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INTERNATIONAL A LEVEL MATHEMATICS • MECHANICS 1

Mechanics 1

Exam Questions by Topic

Pearson Edexcel International Advanced Level (WME01/01) • Calculator allowed • Take $g = 9.8 \text{ m s}^{-2}$

Multi-step exam questions at the difficulty of the real WME01 paper, with a full mark scheme

Chapters (tap a chapter to jump to it)	Qs	Marks	Page	My score
1 Mathematical Models in Mechanics Not examined on its own: modelling ideas are tested within Chapters 2 to 8	—	—	Not applicable	
2 Constant Acceleration Motion graphs, the suvat formulae, vertical motion under gravity	10	82	2	
3 Vectors in Mechanics Resultants, velocity and position vectors, $\mathbf{r} = \mathbf{r}_0 + \mathbf{v}t$	10	81	own PDF	
4 Dynamics of a Particle Moving in a Straight Line $F = ma$, connected particles, pulleys, lifts	10	82	own PDF	
5 Forces and Friction Resolving forces, friction, inclined planes	10	86	own PDF	
6 Momentum and Impulse Conservation of momentum, impulse	10	81	own PDF	
7 Statics of a Particle Equilibrium, limiting friction	10	82	own PDF	
8 Moments Beams and rods, tilting, non-uniform rods	10	82	own PDF	

[Full mark scheme](#)

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CHAPTER 2 • KEY SKILLS

2

Constant Acceleration

Specification M1: Kinematics • 10 questions • 82 marks • about 98 minutes

1 Units

Work in metres and seconds:

 $1 \text{ km} = 1000 \text{ m}$, $36 \text{ km h}^{-1} = 10 \text{ m s}^{-1}$.

Give units with every answer.

2 The suvat formulae

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

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

$$v^2 = u^2 + 2as \quad (\text{list } s, u, v, a, t \text{ first})$$

3 Direction and signs

Choose a positive direction. A

deceleration is a negative a ; give its size as a positive answer.

Displacement is not distance.

4 Velocity–time graphs

Gradient = acceleration; area =

distance. Straight lines only, and no solid vertical lines. Label the values on both axes.

5 Multi-stage motion

The final velocity of one stage is the initial velocity of the next. Keep a separate time for each stage.

6 Vertical motion

With up positive, $a = -9.8 \text{ m s}^{-2}$ throughout the flight. At the top $v = 0$.After using $g = 9.8$, give 2 or 3 s.f.

7 Two objects

Write each displacement from the same point in terms of the same t , then equate: they meet or draw level.

8 Quadratics

Solve fully, then reject a root that is negative or outside the stage, giving a reason in context.

9 Other motion graphs

Displacement–time: gradient =

velocity. Acceleration–time: horizontal

lines for constant a . Average speed

$$= \frac{\text{total distance}}{\text{total time}}$$

Skills map every skill above is tested at least once; interleaved skills come from GCSE or other chapters

Skill	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Marks	6	6	7	6	6	10	10	10	10	11
1 Units			•	•				•		
2 The suvat formulae	•	•	•		•	•	•	•	•	•
3 Direction and signs		•		•	•	•	•		•	
4 Velocity–time graphs			•	•		•	•	•	•	•
5 Multi-stage motion			•			•	•	•		•
6 Vertical motion		•			•		•	•	•	
7 Two objects									•	•
8 Quadratics		•			•	•		•		•
9 Other motion graphs				•						•
Interleaved: quadratics, completing the square, simultaneous equations (P1)	•	•			•	•		•	•	•
Interleaved: geometric series (P2)							•			
Interleaved: modelling assumptions (Chapter 1 ideas)							•	•		•

Exam difficulty. Questions 1 to 5 check each skill on its own. Questions 6 to 10 are multi-step questions built like the last questions on a real WME01 paper, where one part leads into the next and skills from different topics are combined.

Must learn. Take $g = 9.8 \text{ m s}^{-2}$ (not 9.81) and give answers to 2 or 3 significant figures. Draw a sketch, choose a positive direction and keep to it. When a quadratic gives two roots, say why one is rejected.



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1. A car moves along a straight horizontal road with constant acceleration. The car passes the point P with speed $u \text{ m s}^{-1}$ and, 6 seconds later, it passes the point Q with speed $2.5u \text{ m s}^{-1}$. The distance PQ is 84 m.

(a) Find the value of u .

(3)

(b) Find the acceleration of the car.

(1)

(c) Find the distance of the car from P at the instant when its speed is 14 m s^{-1}

(2)

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Question 1 continued

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(Total for Question 1 is 6 marks)



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2. A ball is projected vertically upwards with speed 14.7 ms^{-1} from a point A which is 19.6 m above horizontal ground. The ball moves freely under gravity until it hits the ground.

Find

- (a) the speed of the ball at the instant before it hits the ground, (3)

- (b) the time between the instant the ball is projected and the instant it hits the ground. (3)

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Question 2 continued

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Question 3 continued

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4.

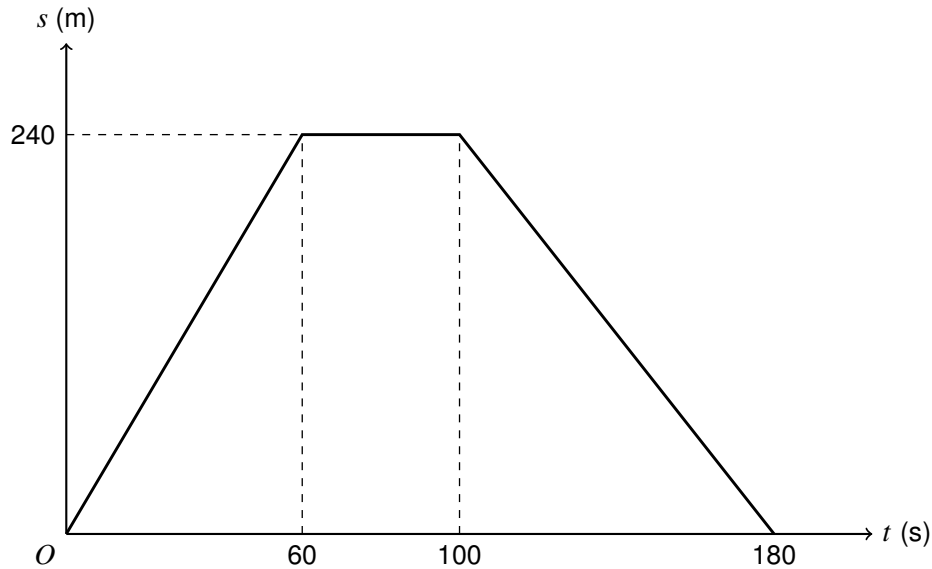


Figure 1

A cyclist rides along a straight path. Figure 1 shows the displacement–time graph for the motion of the cyclist, where s metres is the displacement of the cyclist from her starting point O , t seconds after she leaves O .

- (a) Find the velocity of the cyclist for $0 < t < 60$ and for $100 < t < 180$ (2)
- (b) Find the average speed and the average velocity of the cyclist for the whole 180 seconds. (2)
- (c) Sketch a velocity–time graph for the motion of the cyclist for $0 < t < 180$ (2)



Question 4 continued

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5. A ball is projected vertically upwards with speed 24.5 ms^{-1} from a point O . The ball moves freely under gravity.

(a) Find the greatest height above O reached by the ball. (2)

(b) Find the length of time for which the ball is at least 19.6 m above O . (4)

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Question 5 continued

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(Total for Question 5 is 6 marks)



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- (a)** Sketch a speed–time graph for the motion of the cyclist from A to C.

(2)

- (b)** Show that $5V^2 - 63V - 180 = 0$

(4)

- (c)** Hence find the value of V , explaining why there is only one possible value.

(2)

- (d)** Find the deceleration of the cyclist between B and C .

(2)

Question 6 continued

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Question 6 continued

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7. A small ball is released from rest at a point 10 m above horizontal ground. The ball falls freely under gravity. Each time the ball hits the ground it rebounds vertically upwards with half of the speed with which it hit the ground.
- (a) Find the speed of the ball at the instant before it first hits the ground. (2)
- (b) Find the greatest height reached by the ball after its first bounce. (2)
- (c) Show that the greatest heights after successive bounces form a geometric sequence and hence find the total distance travelled by the ball before it comes to rest. (3)
- (d) Taking downwards as positive, sketch a velocity–time graph for the motion of the ball from the instant it is released until it reaches its greatest height after the first bounce. Show the values of the velocity at the bounce. (2)
- (e) Give one reason why the model is unlikely to predict the total distance accurately. (1)



Question 7 continued

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Question 7 continued

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Question 8 continued

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Question 8 continued

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9. A ball A is projected vertically upwards with speed 19.6 m s^{-1} from a point O on horizontal ground. At the same instant, a ball B is released from rest at a point 29.4 m vertically above O . The balls move freely under gravity and they collide.
- (a) Show that the balls collide 1.5 s after they start to move. (3)
- (b) Find the height above O at which they collide. (2)
- (c) Find the velocity of each ball at the instant before they collide, and state whether A is moving up or down. (2)
- (d) Taking upwards as positive, sketch on the same axes the velocity–time graphs for the two balls from $t = 0$ to $t = 1.5$ (2)
- (e) Explain why the two lines in your sketch are parallel. (1)



Question 9 continued

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Question 9 continued

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A velocity-time graph showing the motion of two particles, P and Q. The vertical axis is labeled $v \text{ (ms}^{-1}\text{)}$ and the horizontal axis is labeled $t \text{ (s)}$. The origin is labeled O . Particle P starts at the origin O and moves with constant acceleration until $t = 12$ s, where its velocity is 24 ms^{-1} . After $t = 12$ s, particle P moves with constant velocity of 24 ms^{-1} . Particle Q starts at the origin O and moves with constant velocity of 16 ms^{-1} . The graph shows that particle P overtakes particle Q at $t = 8$ s.

Two cars P and Q move in the same direction along parallel straight lanes of a road. At time $t = 0$, car P starts from rest at the point O and car Q passes O . Figure 2 shows the velocity–time graphs for the two cars for $0 \leq t \leq 24$

- (a) Show that, at $t = 12$, car Q is 48 m ahead of car P . (2)
- (b) Find the greatest distance between the two cars before car P draws level with car Q . (3)
- (c) Find the time at which car P draws level with car Q . (3)
- (d) Sketch an acceleration–time graph for car P for $0 \leq t \leq 24$ (2)
- (e) Give one criticism of the model for the motion of car P . (1)

Question 10 continued

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Question 10 continued

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(Total for Question 10 is 11 marks)**TOTAL FOR CHAPTER 2 IS 82 MARKS****Join students already acing their exams.**Book your FREE lesson at www.eclassroom.org.uk