IB MATHS AI HL · UNIT 5

Kinematics: exam practice

10 questions · 32 marks · worked solutions and markschemes

Name _____ Date _____ Score / 32

- Answer every question before you look at the solutions. They start after the last question, with the marks for each line: M for method, A for accuracy, R for reasoning.
- Online, with more practice: ibmathrevision.com/hlai/kinematics-exam-practice

1. **2 marks · Paper 2 style · calculator allowed**

A car's velocity is $v(t) = 20 - 2t$ m/s for $0 \leq t \leq 10$.

Find the distance travelled before it stops. **[2]**

2. **3 marks · Paper 2 style · calculator allowed**

A particle has $v(t) = 4\sin(t)$ m/s for $0 \leq t \leq 2\pi$.

Find the displacement and the total distance travelled. **[3]**

3. **3 marks · Paper 2 style · calculator allowed**

A ball is thrown up with $v(t) = 15 - 9.8t$ m/s.

Find the time to reach the top and the maximum height above the start. **[3]**

4. **3 marks · Paper 2 style · calculator allowed**

A particle has acceleration $a = 2t$ m/s^2, starting from rest at the origin.

Find $v(t)$, $s(t)$ and the distance travelled in the first 3 s. **[3]**

5. **3 marks · Paper 1 style · calculator allowed**

A particle's displacement is $s(t) = 5e^{-0.2t}$ m.

Find its velocity at $t = 0$ and the time when its speed is 0.5 m/s. **[3]**

6. **3 marks · Paper 1 style · calculator allowed**

The velocity of a particle is $v(t) = 6t - t^2$ m/s.

Find the maximum velocity and the acceleration at $t = 1$. **[3]**

7. **3 marks · Paper 2 style · calculator allowed**

A particle starts at $s = 4$ m with $v(t) = 3\cos(2t)$ m/s.

Find $s(t)$ and its maximum value. **[3]**

8. **4 marks · Paper 1 style · calculator allowed**

A particle moves with $s(t) = t^3 - 9t^2 + 15t$ m.

Find when the particle is at rest and its acceleration at those times. **[4]**

9. **4 marks · Paper 2 style · calculator allowed**

A cyclist accelerates with $a(t) = 1.2 - 0.1t$ m/s^2 from 5 m/s, for $0 \le t \le 12$.

Find the velocity at $t = 12$ and the distance travelled. **[4]**

10. **4 marks · Paper 2 style · calculator allowed**

A particle has $v(t) = t^2 - 4t + 3$ m/s for $0 \le t \le 4$.

Find the total distance travelled. **[4]**

Answers and worked solutions

Question 1 — 2 marks

Answer: $100\ m$

$\int_0^{10} (20 - 2t)\,dt$ **M1**

$100\ m$ **A1**

Question 2 — 3 marks

Answer: 0; $16\ m$

displacement 0 **A1**

$2\int_0^{\pi} 4\sin t\,dt$ **M1**

$16\ m$ **A1**

Question 3 — 3 marks

Answer: $1.53\ s$; $11.5\ m$

$t = 1.53\ s$ **A1**

$\int_0^{1.53} v\,dt$ **M1**

$11.5\ m$ **A1**

Question 4 — 3 marks

Answer: $v = t^2$, $s = \frac{t^3}{3}$; $9\ m$

$v = t^2$ **A1**

$s = \frac{t^3}{3}$ **A1**

$9\ m$ **A1**

Question 5 — 3 marks

Answer: $-1\ \text{m/s}$; $3.47\ s$

$v = -e^{-0.2t}$, $v(0) = -1$ **A1**

$e^{-0.2t} = 0.5$ **M1**

$t = 3.47\ s$ **A1**

Question 6 — 3 marks

Answer: $9\ \text{m/s}$; $4\ \text{m/s}^2$

$a = 6 - 2t$ **A1**

max at $t = 3$: $9\ \text{m/s}$ **A1**

$a(1) = 4\ \text{m/s}^2$ **A1**

Question 7 — 3 marks

Answer: $s = 1.5\sin 2t + 4$; $5.5\ m$

$s = \frac{3}{2}\sin 2t + c$ **A1**

$c = 4$ **A1**

maximum $5.5\ m$ **A1**

Question 8 — 4 marks

Answer: $t = 1, 5$; $a = -12, 12$

$v = 3t^2 - 18t + 15 = 0$ **M1**

$t = 1$, $t = 5$ **A1**

$a = 6t - 18$ **A1**

$a(1) = -12$, $a(5) = 12$ **A1**

Question 9 — 4 marks

Answer: $12.2\ \text{m/s}$; $117.6\ m$

$v = 5 + 1.2t - 0.05t^2$ **A1**

$v(12) = 12.2\ \text{m/s}$ **A1**

$\int_0^{12} v\,dt$ **M1**

$117.6\ m$ **A1**

Question 10 — 4 marks

Answer: $4\ m$

$v = 0$ at $t = 1, 3$ **A1**

$\int_0^{4} |v|\,dt$ **M1**

$\frac{4}{3} + \frac{4}{3} + \frac{4}{3}$ **A1**

$4\ m$ **A1**

Every solution is also on ibmathrevision.com/hlai/kinematics-exam-practice
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