

4.2 Kinematics of motion in a straight line

Name: _____ Class: _____ Date: _____ **Total: 16 marks**

KEY WORDS distance 距离 • velocity 速度 • speed 速率 • displacement 位移
• constant acceleration 匀加速

Objective

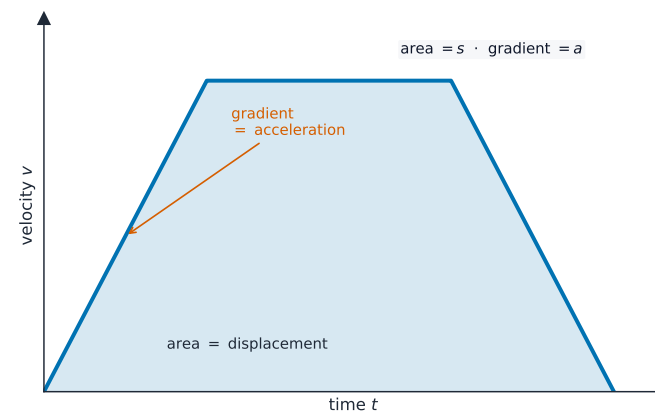
Build the skills to answer exam questions on **kinematics** 运动学 — the **velocity–time graph** 速度时间图, the **suvat** equations for constant acceleration, and using calculus for variable acceleration. Take $g = 10 \text{ m s}^{-2}$.

You must be able to:

- read displacement (area) and acceleration (gradient) from a v – t graph
- use $v = u + at$, $s = ut + \frac{1}{2}at^2$, $v^2 = u^2 + 2as$
- differentiate/integrate between s , v , a for variable acceleration

1 Worked examples

■ Graph & suvat



Area under a v – t graph = displacement; gradient = acceleration

Car from rest, $a = 2.5 \text{ m s}^{-2}$ for 4 s: $v = 2.5 \times 4 = 10 \text{ m s}^{-1}$; $s = \frac{1}{2}(2.5)(16) = 20 \text{ m}$.

Variable: if $s = t^3 - 3t^2$ then $v = \frac{ds}{dt} = 3t^2 - 6t$, $a = \frac{dv}{dt} = 6t - 6$.

2 Practice

2.1 A particle accelerates from 4 m s^{-1} at 3 m s^{-2} for 5 s. Find its final velocity. [2]

2.2 A v – t graph is a straight line from $(0, 2)$ to $(6, 14)$. Find the acceleration. [2]

3 Exam-style questions

3.1 A stone is dropped from rest. After 3 s its speed is ($g = 10$): [1]

- | | |
|---|---|
| A | B |
| C | D |
- A 10 m s^{-1}
 B 20 m s^{-1}
 C 30 m s^{-1}
 D 45 m s^{-1}

3.2 A car travelling at 30 m s^{-1} brakes with constant deceleration and stops in 75 m.

(a) Find the deceleration. [3]

(b) Find the time taken to stop. [2]

3.3 A particle moves so that its velocity is $v = 12t - 3t^2 \text{ m s}^{-1}$ at time $t \text{ s}$.

(a) Find the time when the particle is instantaneously at rest (other than $t = 0$). [2]

(b) Find the distance travelled in the first 4 seconds. [4]
