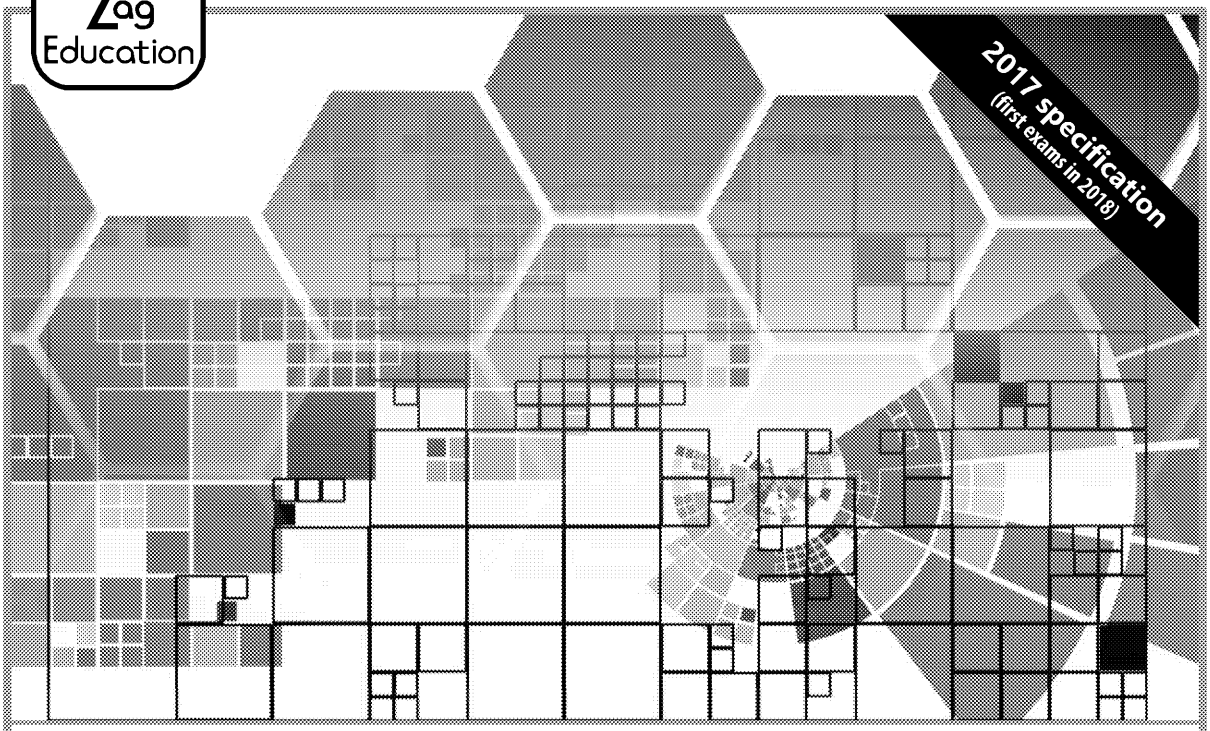
Zig Zag Education

Maths **AS / A Level | OCR A | H230/H240**



Topic Tests: Challenge Tests – Set B

For AS / A Level Year 1 OCR A Statistics and Mechanics

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POD 8686

Contents

Teacher's Introduction

Content

This pack contains 9 challenge level topic tests and solutions for the OCR A 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.

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.

The large data set

As part of their assessment, students will be tested on data from the **large data set** provided by OCR. This data set contains data on workers' commutes and the age structure of the England & Wales population from two years in various locations. Familiarity with the large data set is assumed in these topic tests, but a copy of it is not needed to take the tests themselves.

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.

Cross-referencing Grid

Topic	OCR A spec. points	Sub-topics	Edexcel Pearson textbook [ISBN: 9781292232539]
Data Collection	2.01a – d	Populations, samples, sampling, non-random sampling, types of data, the large data set	1
Measures of Location and Spread	2.02f – g	Measures of central tendency, other measures of location, measures of spread, variance and standard deviation, *coding (Edexcel only)*	2
Representations of Data & Correlation	2.02a – e, 2.02h – j	Outliers, box plots, cumulative frequency, histograms, comparing data, correlation, linear regression	3 - 4
Probability	2.03a – b	Calculations, mutually exclusive and independent events, Venn diagrams, tree diagrams	5
Statistical distributions	2.04a – c	Probability distributions, binomial distribution, cumulative probabilities	6
Hypothesis testing	2.05a – c	Hypothesis testing, finding critical values, one-tailed tests, two-tailed tests	7
Constant Acceleration	3.02a – d, 3.03f	Displacement-time graphs, velocity-time graphs, constant acceleration formulae, vertical motion under gravity	9
Modelling in Mechanics & Forces and Motion	3.01a – b, 3.03a – d, 3.03f – k, 3.03n, 3.03r	Force diagrams, forces as vectors, forces and acceleration, motion in 2 dimensions, connected particles, pulleys	8, 10
Variable Acceleration	3.02f	Functions of time, using differentiation, maxima and minima problems, using integration, constant acceleration formulae	11

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	1	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	

Variable Acceleration – Test B (36 mins)

Subtopics: Functions of time, using differentiation, maxima and minima proi
constant acceleration formulae

1. A monorail is moving in a straight line. The velocity of the monorail, v m s^{-1}, is given by $v = t^2 + t - 12$ for $0 \le t \le 10$
   a) Find the **initial velocity** of the monorail.
   b) At what time t is the monorail instantaneously **at rest**?
   c) Find the time at which the monorail has velocity 30 m s^{-1}

2. A particle moves along a straight line. Its velocity, v m s^{-1}, at time t se
   $v = 4t^3 - 12t^2 + 8t$ for $0 \le t \le 1$. During this ti[illegible]e velocity of the pa
   Find the **total distance travelled** by the particle between $t = 0$ and $t =$

3. A particle starts at [illegible] O and moves along the x-axis. The displa
   at time t is given by $s = 18t - 3t^2$ for $0 \le t \le 6$
   Find th[illegible]**imum displacement** of the particle away from O.

4. A body is moving in a straight line with velocity v at time t given by th
   a) Find an expression for the **acceleration** of the body at time t.
   The displacement, s, of the particle when $t = 3$ is $s = 100$
   b) Find an expression for the **displacement** of the body at time t.

5. A particle is moving along a straight line. The initial velocity of the pa
   seconds the acceleration, a m s^{-2}, of the particle is given by $a = 2t - 10$
   a) Find the **velocity** of the particle at time t seconds.
   b) Find the values of t for which the particle is instantaneously **at res**

6. A body moves in a straight line. At time t its velocity is equal to $v = u$
   initial displacement is 0. Use calculus to show that the displacement, s
   by $s = ut + \frac{1}{2}at^2$

7. An astronomer models how a particle of dust thrown straight up from t
   down. In her model the acceleration upwards, a m s^{-2}, of the dust at a
   thrown upwards is described by the expression $a = 2t^{-4/3} - 6t^{-5/3}$ for $t \ge$
   velocity 3 m s^{-1} upwards.
   a) Find the **velocity** of the dust particle at a time [illegible]econds after it wa
   When $t = 1$ the dust is 54 m above the Mo[illegible]s surface.
   b) According to the model, how [illegible] **seconds** does it take for the du
   the Moon?

8. A squ[illegible]rrelling from the base of its tree to various nuts it has bur
   modelling a particle moving along a straight line. The squirrel's velo
   is given by $v = 6t^2 - 14t - 10$ for $0 \le t \le 6$. At time $t = 0$ it is 24 m fro
   positive velocity.
   a) Find an expression for the **acceleration**, a m s^{-2}, of the squirrel at
   b) Show that the squirrel is at the base of its tree when $t = 4$
   c) At what other time is the squirrel at the base of its tree?

Preview of Questions Ends Here

Solutions to Modelling in Mechanics & Forces and Motion – Test B

1. Horizontal forces are balanced so no resultant force horizontally
Resolving vertically (↓)
$56 - F = 13$ **M1**
$\therefore F = 56 - 13 = 43$ N **A1**

2. Resultant force $= \begin{pmatrix} -2 \\ 4 \end{pmatrix} + \begin{pmatrix} 6 \\ -9 \end{pmatrix} = \begin{pmatrix} 4 \\ -5 \end{pmatrix}$ N **M1**

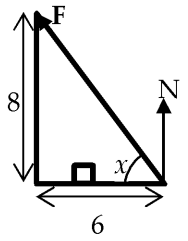
$\therefore$ magnitude of resultant force is

$$\left|\begin{pmatrix} 4 \\ -5 \end{pmatrix}\right| = \sqrt{4^2 + (-5)^2} = \sqrt{16+25} = \sqrt{41} = 6.40312... = 6.40 \text{ N (3 s.f.)}$$ **A1**

3. By Newton's first law, object in equilibrium has no resultant force
$(a\mathbf{i} + b\mathbf{j}) + (7a\mathbf{i} - 3b\mathbf{j}) + (16\mathbf{i} - 2\mathbf{i}) = \mathbf{0}$
$\therefore (8a + 16)\mathbf{i} + (-2b - 2)\mathbf{j} = \mathbf{0}$ **M1**
$\therefore 8a + 16 = 0 \therefore a = -2$ **A1**
$\therefore -2b - 2 = 10 \therefore -12 = 2b \therefore b = -6$ **A1**

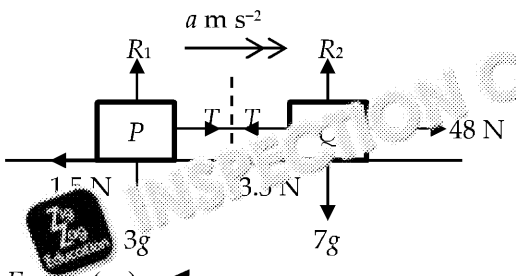
4. a) $F = ma$
Magnitude of force **F** is
$$|(-6\mathbf{i} + 8\mathbf{j})| = \sqrt{(-6)^2 + 8^2} = \sqrt{36+64} = 10 \text{ N}$$ **M1**
$F = 10$, $a = 2.5$
$$10 = m \times 2.5 \therefore m = \frac{10}{2.5} = 4 \text{ kg}$$ **A1**

b)



$$\tan x = \frac{8}{6} = \frac{4}{3} \therefore x = \arctan\frac{4}{3} = 53.1301... = 53.1° \text{ (3 s.f.)}$$ **M1**
Bearings are measured clockwise from north, so
bearing of **F** = 270 + 53.1301... = 323.130... = 323° (3 s.f.) **A1**

5. a)

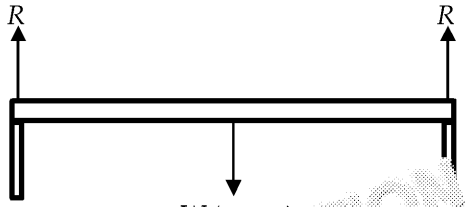


$F = ma$ (→)
$F = 48 - 3.5 - 1.5 = 43$
$m = 3 + 7 = 10$ **M1**
$$43 = 10a \therefore a = \frac{43}{10} = 4.3 \text{ ms}^{-2}$$ **A1**

b) $F = ma$ for P $(\rightarrow)$
$F = T - 1.5$, $a = 4.3$, $m = 3$ **M1**
$T - 1.5 = 3 \times 4.3$ **M1**
$T - 1.5 = 12.9$
$\therefore T = 14.4$ N **A1**

c) The tension in the string is the same at P as at Q **A1**
The string does not have any mass **A1**

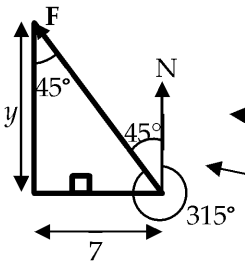
6.



A1A1

7. Particle is in equilibrium / constant speed so resultant force is equal to zero **M1**
Resolving horizontally $(\rightarrow)$: $2F + G - 18 = 0$ $\therefore 2F + G = 18$ **(1)**
Resolving vertically $(\uparrow)$: $3F - G - 7 = 0$ $\therefore 3F - G = 7$ **(2)** **M1**
(1) + (2): $2F + G + 3F - G = 18 + 7$
$\therefore 5F = 25$ $\therefore F = 5$ N **A1**
Substitute $F = 5$ into **(1)**:
$2 \times 5 + G = 18$ $\therefore G = 18 - 10 = 8$ N **A1**

8. a)



$\tan 45° = \dfrac{7}{y}$ **M1**

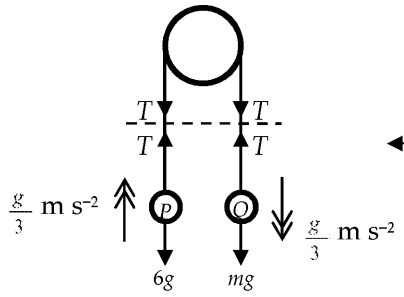
$\therefore y = \dfrac{7}{\tan 45°} = \dfrac{7}{1} = 7$ **M1A1**

b) $\mathbf{F} = (-7\mathbf{i} + 7\mathbf{j})$ N
$|\mathbf{F}| = |(-7\mathbf{i} + 7\mathbf{j})| = \sqrt{(-7)^2 + 7^2} = 7\sqrt{2} = 9.89949... = 9.90$ N (3 s.f.) **A1**

c) $F = ma$
$F = 7\sqrt{2}$, $m = 1.5$
$7\sqrt{2} = 1.5a$ $\therefore a = \dfrac{7\sqrt{2}}{1.5} = \dfrac{14\sqrt{2}}{3} = 6.60...$ $= 6.60$ m s^{-2} (3 s.f.) **A1**

d) $v = u + at$
$u = 0$, $t = 3$, $a = \dfrac{14\sqrt{2}}{3}$
$\therefore v = 0 + \dfrac{14\sqrt{2}}{3} \times 3$ **M1**
$\therefore v = 14\sqrt{2} = 19.7989... = 19.8$ m s^{-1} (3 s.f.) **A1**

9. a)



Tip: D... partic... forces ... calcul...

$F = ma$ for P (↑)

Techn... actin... secon... upwa...

$T - 6g = 6 \times \frac{g}{3} \therefore T - 6g = 2g$ **M1**

$\therefore T = 8g$ N **A1**

b) $F = ma$ for Q (↓)

Techn... actin... secon... down...

$mg - T = m \times \frac{g}{3} \therefore m... = \frac{...}{3}$ **M1**

$\therefore \frac{...}{3} \therefore \frac{...}{3} = 8$ **M1**

$\therefore m = \frac{8 \times 3}{2} = \frac{24}{2} = 12$ kg **A1**

c) The force exerted on the pulley by the string is $2T$ N **M1**

$\therefore$ force $= 2T = 2 \times 8g = 16g$ N **A1**

d) $s = ut + \frac{1}{2}at^2$

Techn... consta... consta...

$u = 0,\ t = 1.3,\ a = \frac{g}{3}$

$\therefore s = 0 + \frac{1}{2} \times \frac{g}{3} \times 1.3^2$ **M1**

$\therefore s = \frac{169g}{600} = 2.76033... = 2.76$ m (3 s.f.) **A1**

Preview of Answers Ends Here