\mathbf{j}$

Acceleration = $(0.01\mathbf{i} - 0.03\mathbf{j})$ ms^{-2}

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(b) Find the distance of the drone from its starting point after one minute.

Answer:

b) Step 1: Draw a sketch

Same as part (a)

Step 2: Write down the values we know/want

$\underline{\mathbf{s} = \mathbf{s}}$ $\quad \mathbf{u} = 0\mathbf{i} + 0\mathbf{j}$ $\quad \mathbf{v} = 0.6\mathbf{i} - 1.8\mathbf{j}$ $\quad t = 60$

Step 3: Select the equation

$$\mathbf{s} = \frac{1}{2}(\mathbf{u} + \mathbf{v})t$$

Step 4: Solve

$$\mathbf{s} = \frac{1}{2}((0\mathbf{i} + 0\mathbf{j}) + (0.6\mathbf{i} - 1.8\mathbf{j}))(60)$$

$$\mathbf{s} = 18\mathbf{i} - 54\mathbf{j}$$

Distance from start = magnitude of displacement

$$|18\mathbf{i} - 54\mathbf{j}| = \sqrt{18^2 + (-54)^2} = 18\sqrt{10} = 56.9209...$$

Distance $= 18\sqrt{10}$ m $= 56.9$ m (3 sf)

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Examiner Tips and Tricks

- Don't let the 2D aspect scare you! It works very similarly to 1D suvat.
- Always read the question carefully to see whether the answer should be a scalar or a vector.
- Acceleration is the awkward one where we use the same word for the scalar and vector. If you are asked to find the acceleration it should be clear from the question whether it wants a scalar or a vector, if in doubt write both!