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GCE AS / A LEVEL – APPLIED MATHEMATICS A QUESTION PACK

0980-01 (Legacy M1) · New spec Unit 2 Topic 5 · AS unit, 25% of A-level, 75 marks, 1h 45min paper

REVISE

.wales

MATHEMATICS – APPLIED A · KINEMATICS - SUVAT & V&NDASH;T GRAPHS

Kinematics - SUVAT and Motion Graphs

Every constant-acceleration / velocity-time kinematics question from the legacy WJEC M1 papers (2011-2017)

LEGACY 2008 SPECIFICATION

Estimated time for entire question pack: ~3 hours 6 minutes

Derived from the legacy M1 paper's pace of ~1.25 min/mark (149 marks over 17 questions).

*You are advised to **not** attempt to complete all of this in one sitting.*

ABOUT THIS QUESTION PACK

This is a **comprehensive practice question pack**, not a single mock paper. It contains questions from the legacy WJEC M1 papers (2008 modular spec) that map onto new-spec AS Unit 2 Topic 5 (2.2.7).

Questions are ordered chronologically.

INSTRUCTIONS

Use black ink or black ball-point pen. Show all working – method marks are awarded for clear setup.

A calculator is allowed (except where specified by individual questions). The WJEC Formula Booklet and statistical tables may be referred to. Take $g = 9.8 \text{ ms}^{-2}$ for mechanics.

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Q	Source	Max	Mark	Q	Source	Max	Mark
1	Jun 11 Q1	6		10	Jan 14 Q1	7	
2	Jun 11 Q3	11		11	Jan 14 Q2	6	
3	Jan 12 Q1	13		12	Jun 14 Q2	14	
4	Jan 12 Q4	6		13	Jun 15 Q6	13	
5	Jun 12 Q7	10		14	Jun 16 Q1	5	
6	Jan 13 Q1	9		15	Jun 16 Q4	8	
7	Jan 13 Q3	5		16	Jun 16 Q8	7	
8	Jun 13 Q1	9		17	Jun 17 Q4	13	
9	Jun 13 Q3	7		Total			149

Kinematics - SUVAT and Motion Graphs – what the new spec asks

WJEC GCE AS / A Level Mathematics (from 2017) · Unit 2: Applied Mathematics A · Topic 2.2.7.

SUVAT (constant acceleration) 2.2.7

- $v = u + at$
- $s = ut + \frac{1}{2}at^2$
- $v^2 = u^2 + 2as, s = \frac{1}{2}(u + v)t, s = vt - \frac{1}{2}at^2$.

Motion graphs 2.2.7

- Position-time graph: slope = v .
- Velocity-time graph: slope = a ; area under = displacement.
- Distance is always non-negative; displacement may be negative.

Kinematics - SUVAT & v-t graphs in one page

Quick-reference notes – revisit before each section. Don't use during questions.

SUVAT

$$v = u + at, s = ut + \frac{1}{2}at^2, v^2 = u^2 + 2as.$$

$$s = \frac{1}{2}(u + v)t, s = vt - \frac{1}{2}at^2.$$

Requires constant a .

Sign convention

Choose a positive direction first; all of s, u, v, a get signs.

Deceleration is acceleration with the opposite sign.

Position-time graph

Slope = velocity. Curve concave up = positive acceleration.

Stationary point on $s-t$ = momentary rest.

Velocity-time graph

Slope = acceleration.

Area under = displacement.

Signed area: below axis = negative displacement.

Free fall

Take $a = -g = -9.8 \text{ ms}^{-2}$ (upward positive).

Time to highest point: $v = 0$ at u/g .

Average vs instantaneous

$$\text{Average velocity} = \frac{\text{displacement}}{\text{time}}.$$

$$\text{Average speed} = \frac{\text{distance}}{\text{time}}. \text{ They can differ.}$$

SECTION T5

Kinematics - SUVAT and Motion Graphs

Questions 1-17 · 149 marks

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1. A stone is thrown vertically **downwards** from the top of a cliff with an initial velocity of 1 ms^{-1} and hits the sea 2.5 seconds later.
- (a) Find the speed with which the stone hits the sea. [3]
- (b) Calculate the height of the cliff. [3]

3. The points A , B and C lie, in that order, on a straight horizontal road. A car travels on the road with constant acceleration $a \text{ ms}^{-2}$. When the car is at A , its speed is $u \text{ ms}^{-1}$. The distance AB is 10 m and the car takes 2 s to travel from A to B . The car takes 7 s to travel from A to C and its speed at C is 17 ms^{-1} .
- (a) Find the value of u and the value of a . [7]
- (b) Draw a velocity-time graph for the motion of the car between A and C . [2]
- (c) Calculate the distance AC . [2]

1. A lift is moving upwards. It accelerates from rest with uniform acceleration 0.4 ms^{-2} until it reaches a speed of 2 ms^{-1} . It then travels at this constant speed of 2 ms^{-1} for 17 s before decelerating uniformly to rest in 8 s.
- (a) Calculate the time taken for the lift to reach the speed of 2 ms^{-1} . [3]
- (b) Sketch a velocity-time graph for the lift's journey. [3]
- (c) Find the distance travelled by the lift during the journey. [3]
- (d) A man, of mass 70 kg, is standing in the lift during its journey. Calculate the greatest value of the reaction exerted by the floor of the lift on the man during the journey. [4]

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4. A stone is thrown vertically upwards with a speed of 14.7 ms^{-1} from a point A which is 49 m above the ground.
- (a) Find the time taken for the stone to reach the ground. [3]
- (b) Calculate the speed of the stone when it hits the ground. [3]

7. A skydiver drops from rest from a hot air balloon and falls vertically under gravity for 5 s before his parachute opens. After the parachute has opened, his speed of descent reduces with uniform retardation for a further 10 s until his speed is 4 ms^{-1} . He then continues to travel at a constant speed of 4 ms^{-1} until he reaches the ground 2 minutes after he left the hot air balloon.
- (a) Calculate the speed of the skydiver just before his parachute opens. [3]
- (b) Draw a sketch of the velocity-time graph for the skydiver's descent. [4]
- (c) Determine the height of the skydiver above the ground when he drops from the hot air balloon. [3]

1. A car moves with constant acceleration along a straight horizontal road. It passes the point O with speed 12 ms^{-1} . It then passes point A , 4 seconds later, with speed 32 ms^{-1} .
- (a) Show that the acceleration of the car is 5 ms^{-2} . [3]
- (b) Determine the distance OA . [3]
- (c) The point M is the midpoint of OA . Calculate the speed of the car as it passes M . Give your answer correct to one decimal place. [3]

3. A particle is projected vertically upwards with an initial speed of 15 ms^{-1} from a point A , which is 1.2 m above horizontal ground.
- (a) Determine the time taken for the particle to reach the ground. Give your answer correct to one decimal place. [4]
- (b) Suppose a heavier particle is projected vertically upwards from the same point A and with the same initial speed of 15 ms^{-1} . Would the time taken for the particle to reach the ground be greater, the same, or less than your answer in (a)? Give a reason for your answer. [1]

1. A vehicle moves along a straight horizontal road. At time $t = 0$ s, the vehicle passes a point A and is moving with a speed of 20 ms^{-1} . It continues with this constant speed of 20 ms^{-1} for 8 s. The vehicle then slows down with uniform deceleration for 10 s so that at time $t = 18$ s, the speed of the vehicle is 6 ms^{-1} . This speed is maintained until the vehicle reaches the point B at time $t = 40$ s.
- (a) Sketch a velocity-time graph for the motion of the vehicle between A and B . [3]
- (b) Find the magnitude of the deceleration between $t = 8$ and $t = 18$. [3]
- (c) Calculate the distance AB . [3]

3. An object is projected vertically upwards with speed $u \text{ ms}^{-1}$ from a point A which is 2.8 m above horizontal ground. The object reaches its greatest height of 18.225 m above A before falling to the ground.
- (a) Show that the value of u is 18.9. [3]
- (b) Find the time between the object being projected and the object hitting the ground. [4]

1. A vehicle travels on a straight horizontal road. As it passes a point A at time $t = 0$, it is moving with a constant velocity of 18 ms^{-1} . It continues travelling at this velocity for 48 seconds. It then decelerates at a constant rate for the next 12 s until it passes a point B with velocity 3 ms^{-1} .
- (a) Sketch a velocity-time graph for the motion of the vehicle between A and B . [2]
- (b) Find the magnitude of the deceleration of the vehicle. [2]
- (c) Determine the distance between A and B . [3]

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2. A pebble is projected vertically upwards with a speed of 7 ms^{-1} from the top of a cliff. It hits the ground at the bottom of the cliff 4 seconds later.
- (a) Calculate the time for the pebble to reach its maximum height. [3]
- (b) Determine the height of the cliff. [3]

2. A vehicle travels along a straight horizontal road. As it passes point A with speed 10 ms^{-1} , it accelerates at a constant rate for 21 s until it reaches a speed of 24 ms^{-1} . It then travels at this constant speed of 24 ms^{-1} for T s before decelerating at a uniform rate, coming to rest at a point B . The time taken to decelerate to rest is 16 s .
- (a) Calculate the magnitude of the acceleration of the vehicle. [3]
- (b) Determine the distance taken for the vehicle to decelerate to rest. [3]
- (c) Draw a sketch of the velocity-time graph for the motion of the vehicle between A and B . [4]
- (d) Given that the distance between A and B is 15000 m , find the value of T . [4]

6. A bus travels on a straight horizontal road. It leaves bus stop A starting from rest and accelerates at a constant rate for 10 s until it reaches a speed of 20 ms^{-1} . It then continues to travel at this constant speed and, T seconds after it stops accelerating, it passes a point B .
- (a) Sketch a velocity-time graph for the motion of the bus between A and B . [3]
- (b) Find the acceleration of the bus. [2]
- (c) Determine an expression for the distance between A and B in terms of T . [3]
- (d) A car leaves A 5 seconds after the bus has left. It starts from rest and travels with a constant acceleration of magnitude 2 ms^{-2} . Given that the car overtakes the bus at the point B , find the distance between A and B . [5]

TURN OVER

1. A lift, starting from rest, descends with a uniform acceleration of 3.2 ms^{-2} until it reaches a speed of 12 ms^{-1} . It then travels at a constant speed of 12 ms^{-1} for a short time and finally, it is brought to rest with a uniform deceleration of 2.4 ms^{-2} . A person of mass 65 kg is standing in the lift. Calculate the magnitude of the reaction of the floor of the lift on the person during each of the three stages of the motion. [5]

4. A man drives a car along a straight road. As he passes the point A , the car is travelling at a constant speed of 30 ms^{-1} . He continues at the speed of 30 ms^{-1} for 5 minutes until he approaches a built-up area, when he applies a constant deceleration for 20 seconds until the car slows down to a speed of 16 ms^{-1} . On reaching the speed of 16 ms^{-1} , he sees his destination point B and applies a constant deceleration for 8 s until the car stops at B .

(a) Sketch a velocity-time graph for the journey between A and B . [4]

(b) Find the distance between A and B . [4]

8. A car is travelling along a straight road ABC with uniform acceleration $a \text{ ms}^{-2}$. The distance AC is 460 m. The time taken by the car to travel from A to B is 6 s and the time taken to travel from B to C is 14 s. At A the speed of the car is $u \text{ ms}^{-1}$ and at B , the speed of the car is 17 ms^{-1} . Find the value of a and the value of u . [7]

4. A car of mass 800 kg is travelling on a horizontal road. It experiences a resistance to motion which is constant throughout the journey. The car accelerates from rest under a constant tractive force of 300 N exerted by its engine. After 50 seconds, the car reaches a speed of 15 ms^{-1} .
- (a) Determine the magnitude of the acceleration of the car. [3]
- (b) Calculate the magnitude of the constant resistance to motion. [3]
- (c) When the car reaches the speed of 15 ms^{-1} , the engine is switched off and the car is brought to rest by a constant braking force. The total distance covered by the car for the **whole** journey is 500 m. Find the constant force exerted by the brakes. [7]

END OF KINEMATICS - SUVAT & V&NDASH;T GRAPHS PACK

Source: WJEC M1 (2008 modular spec) · 2011–2017
Curated for WJEC Maths 2017 spec AS Unit 2 – Topic 5 (2.2.7)

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