



Topic Tests: Challenge Tests – Set B

For AS / A Level Year 1 AQA
Statistics and Mechanics

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- Test 9.2b – Variable Acceleration

Solutions

Teacher's Introduction

Content

This pack contains 9 challenge level topic tests and solutions for the AQA Applied Mathematics AS / Year 1 A Level content.

Each test comes with fully worked solutions, containing helpful tips, hints, and technique boxes for students who are struggling on a particular question.

These topic tests have been **fully cross-referenced** to the Pearson, Hodder and Collins textbooks for your convenience (see reference sheet on page 2). Each test has been designed to reflect the specification fully.

About the challenge tests

These **challenge** tests have been designed to **stretch and challenge** your students. 50% of the marks come from questions similar in style to our fundamentals tests. These questions isolate and test the core skills in each topic. The other 50% of the marks come from questions of increased difficulty that progress and start to combine the concepts in the topic.

Suggested use of the A and B tests

Each test in Set A has a corresponding test in Set B that features the same styles of questions but with different numbers. This allows for a variety of **flexible** uses including:

- **Test → Homework:** Students use test B as a homework to consolidate on areas of weakness identified from completing test A under test conditions in class.
- **Homework → Test:** Students revise as homework using test A before doing test B in class under test conditions.
- **Test → Classwork:** Students work through test B with teacher input to consolidate on areas of weakness identified from completing test A under test conditions in class.

Classwork → Test: Students work through test A with teacher input, before checking their learning by completing test B under test conditions.

Timings

The recommended times for students to complete each test are given at the top of individual tests. Suggested times for our entire range of topic tests are also compiled in a table on the timings sheet for convenience (see page 3). For these fundamentals tests, the relevant times are the first two listed under each topic. This pack is an updated version of the Applied AS / Year 1 topic tests – the suggested times have been increased to provide students with a more reasonable amount of time to complete each test.

Calculator use

The effective use of a calculator is one of the objectives of the new specification and is encouraged for all the enclosed tests. In particular, students should be comfortable using the statistical functions on their calculator.

Large data set questions

As part of their assessment, students will be tested on data from a **large data set** provided by AQA. This data set contains data on vehicles registered in various locations in England between 2002 and 2016. These topic tests make use of the original large data set provided by AQA, which contains data on household food and drink purchases; familiarity with these is not assumed and is not needed to take these tests.

Also available from ZigZag Education

The perfect starting point for students of all abilities are our **fundamentals** tests. These isolate and test the core skills in each topic so that your students can show what they can do. They get a confidence boost and you can see at a glance where each student's weaknesses lie.

To prepare students for the exam itself, our **expert** tests contain 25% repeated marks from the fundamentals and challenge tests, and 75% exam-style material with compound/multistep questions.

Update v1.1, September 2018

Improved and increased suggested times to complete each test. Additionally reduced number of points 3.2b Q3, added 'Graph Paper Needed' flag where needed.

Free Updates!

Register your email address to receive any future free updates* made to this resource or other Maths resources your school has purchased, and details of any promotions for your subject.

* resulting from minor specification changes, suggestions from teachers and peer reviews, or occasional errors reported by customers

Go to zzed.uk/freeupdates

Cross-referencing Grid

Topic	AQA spec. points	Sub-topics	Edexcel Pearson textbook [ISBN: 9781292232539]
Data Collection	K1	Populations and samples, sampling, non-random sampling, types of data, the large data set	1
Measures of Location and Spread	L3	Measures of central tendency, other measures of location, measures of spread, variance and standard deviation, <i>coding (Edexcel only)</i>	2
Representations of Data & Correlation	L1 – L2, L4	Outliers, box plots, cumulative frequency, histograms, comparing data, correlation, linear regression	3 - 4
Probability	M1	Calculations, mutually exclusive and independent events, Venn diagrams, tree diagrams	5
Statistical distributions	N1	Probability distributions, binomial distribution, cumulative probabilities	6
Hypothesis testing	O1 – O2	Hypothesis testing, finding critical values, one-tailed tests, two-tailed tests	7
Constant Acceleration	Q1 – Q3, R3	Displacement-time graphs, velocity-time graphs, constant acceleration formulae, vertical motion under gravity	9
Modelling in Mechanics & Forces and Motion	P1, R1 – R4	Force diagrams, forces as vectors, forces and acceleration, motion in 2 dimensions, connected particles, pulleys	8, 10
Variable Acceleration	Q4	Functions of time, using differentiation, maxima and minima problems, using integration, constant acceleration formulae	11

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Timings Sheet

For the **fundamentals** tests, refer to the tests marked X.1a and X.1b.

For the **challenge** tests, refer to the tests marked X.2a and X.2b.

For the **expert** tests, refer to the tests marked X.3a and X.3b.

Topic test reference	Recommended time (minutes)	Topic test reference	Recommended time (minutes)	
Data Collection		Probability		
1.1.a	12	4.1a	30	
1.1b	12	4.1b	30	
1.2a	9	4.2a	26	
1.2b	10	4.2b	26	
1.3a	11	4.3a	32	
1.3b	12	4.3b	32	
Measures of Location and Spread		Statistical Distributions		M
2.1a	28	5.1a	24	
2.1b	28	5.1b	24	
2.2a	31	5.2a	24	
2.2b	30	5.2b	24	
2.3a	34	5.3a	31	
2.3b	32	5.3b	31	
Representations of Data & Correlation		Hypothesis Testing		
3.1a	16	6.1a	17	
3.1b	16	6.1b	17	
3.2a	19	6.2a	17	
3.2b	19	6.2b	17	
3.3a	22	6.3a	17	
3.3b	22	6.3b	17	

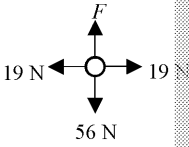
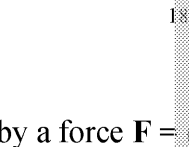
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Modelling in Mechanics & Forces and Motion – Test B (26 marks)

Subtopics: Force diagrams, forces as vectors, forces and acceleration, motion in two dimensions
For this test you should take $g = 9.8 \text{ m s}^{-2}$ unless otherwise stated and give your answers to 3 significant figures.

- Given that there is a resultant force of 13 N downwards acting on the particle in the diagram to the right, calculate the value of F .

- A particle is acted upon by the forces $\begin{pmatrix} -2 \\ 4 \end{pmatrix} \text{ N}$ and $\begin{pmatrix} 6 \\ -9 \end{pmatrix} \text{ N}$. Work out the **resultant force** acting on the particle.
- The forces $(a\mathbf{i} + b\mathbf{j}) \text{ N}$, $(7a\mathbf{i} - 3b\mathbf{j}) \text{ N}$ and $(16\mathbf{i} - 12\mathbf{j}) \text{ N}$ act on an object. Find the values of a and b .
- A particle of mass 4 kg is acted on by a force $\mathbf{F} = (-6\mathbf{i} + 8\mathbf{j}) \text{ N}$ and has acceleration \mathbf{a} .
 - Find the value of m .
 - Assuming that \mathbf{j} represents the unit vector due north, find the **bearing** of the force.
- Two particles P and Q of mass 3 kg and 7 kg respectively are connected by a string. The particles start at rest on a rough horizontal plane. A force of 10 N is applied to particle Q and causes the system to move in the direction PQ with an acceleration of 0.5 m s^{-2} . Particle P experiences a frictional force of 1.5 N and particle Q experiences a frictional force of 2.5 N .
 - Find the value of a .
 - Find the **tension** in the string.
 - State two ways in which you have used the fact that the string is light.
- A uniform bench is supported at each end by two identical legs. Draw a free-body diagram showing the forces acting on the bench.
- The particle in the diagram on the right is moving at a **constant speed**. Find the values of F and G .

- A particle of mass 1.5 kg starts at rest and is acted upon by a force $\mathbf{F} = (y\mathbf{i} + 3\mathbf{j}) \text{ N}$, where \mathbf{j} is assumed to represent the unit vector due north.
 - Find the value of y .
 - Find the **magnitude** of the force \mathbf{F} .
 - Find the **magnitude** of the acceleration of the particle.
 - Find the speed of the particle 3 seconds after the force is applied.
- Two particles P and Q of mass 6 kg and $m \text{ kg}$ respectively are connected by a string. The string passes over a smooth fixed pulley and the particles hang vertically. The system is released from rest. Given that Q descends with acceleration 0.5 m s^{-2} .
 - Find the **tension** in the string, giving your answer in terms of g .
 - Find the value of m .
 - Find the force exerted on the **pulley** by the **string**, giving your answer in terms of g . After Q has been descending for 1.3 s , it strikes the ground. Given that P reaches the pulley:
 - Calculate the distance that particle Q descends before it strikes the ground.

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Preview of Questions Ends Here

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Solutions to Measures of Location and Spread – Test B

1. a) Mean = $\frac{80+88+67+79+44+83+72+81+72}{9}$ **M1**
 $= \frac{666}{9} = 74$ **A1**
 Median = 79 **A1**
 Mode = 72 **A1**
 Range = $88 - 44 = 44$ **A1**
- b) Mean increases since 75 is greater than the original mean of 74. **A1**
 Median decreases since the new median now occurs between the 5th and 6th values.
 Mode stays the same since there are still two 72s and one of every other number.
 Range stays the same since 75 is between the largest and smallest numbers on the list.
2. a) There are $2+6+15+18+6+3 = 60$ data points in the frequency table. **M1**
 The 10th percentile is the 6th smallest value and the 90th percentile is the 54th smallest value.
 The smallest value is 2 so the 10th percentile is 2. **A1**
 The 54th smallest value is 5 so the 90th percentile is 5. **A1**
- b) Interquartile range = $5 - 2 = 3$ **A1**
- c) $\sum fx = 2 \times 1 + 6 \times 2 + 15 \times 3 + 18 \times 4 + 6 \times 5 + 3 \times 6 = 2 + 12 + 45 + 72 + 30 + 18 = 179$
 $\sum fx^2 = 2 \times 1^2 + 6 \times 2^2 + 15 \times 3^2 + 18 \times 4^2 + 6 \times 5^2 + 3 \times 6^2 = 2 + 24 + 135 + 288 + 150 + 108 = 707$ **M1**
- Standard Deviation = $\sqrt{\frac{\sum fx^2}{n} - \left(\frac{\sum fx}{n}\right)^2}$ **M1**
 $= \sqrt{\frac{707}{50} - \left(\frac{179}{50}\right)^2} = \sqrt{14.14 - 3.58^2} = 1.15047... = 1.15$ **A1**
- d) Mean number of people per house in Long Road is $179 \div 50 = 3.58$ **M1**
 This is more than 3.5 so, on average, there are fewer people per house in Short Road than in Long Road.
 The standard deviation of people per house is larger in Short Road than in Long Road.
 per house is more varied in Short Road than in Long Road. **A1**
3. a) Mean = $\frac{\sum x}{n}$ **M1**
 $= \frac{410}{14} = 29.2857... = 29.3$ ml (3 s.f.) **A1**
- Standard Deviation = $\sqrt{\frac{\sum x^2}{n} - \left(\frac{\sum x}{n}\right)^2}$ **M1**
 $= \sqrt{\frac{12160}{14} - 29.2857...^2} = \sqrt{868.5714 - 857.653} = \sqrt{10.9184} = 3.30429... = 3.30$ ml (3 s.f.) **A1**
- b) Let c be the data value that Henry scored in yard.
 Now, mean = $\frac{\sum x}{n} = 29$ where $\sum x = 410 - c$ and $n = 13$ **M1**
 So $29 = \frac{410 - c}{13}$ **M1**
 So $c = 410 - (29 \times 13) = 33$ ml **M1A1**
4. Total height of all students before new student arrives = $126.2 \times 24 = 3028.8$ **M1**
 Total height of all students after new student arrives = $126.4 \times 25 = 3160$ **M1**
 So height of new student = $3160 - 3028.8 = 131.2$ cm (or 131 cm (3 s.f.)) **A1**

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Preview of Answers Ends Here

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