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AS
Mathematics

Sample Assessment Materials

Pearson Edexcel Level 3 Advanced Subsidiary GCE in Mathematics (8MA0)

First teaching from September 2017

First certification from 2018 | Issue 1

Pearson

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Contents

Introduction

The Pearson Edexcel Level 3 Advanced Subsidiary GCE in Mathematics is designed for use in schools and colleges. It is part of a suite of AS/A Level qualifications offered by Pearson.

These sample assessment materials have been developed to support this qualification and will be used as the benchmark to develop the assessment students will take.

General marking guidance

- All candidates must receive the same treatment. Examiners must mark the last candidate in exactly the same way as they mark the first.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than be penalised for omissions.
- Examiners should mark according to the mark scheme – not according to their perception of where the grade boundaries may lie.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification/indicative content will not be exhaustive. However different examples of responses will be provided at standardisation.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, a senior examiner must be consulted before a mark is given.
- Crossed-out work should be marked **unless** the candidate has replaced it with an alternative response.

Specific guidance for mathematics

1. These mark schemes use the following types of marks:
   - **M** marks: Method marks are awarded for 'knowing a method and attempting to apply it', unless otherwise indicated.
   - **A** marks: Accuracy marks can only be awarded if the relevant method (M) marks have been earned.
   - **B** marks are unconditional accuracy marks (independent of M marks)
   - Marks should not be subdivided.
2. Abbreviations

   These are some of the traditional marking abbreviations that may appear in the mark schemes.

   - **bod** benefit of doubt
   - **ft** follow through
   - $\surd$ this symbol is used for correct ft
   - **cao** correct answer only
   - **cso** correct solution only. There must be no errors in this part of the question to obtain this mark
   - **isw** ignore subsequent working
   - **awrt** answers which round to
   - **SC:** special case
   - **o.e.** or equivalent (and appropriate)
   - **d…** or **dep** dependent
   - **indep** independent
   - **dp** decimal places
   - **sf** significant figures
   - ***** The answer is printed on the paper or ag- answer given

- ⎣ or d… The second mark is dependent on gaining the first mark

3. All M marks are follow through.

   All A marks are 'correct answer only' (cao.), unless shown, for example, as A1 ft to indicate that previous wrong working is to be followed through. After a misread however, the subsequent A marks affected are treated as A ft, but answers that don't logically make sense e.g. if an answer given for a probability is >1 or <0, should never be awarded A marks.

4. For misreading which does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, in that part of the question affected.

5. Where a candidate has made multiple responses and indicates which response they wish to submit, examiners should mark this response. If there are several attempts at a question which have not been crossed out, examiners should mark the final answer which is the answer that is the most complete.

6. Ignore wrong working or incorrect statements following a correct answer.

7. Mark schemes will firstly show the solution judged to be the most common response expected from candidates. Where appropriate, alternative answers are provided in the notes. If examiners are not sure if an answer is acceptable, they will check the mark scheme to see if an alternative answer is given for the method used. If no such alternative answer is provided but deemed to be valid, examiners must escalate the response to a senior examiner to review.

Write your name here

Surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number	Candidate Number

Mathematics
Advanced Subsidiary
Paper 1: Pure Mathematics

Sample Assessment Material for first teaching September 2017

Time: 2 hours

Paper Reference **8MA0/01**

You must have:
Mathematical Formulae and Statistical Tables, calculator

Total Marks

Candidates may use any calculator permitted by Pearson regulations. Calculators must not have the facility for algebraic manipulation, differentiation and integration, or have retrievable mathematical formulae stored in them.

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** the questions and ensure that your answers to parts of questions are clearly labelled.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- You should show sufficient working to make your methods clear. Answers without working may not gain full credit.
- Answers should be given to three significant figures unless otherwise stated.

Information

- A booklet 'Mathematical Formulae and Statistical Tables' is provided.
- There are 17 questions in this question paper. The total mark for this paper is 100.
- The marks for each question are shown in brackets – *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.
- If you change your mind about an answer, cross it out and put your new answer and any working underneath.

Turn over ▶

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Answer ALL questions. Write your answers in the spaces provided.

1. The line l passes through the points A (3, 1) and B (4, −2).

Find an equation for l.

(3)

(Total for Question 1 is 3 marks)

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2. The curve C has equation

$$y = 2x^2 - 12x + 16$$

Find the gradient of the curve at the point P (5, 6).

(*Solutions based entirely on graphical or numerical methods are not acceptable.*)

(4)

(Total for Question 2 is 4 marks)

3. Given that the point A has position vector $3\mathbf{i} - 7\mathbf{j}$ and the point B has position vector $8\mathbf{i} + 3\mathbf{j}$,

(a) find the vector $\overrightarrow{AB}$

(2)

(b) Find $|\overrightarrow{AB}|$. Give your answer as a simplified surd.

(2)

(Total for Question 3 is 4 marks)

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4.

$$f(x) = 4x^3 - 12x^2 + 2x - 6$$

(a) Use the factor theorem to show that $(x - 3)$ is a factor of $f(x)$.

(2)

(b) Hence show that 3 is the only real root of the equation $f(x) = 0$

(4)

(Total for Question 4 is 6 marks)

5. Given that

$$f(x) = 2x + 3 + \frac{12}{x^2}, \quad x > 0$$

show that $\int_1^{2\sqrt{2}} f(x)\,dx = 16 + 3\sqrt{2}$

(5)

(Total for Question 5 is 5 marks)

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6. Prove, from first principles, that the derivative of $3x^2$ is $6x$.

(4)

(Total for Question 6 is 4 marks)

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7. (a) Find the first 3 terms, in ascending powers of x, of the binomial expansion of $\left(2 - \frac{x}{2}\right)^7$, giving each term in its simplest form.

(4)

(b) Explain how you would use your expansion to give an estimate for the value of 1.995^7

(1)

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Question 7 continued

(Total for Question 7 is 5 marks)

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8.

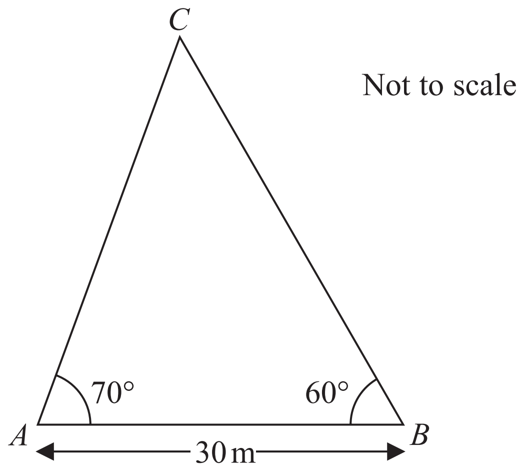

Figure 1

A triangular lawn is modelled by the triangle *ABC*, shown in Figure 1. The length *AB* is to be 30 m long.

Given that angle $BAC = 70°$ and angle $ABC = 60°$,

(a) calculate the area of the lawn to 3 significant figures.

(4)

(b) Why is your answer unlikely to be accurate to the nearest square metre?

(1)

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Question 8 continued

(Total for Question 8 is 5 marks)

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9. Solve, for $360° \leqslant x < 540°$,

$$12\sin^2 x + 7\cos x - 13 = 0$$

Give your answers to one decimal place.

(*Solutions based entirely on graphical or numerical methods are not acceptable.*)

(5)

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Question 9 continued

(Total for Question 9 is 5 marks)

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10. The equation $kx^2 + 4kx + 3 = 0$, where k is a constant, has no real roots.

Prove that

$$0 \leqslant k < \frac{3}{4}$$

(4)

(Total for Question 10 is 4 marks)

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11. (a) Prove that for all positive values of x and y

$$\sqrt{xy} \leqslant \frac{x + y}{2}$$

(2)

(b) Prove by counter example that this is not true when x and y are both negative.

(1)

(Total for Question 11 is 3 marks)

12. A student was asked to give the exact solution to the equation

$$2^{2x+4} - 9(2^x) = 0$$

The student's attempt is shown below:

$$2^{2x+4} - 9(2^x) = 0$$

$$2^{2x} + 2^4 - 9(2^x) = 0$$

$$\text{Let} \quad 2^x = y$$

$$y^2 - 9y + 8 = 0$$

$$(y - 8)(y - 1) = 0$$

$$y = 8 \text{ or } y = 1$$

$$\text{So } x = 3 \text{ or } x = 0$$

(a) Identify the two errors made by the student.

(2)

(b) Find the exact solution to the equation.

(2)

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Question 12 continued

(Total for Question 12 is 4 marks)

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13. (a) Factorise completely $x^3 + 10x^2 + 25x$

(2)

(b) Sketch the curve with equation

$$y = x^3 + 10x^2 + 25x$$

showing the coordinates of the points at which the curve cuts or touches the x-axis.

(2)

The point with coordinates $(-3, 0)$ lies on the curve with equation

$$y = (x + a)^3 + 10(x + a)^2 + 25(x + a)$$

where a is a constant.

(c) Find the two possible values of a.

(3)

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Question 13 continued

(Total for Question 13 is 7 marks)

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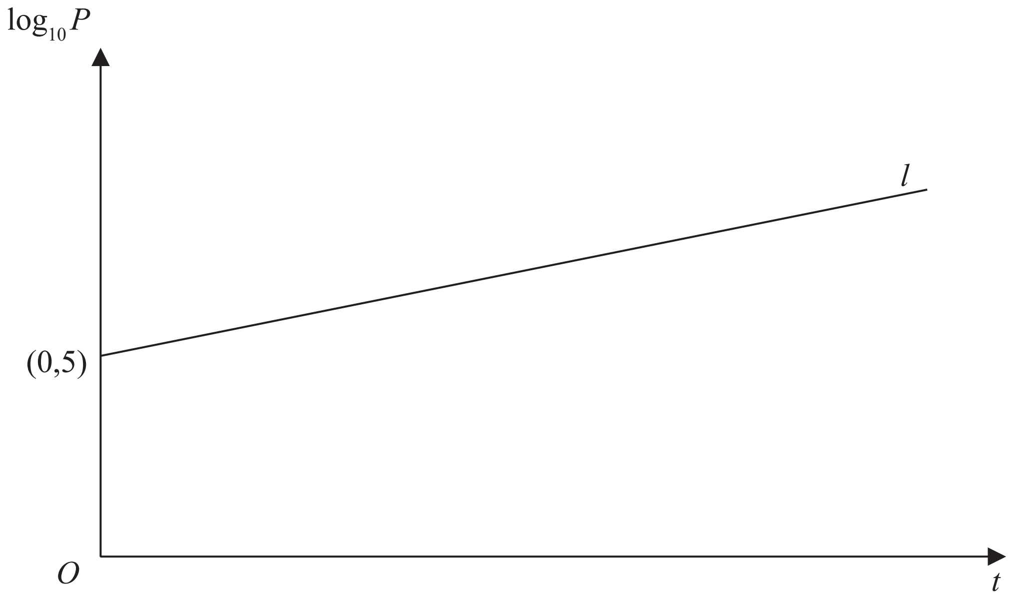

Figure 2

A town's population, P, is modelled by the equation $P = ab^t$, where a and b are constants and t is the number of years since the population was first recorded.

The line l shown in Figure 2 illustrates the linear relationship between t and $\log_{10} P$ for the population over a period of 100 years.

The line l meets the vertical axis at (0, 5) as shown. The gradient of l is $\frac{1}{200}$.

(a) Write down an equation for l.

(2)

(b) Find the value of a and the value of b.

(4)

(c) With reference to the model interpret

(i) the value of the constant a,

(ii) the value of the constant b.

(2)

(d) Find

(i) the population predicted by the model when $t = 100$, giving your answer to the nearest hundred thousand,

(ii) the number of years it takes the population to reach 200 000, according to the model.

(3)

(e) State two reasons why this may not be a realistic population model.

(2)

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Question 14 continued

(Total for Question 14 is 13 marks)

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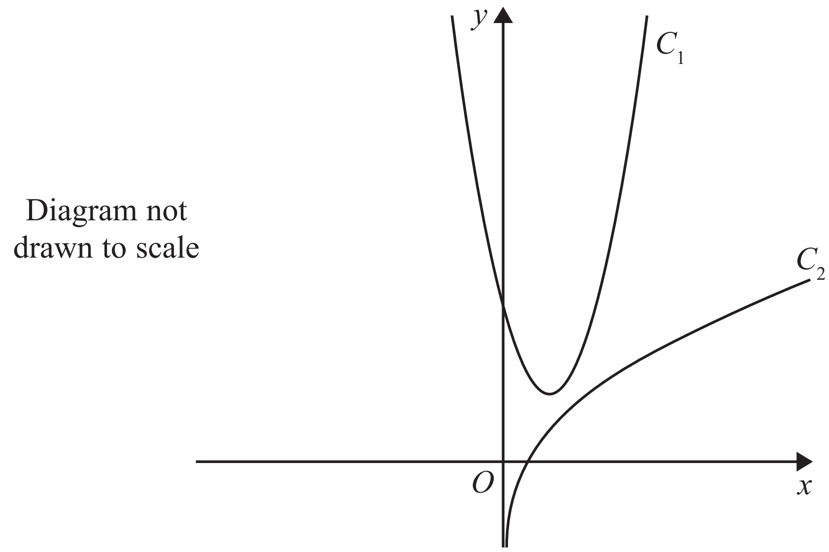

Figure 3

The curve C_1, shown in Figure 3, has equation $y = 4x^2 - 6x + 4$.

The point $P\left(\frac{1}{2}, 2\right)$ lies on C_1

The curve C_2, also shown in Figure 3, has equation $y = \frac{1}{2}x + \ln(2x)$.

The normal to C_1 at the point P meets C_2 at the point Q.

Find the exact coordinates of Q.

(*Solutions based entirely on graphical or numerical methods are not acceptable.*)

(8)

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Question 15 continued

(Total for Question 15 is 8 marks)

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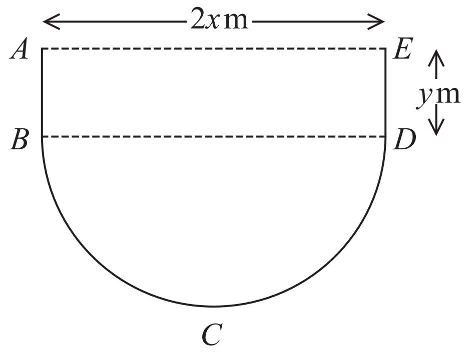

Figure 4

Figure 4 shows the plan view of the design for a swimming pool.

The shape of this pool *ABCDEA* consists of a rectangular section *ABDE* joined to a semicircular section *BCD* as shown in Figure 4.

Given that $AE = 2x$ metres, $ED = y$ metres and the area of the pool is $250\,\text{m}^2$,

(a) show that the perimeter, P metres, of the pool is given by

$$P = 2x + \frac{250}{x} + \frac{\pi x}{2}$$

(4)

(b) Explain why $0 < x < \sqrt{\dfrac{500}{\pi}}$

(2)

(c) Find the minimum perimeter of the pool, giving your answer to 3 significant figures.

(4)

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Question 16 continued

(Total for Question 16 is 10 marks)

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17. A circle C with centre at $(-2, 6)$ passes through the point $(10, 11)$.

(a) Show that the circle C also passes through the point $(10, 1)$.

(3)

The tangent to the circle C at the point $(10, 11)$ meets the y axis at the point P and the tangent to the circle C at the point $(10, 1)$ meets the y axis at the point Q.

(b) Show that the distance PQ is 58 explaining your method clearly.

(7)

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Question 17 continued

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Question 17 continued

(Total for Question 17 is 10 marks)

TOTAL FOR PAPER IS 100 MARKS

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Paper 1: Pure Mathematics Mark Scheme

Question	Scheme	Marks	AOs
1 **Way 1**	Uses $y = mx + c$ with both (3, 1) and (4, −2) and attempt to find m or c	M1	1.1b
	$m = -3$	A1	1.1b
	$c = 10$ so $y = -3x + 10$ o.e.	A1	1.1b
		(3)	
Or **Way 2**	Uses $\frac{y-y_1}{x-x_1} = \frac{y_2-y_1}{x_2-x_1}$ with both (3, 1) and (4, −2)	M1	1.1b
	Gradient simplified to -3 (may be implied)	A1	1.1b
	$y = -3x + 10$ o.e.	A1	1.1b
		(3)	
Or **Way 3**	Uses $ax + by + k = 0$ and substitutes both $x = 3$ when $y = 1$ and $x = 4$ when $y = -2$ with attempt to solve to find a, b or k in terms of one of them	M1	1.1b
	Obtains $a = 3b$, $k = -10b$ or $3k = -10a$	A1	1.1b
	Obtains $a = 3$, $b = 1$, $k = -10$ Or writes $3x + y - 10 = 0$ o.e.	A1	1.1b
		(3)	
			(7 marks)

Notes:

M1: Need correct use of the given coordinates

A1: Need fractions simplified to -3 (in ways 1 and 2)

A1: Need constants combined accurately

N.B. Answer left in the form $(y-1) = -3(x-3)$ or $(y-(-2)) = -3(x-4)$ is awarded M1A1A0 as answers should be simplified by constants being collected

Note that a correct answer implies all three marks in this question

Question	Scheme	Marks	AOs
2	Attempt to differentiate	M1	1.1a
	$\frac{dy}{dx} = 4x - 12$	A1	1.1b
	Substitutes $x = 5 \Rightarrow \frac{dy}{dx} = \ldots$	M1	1.1b
	$\Rightarrow \frac{dy}{dx} = 8$	A1ft	1.1b
			(4 marks)

Notes:

M1: Differentiation implied by one correct term

A1: Correct differentiation

M1: Attempts to substitute $x = 5$ into their derived function

A1ft: Substitutes $x = 5$ into **their** derived function **correctly** i.e. Correct calculation of their $f'(5)$ so follow through slips in differentiation

Question	Scheme	Marks	AOs
3(a)	Attempts $\overrightarrow{AB} = \overrightarrow{OB} - \overrightarrow{OA}$ or similar	M1	1.1b
	$\overrightarrow{AB} = 5\mathbf{i} + 10\mathbf{j}$	A1	1.1b
		(2)	
(b)	Finds length using 'Pythagoras' $\lvert AB \rvert = \sqrt{(5)^2 + (10)^2}$	M1	1.1b
	$\lvert AB \rvert = 5\sqrt{5}$	A1ft	1.1b
		(2)	
			(4 marks)

Notes:

(a)

M1: Attempts subtraction but may omit brackets

A1: cao (allow column vector notation)

(b)

M1: Correct use of Pythagoras theorem or modulus formula using their answer to (a)

A1ft: $\lvert AB \rvert = 5\sqrt{5}$ ft from their answer to (a)

Note that the correct answer implies M1A1 in each part of this question

Question	Scheme	Marks	AOs
4(a)	States or uses $f(+3)=0$	M1	1.1b
	$4(3)^3 - 12(3)^2 + 2(3) - 6 = 108 - 108 + 6 - 6 = 0$ and so $(x - 3)$ is a factor	A1	1.1b
		(2)	
(b)	Begins division or factorisation so x $4x^3 - 12x^2 + 2x - 6 = (x - 3)(4x^2 + \ldots)$	M1	2.1
	$4x^3 - 12x^2 + 2x - 6 = (x - 3)(4x^2 + 2)$	A1	1.1b
	Considers the roots of their quadratic function using completion of square or discriminant	M1	2.1
	$(4x^2 + 2) = 0$ has no real roots with a reason (e.g. negative number does not have a real square root, or $4x^2 + 2 > 0$ for all x So $x = 3$ is the only real root of $f(x) = 0$ *	A1*	2.4
		(4)	
		(6 marks)	

Notes:

(a)

M1: States or uses $f(+3) = 0$

A1: See correct work evaluating and achieving zero, together with correct conclusion

(b)

M1: Needs to have $(x - 3)$ and first term of quadratic correct

A1: Must be correct – may further factorise to $2(x - 3)(2x^2 + 1)$

M1: Considers their quadratic for no real roots by use of completion of the square or consideration of discriminant then

A1*: A correct explanation

Question	Scheme	Marks	AOs
5	$\text{f}(x) = 2x + 3 + 12\,x^{-2}$	B1	1.1b
	Attempts to integrate	M1	1.1a
	$\int\left(+2x+3+\frac{12}{x^2}\right)\text{d}x = x^2+3x-\frac{12}{x}$	A1	1.1b
	$\left((2\sqrt{2})^2+3(2\sqrt{2})-\frac{12(\sqrt{2})}{2\times 2}\right)-(-8)$	M1	1.1b
	$=16+3\sqrt{2}$ *	A1*	1.1b
			(5 marks)

Notes:

B1: Correct function with numerical powers

M1: Allow for raising power by one. $x^n \to x^{n+1}$

A1: Correct three terms

M1: Substitutes limits and rationalises denominator

A1*: Completely correct, no errors seen

Question	Scheme	Marks	AOs
6	Considers $\dfrac{3(x+h)^2-3x^2}{h}$	B1	2.1
	Expands $3(x+h)^2 = 3x^2 + 6xh + 3h^2$	M1	1.1b
	So gradient $=\dfrac{6xh+3h^2}{h}=6x+3h$ or $\dfrac{6x\delta x+3(\delta x)^2}{\delta x}=6x+3\delta x$	A1	1.1b
	States as $h\to 0$, gradient $\to 6x$ so in the limit derivative $=6x$ *	A1*	2.5
			(4 marks)

Notes:

B1: Gives correct fraction as in the scheme above or $\dfrac{3(x+\delta x)^2-3x^2}{\delta x}$

M1: Expands the bracket as above or $3(x+\delta x)^2=3x^2+6x\delta x+3(\delta x)^2$

A1: Substitutes correctly into earlier fraction and simplifies

A1*: Uses Completes the proof, as above (may use $\delta x \to 0$), considers the limit and states a conclusion with no errors

Question	Scheme	Marks	AOs
7(a)	$\left(2-\frac{x}{2}\right)^7 = 2^7 + \binom{7}{1}2^6.\left(-\frac{x}{2}\right) + \binom{7}{2}2^5.\left(-\frac{x}{2}\right)^2 + ...$	M1	1.1b
	$\left(2-\frac{x}{2}\right)^7 = 128 + ...$	B1	1.1b
	$\left(2-\frac{x}{2}\right)^7 = ... -224x + ...$	A1	1.1b
	$\left(2-\frac{x}{2}\right)^7 = ... + ... + 168x^2 \; (+ ...)$	A1	1.1b
		(4)	
(b)	Solve $\left(2-\frac{x}{2}\right) = 1.995$ so $x = 0.01$ and state that 0.01 would be substituted for x into the expansion	B1	2.4
		(1)	
		(5 marks)	

Notes:

(a)

M1: Need correct binomial coefficient with correct power of 2 and correct power of x. Coefficients may be given in any correct form; e.g. 1, 7, 21 or ${}^7C_0$, ${}^7C_1$, ${}^7C_2$ or equivalent

B1: Correct answer, simplified as given in the scheme

A1: Correct answer, simplified as given in the scheme

A1: Correct answer, simplified as given in the scheme

(b)

B1: Needs a full explanation i.e. to state $x = 0.01$ and that this would be substituted and that it is a solution of $\left(2-\frac{x}{2}\right) = 1.995$

Question	Scheme		Marks	AOs
8(a)	**<u>Way 1</u>** Finds third angle of triangle and uses or states $\dfrac{x}{\sin 60°} = \dfrac{30}{\sin"50°"}$	**<u>Way 2</u>** Finds third angle of triangle and uses or states $\dfrac{y}{\sin 70°} = \dfrac{30}{\sin"50°"}$	M1	2.1
	So $x = \dfrac{30\sin 60°}{\sin 50°}$ $(= 33.9)$	So $y = \dfrac{30\sin 70°}{\sin 50°}$ $(= 36.8)$	A1	1.1b
	Area = $\frac{1}{2} \times 30 \times x \times \sin 70$ ° or $\frac{1}{2} \times 30 \times y \times \sin 60$		M1	3.1a
	= 478 m^2		A1ft	1.1b
			(4)	
(b)	Plausible reason e.g. Because the angles and the side length are not given to four significant figures Or e.g. The lawn may not be flat		B1	3.2b
			(1)	
			(5 marks)	

Notes:

(a)

M1: Uses sine rule with their third angle to find one of the unknown side lengths

A1: Finds expression for, or value of either side length

M1: Completes method to find area of triangle

A1ft: Obtains a correct answer for their value of x or their value of y

(b)

B1: As information given in the question may not be accurate to 4sf or the lawn may not be flat so modelling by a plane figure may not be accurate

Question	Scheme	Marks	AOs
9	Uses $\sin^2 x = 1 - \cos^2 x \Rightarrow 12(1-\cos^2 x) + 7\cos x - 13 = 0$	M1	3.1a
	$\Rightarrow 12\cos^2 x - 7\cos x + 1 = 0$	A1	1.1b
	Uses solution of quadratic to give $\cos x =$	M1	1.1b
	Uses inverse cosine on their values, giving two correct follow through values (see note)	M1	1.1b
	$\Rightarrow x =$ 430.5°, 435.5°	A1	1.1b
			(5 marks)

Notes:

M1: Uses correct identity

A1: Correct three term quadratic

M1: Solves their three term quadratic to give values for cos x. (The correct answers are $\cos x = \frac{1}{3}$ or $\frac{1}{4}$ but this is not necessary for this method mark)

M1: Uses inverse cosine on their values, giving two correct follow through values - may be outside the given domain

A1: Two correct answers in the given domain

Question	Scheme	Marks	AOs
10	Realises that $k = 0$ will give no real roots as equation becomes $3 = 0$ (proof by contradiction)	B1	3.1a
	(For $k \neq 0$) quadratic has no real roots provided $b^2 < 4ac$ so $16k^2 < 12k$	M1	2.4
	$4k(4k-3) < 0$ with attempt at solution	M1	1.1b
	So $0 < k < \frac{3}{4}$, which together with $k = 0$ gives $0 \leqslant k < \frac{3}{4}$ *	A1*	2.1
			(4 marks)

Notes:

B1: Explains why $k = 0$ gives no real roots

M1: Considers discriminant to give quadratic inequality – does not need the $k \neq 0$ for this mark

M1: Attempts solution of quadratic inequality

A1*: Draws conclusion, which is a printed answer, with no errors (dependent on all three previous marks)

Question	Scheme	Marks	AOs
11 (a) Way 1	Since x and y are positive, their square roots are real and so $(\sqrt{x}-\sqrt{y})^2 \geq 0$ giving $x-2\sqrt{x}\sqrt{y}+y \geq 0$	M1	2.1
	$\therefore \; 2\sqrt{xy} \leq x+y$ provided x and y are positive and so $\sqrt{xy} \leq \dfrac{x+y}{2}$ *	A1*	2.2a
		(2)	
Way 2 Longer method	Since $(x-y)^2 \geq 0$ for real values of x and y, $x^2-2xy+y^2 \geq 0$ and so $4xy \leq x^2+2xy+y^2$ i.e. $4xy \leq (x+y)^2$	M1	2.1
	$\therefore \; 2\sqrt{xy} \leq x+y$ provided x and y are positive and so $\sqrt{xy} \leq \dfrac{x+y}{2}$ *	A1*	2.2a
		(2)	
(b)	Let $x = -3$ and $y = -5$ then LHS = $\sqrt{15}$ and RHS= -4 so as $\sqrt{15} > -4$ result does not apply	B1	2.4
		(1)	
			(3 marks)

Notes:

(a)

M1: Need two stages of the three stage argument involving the three stages, squaring, square rooting terms and rearranging

A1*: Need all three stages making the correct deduction to achieve the printed result

(b)

B1: Chooses two negative values and substitutes, then states conclusion

Question	Scheme		Marks	AOs
12(a)	$2^{2x}+2^4$ is wrong in line 2 - it should be $2^{2x}\times 2^4$		B1	2.3
	In line 4, 2^4 has been replaced by 8 instead of by 16		B1	2.3
			(2)	
(b)	**Way 1:** $2^{2x+4}-9(2^x)=0$ $2^{2x}\times 2^4-9(2^x)=0$ Let $2^x=y$ $16y^2-9y=0$	**Way 2:** $(2x+4)\log 2-\log 9-x\log 2=0$	M1	2.1
	$y=\frac{9}{16}$ or $y=0$ So $x=\log_2\left(\frac{9}{16}\right)$ or $\dfrac{\log\left(\frac{9}{16}\right)}{\log 2}$ o.e. with no second answer	$x=\dfrac{\log 9}{\log 2}-4$ o.e.	A1	1.1b
			(2)	
			(4 marks)	

Notes:

(a)

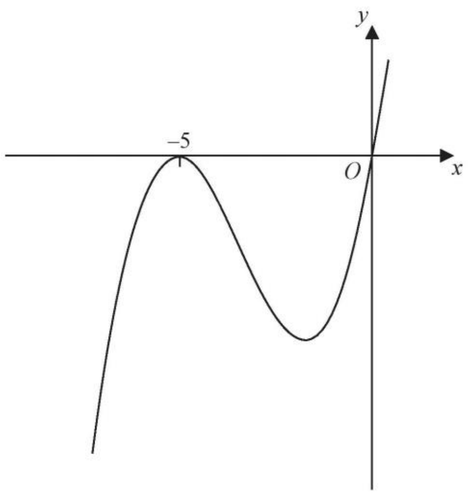
B1: Lists error in line 2 (as above)

B1: Lists error in line 4 (as above)

(b)

M1: Correct work with powers reaching this equation

A1: Correct answer here – there are many exact equivalents

Question	Scheme		Marks	AOs
13(a)	$x^3 + 10x^2 + 25x = x(x^2 + 10x + 25)$		M1	1.1b
	$= x(x+5)^2$		A1	1.1b
			(2)	
(b)		A cubic with correct orientation	M1	1.1b
		Curve passes through the origin (0, 0) and touches at (−5, 0) (see note below for ft)	A1ft	1.1b
			(2)	
(c)	Curve has been translated *a* to the left		M1	3.1a
	$a = -2$		A1ft	3.2a
	$a = 3$		A1ft	1.1b
			(3)	
				(7 marks)

Notes:

(a)

M1: Takes out factor x

A1: Correct factorisation – allow $x(x + 5)(x + 5)$

(b)

M1: Correct shape

A1ft: Curve passes through the origin (0, 0) and touches at (−5, 0) – allow follow through from incorrect factorisation

(c)

M1: May be implied by one of the correct answers for a or by a statement

A1ft: ft from their cubic as long as it meets the x-axis only twice

A1ft: ft from their cubic as long as it meets the x-axis only twice

Question	Scheme		Marks	AOs
14(a)	$\log_{10} P = mt + c$		M1	1.1b
	$\log_{10} P = \frac{1}{200}t + 5$		A1	1.1b
			(2)	
(b)	**Way 1:** As $P = ab^t$ then $\log_{10} P = t\log_{10} b + \log_{10} a$	**Way 2:** As $\log_{10} P = \frac{t}{200} + 5$ then $P = 10^{\left(\frac{t}{200}+5\right)} = 10^5 10^{\left(\frac{t}{200}\right)}$	M1	2.1
	$\log_{10} b = \frac{1}{200}$ or $\log_{10} a = 5$	$a = 10^5$ or $b = 10^{\left(\frac{1}{200}\right)}$	M1	1.1b
	So a = 100 000 **or** b = 1.0116		A1	1.1b
	Both a = 100 000 **and** b = 1.0116 (awrt 1.01)		A1	1.1b
			(4)	
(c)(i)	The initial population		B1	3.4
(c)(ii)	The proportional increase of population each year		B1	3.4
			(2)	
(d)(i)	300000 to nearest hundred thousand		B1	3.4
(d)(ii)	Uses $200000 = ab^t$ with their values of a and b or $\log_{10} 200000 = \frac{1}{200}t + 5$ and rearranges to give t =		M1	3.4
	60.2 years to 3sf		A1ft	1.1b
			(3)	
(e)	Any two valid reasons- e.g. • 100 years is a long time and population may be affected by wars and disease • Inaccuracies in measuring gradient may result in widely different estimates • Population growth may not be proportional to population size • The model predicts unlimited growth		B2	3.5b
			(2)	

Question 14 continued	
Notes:	
(a)	
M1:	Uses a linear equation to relate log P and t
A1:	Correct use of gradient and intercept to give a correct line equation
(b)	
M1:	**Way 1:** Uses logs correctly to give log equation; **Way 2:** Uses powers correctly to "undo" log equation and expresses as product of two powers
M1:	**Way 1:** Identifies log b or log a or both; **Way 2:** Identifies a or b as powers of 10
A1:	Correct value for a or b
A1:	Correct values for both
(c)(i)	
B1:	Accept equivalent answers e.g. The population at $t = 0$
(c)(ii)	
B1:	So accept rate at which the population is increasing each year or scale factor 1.01 or increase of 1% per year
(d)(i)	
B1:	cao
(d)(ii)	
M1:	As in the scheme
A1ft:	On their values of a and b with correct log work
(e)	
B2:	As given in the scheme – any two valid reasons

Question	Scheme	Marks	AOs
15	Finds $\frac{dy}{dx} = 8x - 6$	M1	3.1a
	Gradient of curve at P is –2	M1	1.1b
	Normal gradient is $-\frac{1}{m} = \frac{1}{2}$	M1	1.1b
	So equation of normal is $(y-2) = \frac{1}{2}\left(x - \frac{1}{2}\right)$ or $4y = 2x+7$	A1	1.1b
	Eliminates y between $y = \frac{1}{2}x + \ln(2x)$ and their normal equation to give an equation in x	M1	3.1a
	Solves their $\ln 2x = \frac{7}{4}$ so $x = \frac{1}{2}e^{\frac{7}{4}}$	M1	1.1b
	Substitutes to give value for y	M1	1.1b
	Point Q is $\left(\frac{1}{2}e^{\frac{7}{4}}, \frac{1}{4}e^{\frac{7}{4}} + \frac{7}{4}\right)$	A1	1.1b
		(8 marks)	

Notes:

M1: Differentiates correctly

M1: Substitutes $x = \frac{1}{2}$ to find gradient (may make a slip)

M1: Uses negative reciprocal gradient

A1: Correct equation for normal

M1: Attempts to eliminate y to find an equation in x

M1: Attempts to solve their equation using exp

M1: Uses their x value to find y

A1: Any correct exact form

Question	Scheme	Marks	AOs
16(a)	Sets $2xy + \frac{\pi x^2}{2} = 250$	B1	2.1
	Obtain $y = \frac{250 - \frac{\pi x^2}{2}}{2x}$ and substitute into P	M1	1.1b
	Use $P = 2x + 2y + \pi x$ with their y substituted	M1	2.1
	$P = 2x + \frac{250}{x} - \frac{\pi x^2}{2x} + \pi x = 2x + \frac{250}{x} + \frac{\pi x}{2}$ *	A1*	1.1b
		(4)	
(b)	$x > 0$ and $y > 0$ (distance) $\Rightarrow \frac{250 - \frac{\pi x^2}{2}}{2x} > 0$ or $250 - \frac{\pi x^2}{2} > 0$ o.e.	M1	2.4
	As x and y are distances they are positive so $0 < x < \sqrt{\frac{500}{\pi}}$ *	A1*	3.2a
		(2)	
(c)	Differentiates P with negative index correct in $\frac{dP}{dx}$; $x^{-1} \to x^{-2}$	M1	3.4
	$\frac{dP}{dx} = 2 - \frac{250}{x^2} + \frac{\pi}{2}$	A1	1.1b
	Sets $\frac{dP}{dx} = 0$ and proceeds to $x =$	M1	1.1b
	Substitutes their x into $P = 2x + \frac{250}{x} + \frac{\pi x}{2}$ to give perimeter = 59.8 M	A1	1.1b
		(4)	
			(10 marks)

Question 16 continued
Notes:
(a) **B1:** Correct area equation **M1:** Rearranges **their** area equation to make y the subject of the formula and attempt to use with an expression for P **M1:** Use correct equation for perimeter with their y substituted **A1*:** Completely correct solution to obtain and state printed answer
(b) **M1:** States $x > 0$ and $y > 0$ and uses their expression from (a) to form inequality **A1*:** Explains that x and y are positive because they are distances, and uses correct expression for y to give the printed answer correctly
(c) **M1:** Attempt to differentiate P (deals with negative power of x correctly) **A1:** Correct differentiation **M1:** Sets derived function equal to zero and obtains $x =$ **A1:** The value of x may not be seen (it is 8.37 to 3sf or $\sqrt{\left(\frac{500}{4+\pi}\right)}$) Need to see awrt 59.8 M with units included for the perimeter

Question	Scheme		Marks	AOs
17 (a)	**Way 1:** Finds circle equation $(x \pm 2)^2 + (y \mp 6)^2 = (10 \pm (-2))^2 + (11 \mp 6)^2$	**Way 2:** Finds distance between $(-2, 6)$ and $(10, 11)$	M1	3.1a
	Checks whether (10, 1) satisfies their circle equation	Finds distance between $(-2, 6)$ and (10, 1)	M1	1.1b
	Obtains $(x+2)^2 + (y-6)^2 = 13^2$ and checks that $(10+2)^2 + (1-6)^2 = 13^2$ so states that (10, 1) lies on C *	Concludes that as distance is the same (10, 1) lies on the circle C *	A1*	2.1
			(3)	
(b)	Finds radius gradient $\dfrac{11-6}{10-(-2)}$ or $\dfrac{1-6}{10-(-2)}$ (m)		M1	3.1a
	Finds gradient perpendicular to their radius using $-\dfrac{1}{m}$		M1	1.1b
	Finds (equation and) y intercept of tangent (see note below)		M1	1.1b
	Obtains a correct value for y intercept of their tangent i.e. 35 or –23		A1	1.1b
	Way 1: Deduces gradient of second tangent	**Way 2:** Deduces midpoint of PQ from symmetry (0, 6)	M1	1.1b
	Finds (equation and) y intercept of second tangent	Uses this to find other intercept	M1	1.1b
	So obtains distance PQ = 35 + 23= 58*		A1*	1.1b
			(7)	
			(10 marks)	

Question 17 continued
Notes:
(a) <u>Way 1</u> and <u>Way 2</u>: **M1:** Starts to use information in question to find equation of circle or radius of circle **M1:** Completes method for checking that (10, 1) lies on circle **A1*:** Completely correct explanation with no errors concluding with statement that circle passes through (10, 1)
(b) **M1:** Calculates $\frac{11-6}{10-(-2)}$ or $\frac{1-6}{10-(-2)}$ (m) **M1:** Finds $-\frac{1}{m}$ (correct answer is $-\frac{12}{5}$ **or** $\frac{12}{5}$). This is referred to as m' in the next note **M1:** Attempts $y-11=their\left(-\frac{12}{5}\right)(x-10)$ or $y-1=their\left(\frac{12}{5}\right)(x-10)$ and puts $x=0$, or uses vectors to find intercept e.g. $\frac{y-11}{10}=-m'$ **A1:** One correct intercept 35 or – 23
<u>Way 1</u>: **M1:** Uses the negative of their previous tangent gradient or uses a correct $-\frac{12}{5}$ or $\frac{12}{5}$ **M1:** Attempts the second tangent equation and puts $x = 0$ or uses vectors to find intercept e.g. $\frac{11-y}{10}=m'$
<u>Way 2</u>: **M1:** Finds midpoint of PQ from symmetry. (This is at (0, 6)) **M1:** Uses this midpoint to find second intercept or to find difference between midpoint and first intercept. e.g. 35 – 6 = 29 then 6 – 29 = –23 so second intercept is at (–23, 0)
<u>Ways 1 and 2</u>: **A1*:** Obtain 58 correctly from a valid method

Write your name here

Surname	Other names

Pearson Edexcel
Level 3 GCE

Centre Number | Candidate Number

Mathematics

Advanced Subsidiary
Paper 2: Statistics and Mechanics

Sample Assessment Material for first teaching September 2017
Time: 1 hour 15 minutes

Paper Reference
8MA0/02

You must have:
Mathematical Formulae and Statistical Tables, calculator

Total Marks

Candidates may use any calculator permitted by Pearson regulations. Calculators must not have the facility for algebraic manipulation, differentiation and integration, or have retrievable mathematical formulae stored in them.

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- There are **two** sections in this question paper. Answer **all** the questions in Section A and **all** the questions in Section B.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- You should show sufficient working to make your methods clear. Answers without working may not gain full credit.
- Answers should be given to three significant figures unless otherwise stated.

Information

- A booklet 'Mathematical Formulae and Statistical Tables' is provided.
- There are 9 questions in this question paper. The total mark for this paper is 60.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.
- If you change your mind about an answer, cross it out and put your new answer and any working underneath.

Turn over

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SECTION A: STATISTICS

Answer ALL questions. Write your answers in the spaces provided.

1. Sara is investigating the variation in daily maximum gust, t kn, for Camborne in June and July 1987.

She used the large data set to select a sample of size 20 from the June and July data for 1987. Sara selected the first value using a random number from 1 to 4 and then selected every third value after that.

(a) State the sampling technique Sara used.

(1)

(b) From your knowledge of the large data set explain why this process may not generate a sample of size 20.

(1)

The data Sara collected are summarised as follows

$$n = 20 \qquad \sum t = 374 \qquad \sum t^2 = 7600$$

(c) Calculate the standard deviation.

(2)

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Question 1 continued

(Total for Question 1 is 4 marks)

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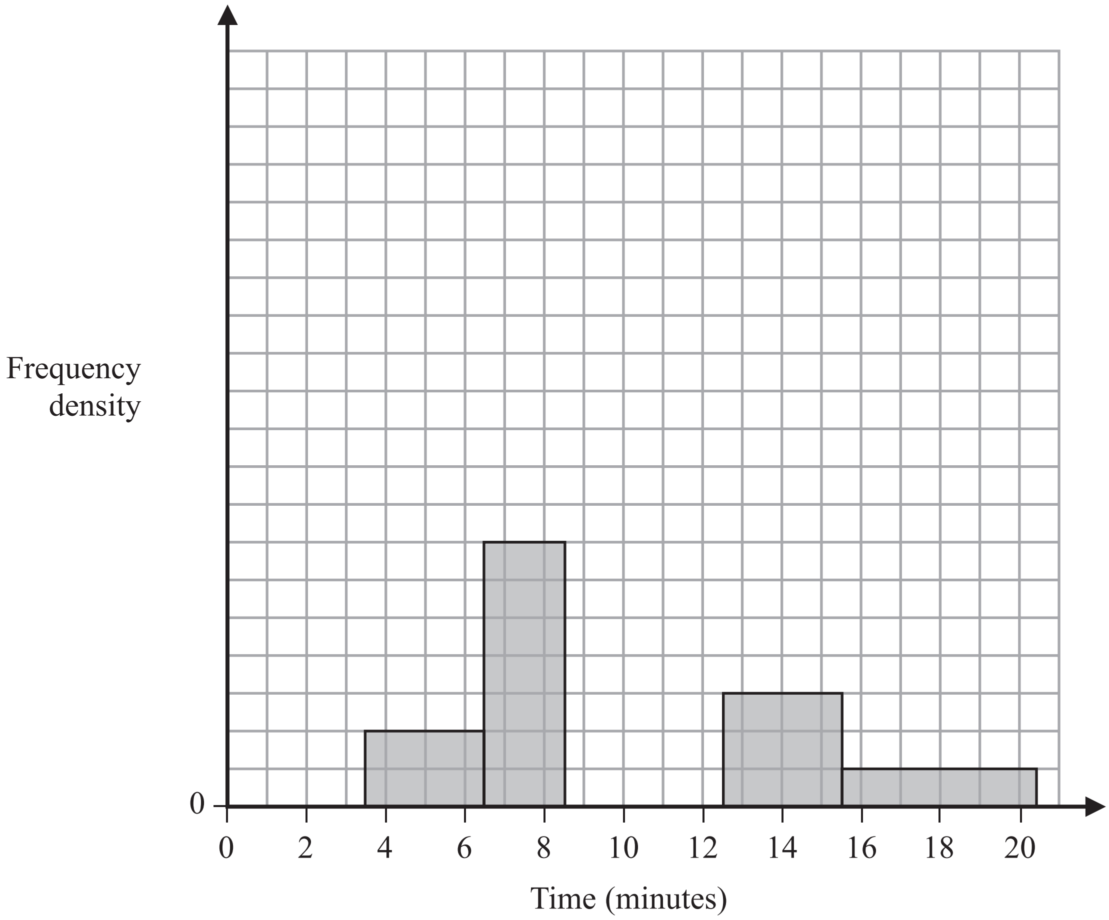
2. The partially completed histogram and the partially completed table show the time, to the nearest minute, that a random sample of motorists was delayed by roadworks on a stretch of motorway.



Delay (minutes)	Number of motorists
4 – 6	6
7 – 8	
9	17
10 – 12	45
13 – 15	9
16 – 20	

Estimate the percentage of these motorists who were delayed by the roadworks for between 8.5 and 13.5 minutes.

(5)

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Question 2 continued

(Total for Question 2 is 5 marks)

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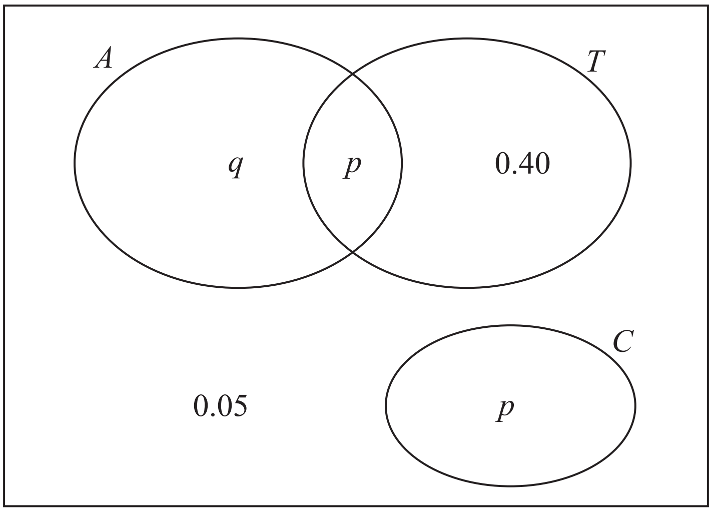
3. The Venn diagram shows the probabilities for students at a college taking part in various sports.

A represents the event that a student takes part in Athletics.

T represents the event that a student takes part in Tennis.

C represents the event that a student takes part in Cricket.

p and q are probabilities.



The probability that a student selected at random takes part in Athletics or Tennis is 0.75

(a) Find the value of p.

(1)

(b) State, giving a reason, whether or not the events A and T are statistically independent. Show your working clearly.

(3)

(c) Find the probability that a student selected at random does not take part in Athletics or Cricket.

(1)

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Question 3 continued

(Total for Question 3 is 5 marks)

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4. Sara was studying the relationship between rainfall, r mm, and humidity, h%, in the UK.
She takes a random sample of 11 days from May 1987 for Leuchars from the large data set.

She obtained the following results.

h	93	86	95	97	86	94	97	97	87	97	86
r	1.1	0.3	3.7	20.6	0	0	2.4	1.1	0.1	0.9	0.1

Sara examined the rainfall figures and found

$$Q_1 = 0.1 \qquad Q_2 = 0.9 \qquad Q_3 = 2.4$$

A value that is more than 1.5 times the interquartile range (IQR) above Q_3 is called an outlier.

(a) Show that $r = 20.6$ is an outlier.

(1)

(b) Give a reason why Sara might:

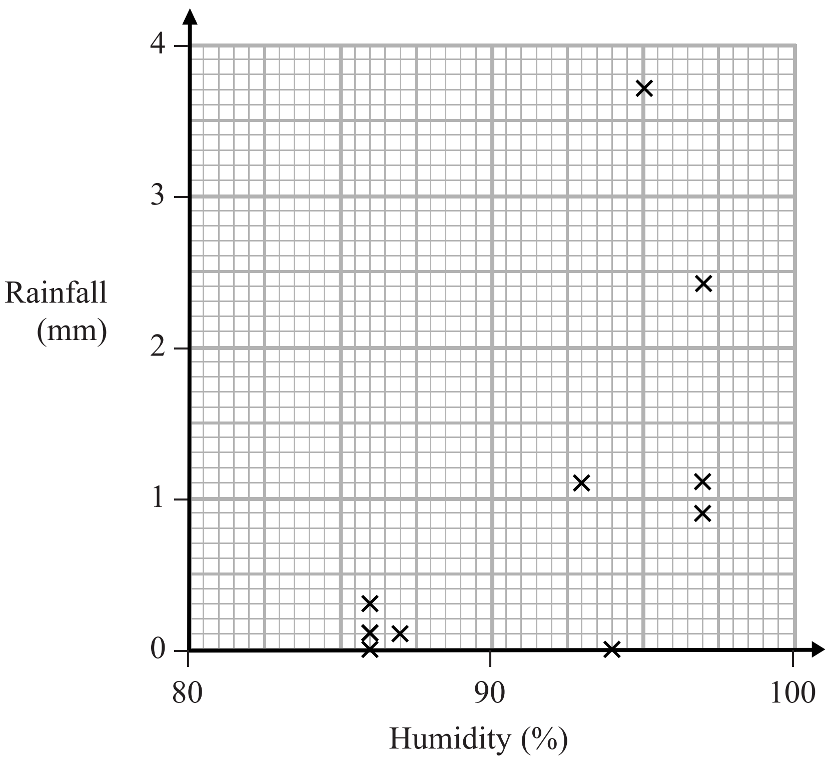
(i) include

(ii) exclude

this day's reading.

(2)

Sara decided to exclude this day's reading and drew the following scatter diagram for the remaining 10 days' values of r and h.



(c) Give an interpretation of the correlation between rainfall and humidity.

(1)

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Question 4 continued

The equation of the regression line of r on h for these 10 days is $r = -12.8 + 0.15h$

(d) Give an interpretation of the gradient of this regression line.

(1)

(e) (i) Comment on the suitability of Sara's sampling method for this study.

(ii) Suggest how Sara could make better use of the large data set for her study.

(2)

(Total for Question 4 is 7 marks)

5. (a) The discrete random variable $X \sim B(40, 0.27)$

Find $P(X \geqslant 16)$

(2)

Past records suggest that 30% of customers who buy baked beans from a large supermarket buy them in single tins. A new manager suspects that there has been a change in the proportion of customers who buy baked beans in single tins. A random sample of 20 customers who had bought baked beans was taken.

(b) Write down the hypotheses that should be used to test the manager's suspicion.

(1)

(c) Using a 10% level of significance, find the critical region for a two-tailed test to answer the manager's suspicion. You should state the probability of rejection in each tail, which should be less than 0.05

(3)

(d) Find the actual significance level of a test based on your critical region from part (c).

(1)

One afternoon the manager observes that 12 of the 20 customers who bought baked beans, bought their beans in single tins.

(e) Comment on the manager's suspicion in the light of this observation.

(1)

Later it was discovered that the local scout group visited the supermarket that afternoon to buy food for their camping trip.

(f) Comment on the validity of the model used to obtain the answer to part (e), giving a reason for your answer.

(1)

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Question 5 continued

(Total for Question 5 is 9 marks)

TOTAL FOR SECTION A IS 30 MARKS

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SECTION B: MECHANICS

Answer ALL questions. Write your answers in the spaces provided.

Unless otherwise indicated, whenever a numerical value of g is required, take $g = 9.8$ m s^{-2} and give your answer to either 2 significant figures or 3 significant figures.

6.

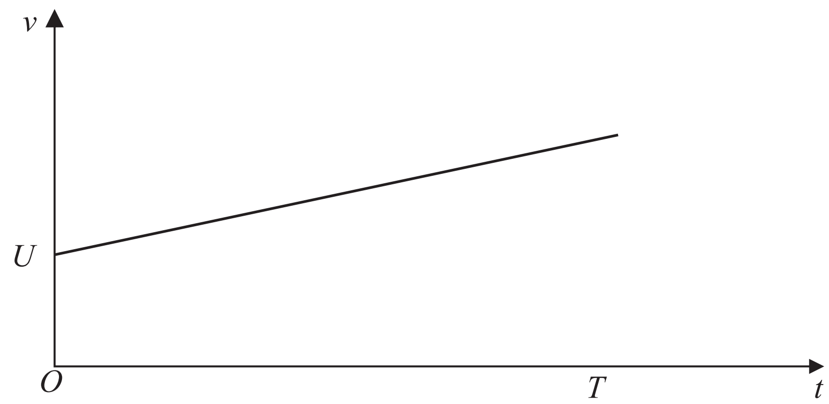

Figure 1

A car moves along a straight horizontal road. At time $t = 0$, the velocity of the car is U m s^{-1}. The car then accelerates with constant acceleration a m s^{-2} for T seconds. The car travels a distance D metres during these T seconds.

Figure 1 shows the velocity-time graph for the motion of the car for $0 \leqslant t \leqslant T$.

Using the graph, show that $D = UT + \frac{1}{2} aT^2$.

(No credit will be given for answers which use any of the kinematics (*suvat*) formulae listed under Mechanics in the AS Mathematics section of the formulae booklet.)

(4)

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Question 6 continued

(Total for Question 6 is 4 marks)

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7. A car is moving along a straight horizontal road with constant acceleration. There are three points A, B and C, in that order, on the road, where $AB = 22$ m and $BC = 104$ m. The car takes 2 s to travel from A to B and 4 s to travel from B to C.

Find

(i) the acceleration of the car,

(ii) the speed of the car at the instant it passes A.

(7)

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Question 7 continued

(Total for Question 7 is 7 marks)

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8. A bird leaves its nest at time $t = 0$ for a short flight along a straight line.

The bird then returns to its nest.

The bird is modelled as a particle moving in a straight horizontal line.

The distance, s metres, of the bird from its nest at time t seconds is given by

$$s = \frac{1}{10}(t^4 - 20t^3 + 100t^2), \quad \text{where } 0 \leqslant t \leqslant 10$$

(a) Explain the restriction, $0 \leqslant t \leqslant 10$

(3)

(b) Find the distance of the bird from the nest when the bird first comes to instantaneous rest.

(6)

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Question 8 continued

(Total for Question 8 is 9 marks)

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9.

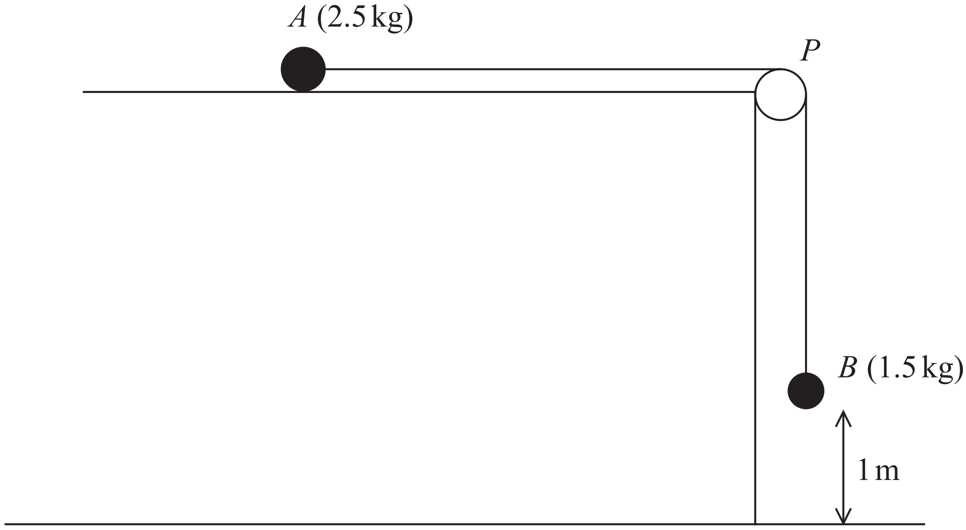

Figure 2

A small ball *A* of mass 2.5 kg is held at rest on a rough horizontal table.

The ball is attached to one end of a string.

The string passes over a pulley *P* which is fixed at the edge of the table. The other end of the string is attached to a small ball *B* of mass 1.5 kg hanging freely, vertically below *P* and with *B* at a height of 1 m above the horizontal floor.

The system is release from rest, with the string taut, as shown in Figure 2.

The resistance to the motion of *A* from the rough table is modelled as having constant magnitude 12.7 N. Ball *B* reaches the floor before ball *A* reaches the pulley.

The balls are modelled as particles, the string is modelled as being light and inextensible, the pulley is modelled as being small and smooth and the acceleration due to gravity, *g*, is modelled as being $9.8\,\text{m s}^{-2}$.

(a) (i) Write down an equation of motion for *A*.

(ii) Write down an equation of motion for *B*.

(4)

(b) Hence find the acceleration of *B*.

(2)

(c) Using the model, find the time it takes, from release, for *B* to reach the floor.

(2)

(d) Suggest two improvements that could be made in the model.

(2)

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Question 9 continued

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Question 9 continued

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Question 9 continued

(Total for Question 9 is 10 marks)

TOTAL FOR SECTION B IS 30 MARKS
TOTAL FOR PAPER IS 60 MARKS

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Paper 2: Statistics and Mechanics Mark Scheme

Question	Scheme	Marks	AOs
1(a)	Systematic (sample) cao	B1	1.2
(b)	In LDS some days have gaps because the data was not recorded	B1	2.4
(c)	$\left[\bar{t} = \frac{374}{20} = 18.7\right]$ $\sigma_t = \sqrt{\frac{7600}{20} - \bar{t}^2}$ $[= \sqrt{30.31}\ ]$	M1	1.1a
	= 5.5054… awrt **<u>5.51</u>** (Accept use of $s_t = \sqrt{\frac{7600 - 20\bar{t}^2}{19}}$ = 5.6484…)	A1	1.1b
			(4 marks)

Notes:

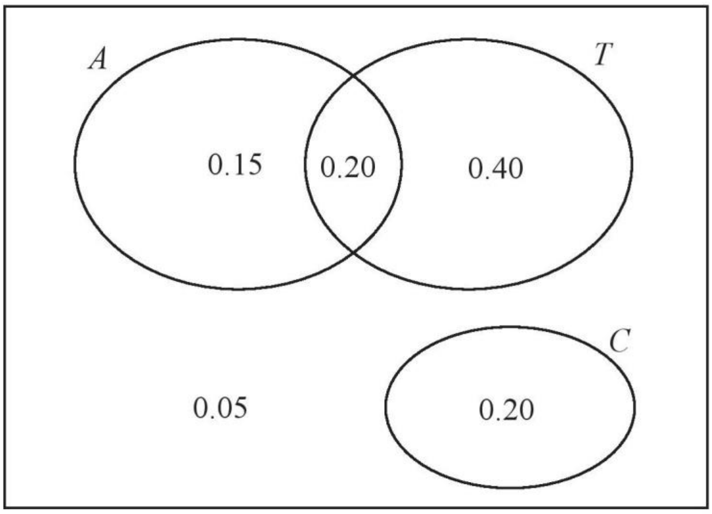
(b)
B1: A correct explanation

(c)
M1: For a correct expression for $\bar{t}$ and σ_t or s_t
ft an incorrect evaluation of $\bar{t}$
A1: For σ_t = awrt 5.51 or s_t = awrt 5.65

Question	Scheme	Marks	AOs
2	$17 + 45 + \frac{1}{3}\times 9$ $[= 65]$	M1	2.2a
	(7 – 8) **<u>14</u>** <u>or</u> (16 – 20) **<u>5</u>** [Values may be seen in the table]	M1 A1	3.1a 1.1b
	Percentage of motorists is $\frac{\text{"65"}}{6+\text{"14"}+17+45+9+\text{"5"}}\times 100$	M1	3.1b
	= **<u>67.7%</u>**	A1	1.1b
			(5 marks)

Notes:

M1: For a fully correct expression for the number of motorists in the interval
M1: For clear use of frequency density in (4- 6) or (13- 15) cases to establish the fd scale. Then use of area to find frequency in one of the missing cases
A1: For both correct values seen
M1: For realising that total is required and attempting a correct expression for %
A1: For awrt 67.7%

Question	Scheme	Marks	AOs
3(a)	p = [1 – 0.75 – 0.05 =] **0.20**	B1	1.1b
		(1)	
(b)	q = **0.15**	B1ft	1.1b
	P(A) = 0.35 P(T) = 0.6 P(A and T) = 0.20 $P(A) \times P(T) = 0.21$	M1	2.1
	Since $0.20 \neq 0.21$ therefore A and T are **not** independent	A1	2.4
		(3)	
			
(c)	P(not [A or C]) = **0.45**	B1	1.1b
		(1)	
			(5 marks)

Notes:

(a)

B1: cao for $p = 0.20$

(b)

B1: Ft for use of their p and P(A or T) to find q i.e. 0.75 – "p" – 0.40 **or** $q = 0.15$

M1: For the statement of all probabilities required for a suitable test and sight of any appropriate calculations required

(c)

A1: All probabilities correct, correct comparison and suitable comment

B1: cao for 0.45

Question	Scheme	Marks	AOs
4(a)	IQR = 2.3 and 20.6 $\gg$ 2.4 + 1.5×2.3 (= 5.85) (Compare correct values)	B1	1.1b
		(1)	
(b)(i)	e.g. It is a piece of data and we should consider all the data o.e.	B1	2.4
(ii)	e.g. It is an extreme value and could unduly influence the analysis **or** It could be a mistake	B1	2.4
		(2)	
(c)	e.g. "as humidity increases rainfall increases"	B1	2.2b
		(1)	
(d)	e.g. a 10% increase in humidity gives rise to a 1.5 mm increase in rainfall **or** represents 0.15mm of rainfall per percentage of humidity	B1	3.4
		(1)	
(e)(i)	Not a good method since only uses 11 days from one location in one month	B1	2.4
(ii)	e.g. She should use data from more of the UK locations and more of the months **or** using a spreadsheet or computer package she could use all of the available UK data	B1	2.4
		(2)	
			(7 marks)

Continued question 4
Notes:
(a) **B1:** For sight of the correct calculation and suitable comparison with 20.6
(b)(i) **B1**: For a suitable reason for including the data point
(b)(ii) **B1:** For a suitable reason for excluding the data point
(c) **B1:** For a suitable interpretation of positive correlation mentioning humidity and rainfall
(d) **B1:** For a suitable description of the rate: rainfall per percentage of humidity including reference to values
(e)(i) **B1:** For a comment that supports the idea that her sampling method was not a good one
(e)(ii) **BI:** For some sensible suggestions that would give a better representation of the data across the UK. Must show some awareness of the fact that LDS has different locations and more months of data available but must be clear they are NOT using any overseas locations
N.B. B0 for a comment that says use more than one location without specifying that only UK locations are required

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Question	Scheme	Marks	AOs
5(a)	$P(X \geqslant 16) = 1 - P(X \leqslant 15)$	M1	1.1b
	$= 1 - 0.949077\ldots$ = awrt **<u>0.0509</u>**	A1	1.1b
		(2)	
(b)	$H_0 : p = 0.3$ $H_1 : p \neq 0.3$ (Both correct in terms of p or π)	B1	2.5
		(1)	
(c)	[$Y \sim B(20, 0.3)$] sight of $P(Y \leqslant 2) = 0.0355$ or $P(Y \leqslant 9) = 0.9520$	M1	2.1
	Critical region is $\{Y \leqslant \mathbf{2}\}$ or (o.e.)	A1	1.1b
	$\{Y \geqslant \mathbf{10}\}$ (o.e.)	A1	1.1b
		(3)	
(d)	[0.0355 + (1 – 0.9520)] = 0.0835 **or** **<u>8.35%</u>**	B1ft	1.1b
		(1)	
(e)	(Assuming that the 20 customers represent a random sample then) 12 is in the CR so the manager's suspicion is supported	B1ft	3.2a
		(1)	
(f)	e.g. (e) requires the 20 customers to be a random sample or independent and the members of the scout group may invalidate this so binomial distribution would not be valid (and conclusion in (e) is probably not valid)	B1	3.5a
		(1)	
			(9 marks)

Continued question 5
Notes:
(a) **M1:** For dealing with P($X \geqslant 16$) – they need to use cumulative prob. function on calc **A1:** awrt 0.0509 (from calculator)
(b) **B1**: For both hypotheses in terms of p or π and H_1 must be 2-tail
(c) **M1:** For correct use of tables to find probability associated with critical value **A1:** For the correct lower limit of the CR. Do not award for P($Y \leqslant 2$) **A1:** For the correct upper limit
(d) **B1:** ft on their 0.0355 and (1 – their 0.9520) provided each probability is less than 0.05
(e) **B1:** ft for a comment that relates 12 to their CR and makes a consistent comment relating this to the manager's suspicion
(f) **BI:** For a comment that: gives a suitable reason based on lack of independence **or** the sample not being random **so** the binomial model is not valid

Question	Scheme	Marks	AOs
6.	Using distance = total area under graph (e.g. area of rectangle + triangle **or** trapezium **or** rectangle – triangle)	M1	2.1
	e.g. $D = UT + ½\ Th$, where h is height of triangle	A1	1.1b
	Using gradient = acceleration to substitute $h = aT$	M1	1.1b
	$D = U\,T + ½\ aT^2$ *	A1 *	1.1b
		(4)	
			(4 marks)

Notes:
M1: For use of distance = total area to give an equation in D, U, T and one other variable **A1:** For a correct equation **M1:** For using gradient = a to eliminate the other variable to give an equation in D, U, T and a *only* **A1*:** For a correct given answer

Question	Scheme	Marks	AOs
7(i)(ii)	Using a correct strategy for solving the problem by setting up two equations in a and u only and solving for either	M1	3.1b
	Equation in a and u only	M1	3.1b
	$22 = 2u + \frac{1}{2}a\,2^2$	A1	1.1b
	Another equation in a and u only	M1	3.1b
	$126 = 6u + \frac{1}{2}a\,6^2$	A1	1.1b
	5 m s^{-2}	A1	1.1b
	6 m s^{-1}	A1ft	1.1b
			(7 marks)

Notes:

M1: For solving the problem by setting up two equations in a and u only and solving for either

M1: Use of (one or more) *suvat* formulae to produce an equation in u and a only

A1: For a correct equation

M1: Use of (one or more) *suvat* formulae to produce another equation in u and a only

A1: For a correct equation

A1: For correct accln 5 m s^{-2}

A1: For correct speed 6 m s^{-1} (The second of these A marks is an **ft** mark, following an incorrect value for u or a, depending on which has been found first)

N.B. Do not award the ft mark for absurd answers e.g. $a > 15$, $u > 50$

See alternative on the next page

ALTERNATIVE

Question	Scheme	Marks	AOs
7(i)(ii)	Using a correct strategy for solving the problem by obtaining actual speeds at two times and using a = change in speed / time taken	M1	3.1b
	Actual speed at $t = 1$ = Average speed over interval	M1	3.1b
	22/2 = 11	A1	1.1b
	Actual speed at $t = 4$ = Average speed over interval	M1	3.1b
	104/4 = 26	A1	1.1b
	5 m s^{-2}	A1	1.1b
	6 m s^{-1}	A1ft	1.1b
			(7 marks)

Notes:

M1: For solving the problem by obtaining two actual speeds and use of $a = (v - u)/ t$
M1: Use of speed at half-time = av speed over interval to produce a speed at $t = 1$
A1: For a correct speed
M1: Use of speed at half-time = av speed over interval to produce a speed at $t = 4$
A1: For a correct speed
A1: For correct accln 5 m s^{-2}
A1: ft for correct speed 6 m s^{-1} (This is an ft mark, following an incorrect value of a)

N.B. Do not award the ft mark for absurd answers e.g. $a > 15$, $u > 50$

Question	Scheme	Marks	AOs
8(a)	Substitution of both $t = 0$ and $t = 10$	M1	2.1
	$s = 0$ for both $t = 0$ and $t = 10$	A1	1.1b
	Explanation ($s > 0$ for $0 < t < 10$) since $s = \frac{1}{10}t^2(t-10)^2$	A1	2.4
		(3)	
(b)	Differentiate displacement s w.r.t. t to give velocity, v	M1	1.1a
	$v = \frac{1}{10}(4t^3 - 60t^2 + 200t)$	A1	1.1b
	Interpretation of 'rest' to give $v = \frac{1}{10}(4t^3 - 60t^2 + 200t) = \frac{2}{5}t(t-5)(t-10) = 0$	M1	1.1b
	$t = 0, 5, 10$	A1	1.1b
	Select $t = 5$ and substitute their $t = 5$ into s	M1	1.1a
	Distance = 62.5 m	A1ft	1.1b
		(6)	
			(9 marks)

Notes:

(a)

M1: For substituting $t = 0$ and $t = 10$ into s expression

A1: For noting that $s = 0$ at both times

A1: Since s is a perfect square, $s > 0$ for all other t- values

(b)

M1: For differentiating s w.r.t. t to give v (powers of t reducing by 1)

A1: For a correct v expression in any form

M1: For equating v to 0 and factorising

A1: For correct t values

M1: For substituting their intermediate t value into s

A1: ft following an incorrect t-value

Question	Scheme	Marks	AOs
9(a)(i)	Equation of motion for *A*	M1	3.3
	$T - 12.7 = 2.5a$	A1	1.1b
(ii)	Equation of motion for *B*	M1	3.3
	$1.5g - T = 1.5a$	A1	1.1b
		(4)	
(b)	Solving two equations for *a*	M1	1.1b
	$a = 0.5$	A1	1.1b
		(2)	
(c)	$1 = \frac{1}{2} \leftarrow 0.5\, t^2$	M1	3.4
	$t = 2$ seconds	A1ft	1.1b
		(2)	
(d)	Valid improvement, see below in notes	B1	3.5c
	Valid improvement, see below in notes	B1	3.5c
		(2)	
			(10 marks)

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Continued question 9
Notes:
(a)(i) **M1:** For resolving horizontally for *A* **A1:** For a correct equation
(a)(ii) **M1:** For resolving vertically for *B* **A1:** For a correct equation
(b) **M1:** For complete correct strategy for solving the problem, setting up **two** equations in *a*, and then solving them for *a* **A1:** For $a = 0.5$
(c) **M1:** For a complete method (which could involve use of more than one *suvat* formula) to give an equation in *t* only **A1:** Ft from their *a* to get time in seconds
(d) **B1, B1** for any two of e.g. Include the dimensions of the ball in the model so that the distance it falls changes e.g. Include the dimensions of the pulley in the model so string not parallel to table e.g. Include a variable resistance in the model instead of taking it to be constant e.g. Include a more accurate value for *g* in the model

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