

Uniform and non-uniform acceleration

ASHPHYS · REVISION CHEAT SHEET

AS Level

9702 AS Ch.2

Chapter 2: Accelerated motion

Lesson 2.10

Sections 2.10

Goal: Tell uniform from non-uniform acceleration on a graph, and handle a curved v-t graph.

01 The big picture

Uniform acceleration means a constant acceleration: a straight v-t graph. Only then can the suvat equations be used.

Non-uniform acceleration gives a curved v-t graph. The acceleration at an instant is the gradient of the tangent there; the displacement is still the area under the curve, estimated by counting squares.

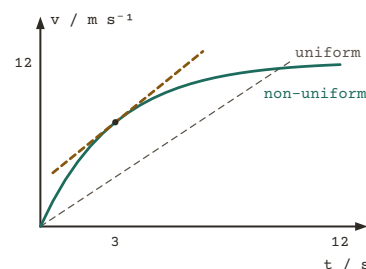
Uniform acceleration [paraphrase]

Constant acceleration: equal changes in velocity in equal times.

Non-uniform acceleration [paraphrase]

The acceleration changes with time; the v-t graph curves.

Fig. 1 · Non-uniform acceleration



The curve flattens: the acceleration falls. The dashed tangent's gradient is the acceleration at 3.0 s.

02 Key equations

Acceleration at an instant

$$a = \text{gradient of the tangent}$$

Displacement

$$s = \text{area under the curve}$$

Symbols and units

a	acceleration	m s^{-2}	s	displacement	m
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03 Sample problems with solutions

Sample 1 · Tangent to a curve

In Fig. 1 the tangent at 3.0 s passes through (1.0 s, 4.6 m s^{-1}) and (5.0 s, 10.5 m s^{-1}). Find the acceleration at 3.0 s, and say why $v = u + at$ cannot be used here.

Step 1. Gradient of the tangent:

$$a = \frac{10.5 - 4.6}{5.0 - 1.0} = 1.48 \text{ m s}^{-2}$$

Step 2. The graph curves, so the acceleration is not constant: suvat does not apply.

Answer: $a = 1.5 \text{ m s}^{-2}$ at 3.0 s; acceleration not constant, so no suvat

04 Practice problems

P1 A v-t curve gets less steep as time goes on. Describe the acceleration.

Answer: Positive but decreasing

P2 A tangent passes through (2.0 s, 3.0 m s^{-1}) and (6.0 s, 15 m s^{-1}). Find the acceleration.

Answer: 3.0 m s^{-2}

P3 Under a curved v-t graph there are 46 squares, each 1.0 m s^{-1} by 0.50 s. Estimate the displacement.

Answer: 23 m

P4 Can $v^2 = u^2 + 2as$ be used for a skydiver before terminal velocity?

Answer: No: the acceleration is not constant

05 Other useful information

Common mistakes

✗ **Wrong:** Join two points on the curve to find the acceleration at an instant.

✓ **Right:** That is an average; draw the tangent at the instant.

Exam tips

- Draw the tangent long, then use a large triangle on it.

What the syllabus asks

- 9702 topic 2: gradient and area of a v-t graph. Coursebook 2.10.

Explore: [Practice questions for this lesson](#)