AS
Mathematics
Paper 1
Mark scheme

Specimen

Version 1.2

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this mark scheme are available from aqa.org.uk

Mark scheme instructions to examiners

General

The mark scheme for each question shows:

- the marks available for each part of the question
- the total marks available for the question
- marking instructions that indicate when marks should be awarded or withheld including the principle on which each mark is awarded. Information is included to help the examiner make his or her judgement and to delineate what is creditworthy from that not worthy of credit
- a typical solution. This response is one we expect to see frequently. However credit must be given on the basis of the marking instructions.

If a student uses a method which is not explicitly covered by the marking instructions the same principles of marking should be applied. Credit should be given to any valid methods. Examiners should seek advice from their senior examiner if in any doubt.

Key to mark types

M	mark is for method
dM	mark is dependent on one or more M marks and is for method
R	mark is for reasoning
A	mark is dependent on M or m marks and is for accuracy
B	mark is independent of M or m marks and is for method and accuracy
E	mark is for explanation
F	follow through from previous incorrect result

Key to mark scheme abbreviations

CAO	correct answer only
CSO	correct solution only
ft	follow through from previous incorrect result
'their'	Indicates that credit can be given from previous incorrect result
AWFW	anything which falls within
AWRT	anything which rounds to
ACF	any correct form
AG	answer given
SC	special case
OE	or equivalent
NMS	no method shown
PI	possibly implied
SCA	substantially correct approach
sf	significant figure(s)
dp	decimal place(s)

Examiners should consistently apply the following general marking principles

No Method Shown

Where the question specifically requires a particular method to be used, we must usually see evidence of use of this method for any marks to be awarded.

Where the answer can be reasonably obtained without showing working and it is very unlikely that the correct answer can be obtained by using an incorrect method, we must award **full marks**. However, the obvious penalty to students showing no working is that incorrect answers, however close, earn **no marks**.

Where a question asks the student to state or write down a result, no method need be shown for full marks.

Where the permitted calculator has functions which reasonably allow the solution of the question directly, the correct answer without working earns **full marks**, unless it is given to less than the degree of accuracy accepted in the mark scheme, when it gains **no marks**.

Otherwise we require evidence of a correct method for any marks to be awarded.

Diagrams

Diagrams that have working on them should be treated like normal responses. If a diagram has been written on but the correct response is within the answer space, the work within the answer space should be marked. Working on diagrams that contradicts work within the answer space is not to be considered as choice but as working, and is not, therefore, penalised.

Work erased or crossed out

Erased or crossed out work that is still legible and has not been replaced should be marked. Erased or crossed out work that has been replaced can be ignored.

Choice

When a choice of answers and/or methods is given and the student has not clearly indicated which answer they want to be marked, only the last complete attempt should be awarded marks.

Q	Marking Instructions	AO	Marks	Typical Solution
1	Circles correct answer	AO1.1b	B1	$\begin{bmatrix} -4 \\ 0 \end{bmatrix}$
	Total		**1**	
2	Circles correct answer	AO2.5	B1	$A \Leftarrow B$
	Total		**1**	
3(a)(i)	States correct value of p	AO1.2	B1	$p = \frac{1}{2}$
(a)(ii)	States correct value of q	AO1.2	B1	$q = -2$
(b)	Uses valid method to find x, PI	AO1.1a	M1	$\frac{1}{2} + x = -2$
	Obtains correct x, ACF	AO1.1b	A1	$x = -2.5$
	Total		**4**	
4	Multiplies numerator and denominator by the conjugate surd of the denominator	AO1.1a	M1	$\frac{(5\sqrt{2}+2)(3\sqrt{2}-4)}{(3\sqrt{2}+4)(3\sqrt{2}-4)}$
	Obtains **either** numerator **or** denominator correctly, in expanded or simplified form	AO1.1b	A1	$= \frac{30-20\sqrt{2}+6\sqrt{2}-8}{2}$ $= \frac{22-14\sqrt{2}}{2}$
	Constructs rigorous mathematical argument to show the required result Only award if they have a completely correct solution, which is clear, easy to follow and contains no slips NMS = 0	AO2.1	R1	$= 11 - 7\sqrt{2}$
	Total		**3**	

Q	Marking Instructions	AO	Marks	Typical Solution
5	Demonstrates a clear understanding that $\sin x = 0$ is a solution, and that this has not been properly taken into account.	AO2.3	R1	$\sin x = 0$ leads to a solution, but when she cancelled $\sin x$ she effectively assumed it was not equal to 0 and hence lost a number of solutions.
	Explains that cancelling $\sin x$ is not allowed if it is zero / only allowed if it is non-zero	AO2.4	E1	
	Total		**2**	

Q	Marking Instructions	AO	Marks	Typical Solution
6	Translates given information into an equation by using the formula for the area of triangle or parallelogram to form a correct equation	AO3.1a	M1	AB × AD × $\sin\alpha = 24$ hence 6 × 4.5 × $\sin\alpha = 24$
	Rearranges 'their' equation to obtain a correct value of $\sin\alpha$	AO1.1b	A1F	$\sin\alpha = \frac{24}{27} = \frac{8}{9}$
	Uses 'their' $\sin\alpha$ value to identify an appropriate right-angled triangle **or** uses identities **and** deduces exact ratio of $\tan\alpha$ – positive or negative Condone only positive ratio seen	AO2.2a	M1	Sides of right angled triangle are 8, 9 and $\sqrt{17}$ Hence $\tan\alpha = \pm\frac{8}{\sqrt{17}}$
	Relates back to mathematical context of problem and hence chooses negative ratio – accept any equivalent exact form FT 'their' tan values for obtuse α	AO3.2a	A1F	α is one of the largest angles and must be obtuse hence tangent is negative $\tan\alpha = -\frac{8}{\sqrt{17}} = -\frac{8\sqrt{17}}{17}$
	Total		**4**	

Q	Marking Instructions	AO	Marks	Typical Solution
7	Explains that equal gradients implies that lines are parallel	AO2.4	E1	Parallel lines have equal gradient
	Finds the gradient of the given line CAO	AO1.1b	B1	$2x + 3y + 4 = 0 \Rightarrow y = -\frac{2}{3}x - \frac{4}{3}$ So gradient is $-\frac{2}{3}$
	Finds the gradient of the line through the 2 given points CAO	AO1.1b	B1	Gradient of line through (9, 4) and (3, 8) is $\frac{8-4}{3-9} = -\frac{2}{3}$
	Deduces that the two lines are parallel	AO2.2a	R1	So line with equation $2x + 3y + 4 = 0$ is parallel to the line joining the points with coordinates (9, 4) and (3, 8) as both have gradient $-\frac{2}{3}$
	Total		**4**	

Q	Marking Instructions	AO	Marks	Typical Solution
8(a)	Uses binomial theorem to expand bracket – correct unsimplified expression but condone sign error	AO1.1a	M1	$1+\binom{10}{1}(-2x)^1+\binom{10}{2}(-2x)^2$
	Obtains constant term and x term, both correct	AO1.1b	A1	$=1-20x+180x^2...$
	Obtains correct x^2 term	AO1.1b	A1	
(b)	Selects x = 0.001	AO3.1a	B1	Substituting $x=0.001$
	Substitutes 'their' chosen value of x into 'their' expansion from part **(a)** to obtain a 5 decimal place value	AO1.1a	M1	$1-0.020+0.000180=0.98018$
	Gives a correct explanation to confirm that the value found from the calculator is 0.98018 to 5 decimal places which is the same as the value found by using the expansion	AO2.4	A1	$0.998^{10}=0.980179\ldots=0.98018$ to 5 dp, which matches Carly's value.
	Total		**6**	

Q	Marking Instructions	AO	Marks	Typical Solution
9(a)	Substitutes $3+h$ to obtain a correct unsimplified expression for $f(3+h)$	AO1.1a	M1	$(3+h)^2-4(3+h)+2$ or $=9+6h+h^2-12-4h+2$
	Expresses simplified answer correctly in given format	AO1.1b	A1	$=h^2+2h-1$
(b)	Identifies and uses $\frac{f(x+h)-f(x)}{h}$ to obtain an expression for the gradient of chord Mark can be awarded for unsimplified expression.	AO1.1a	M1	Gradient of chord $=\frac{f(3+h)-f(3)}{h}$ $=\frac{h^2+2h-1+1}{h}$ $=h+2$
	Obtains a correct and full simplification	AO1.1b	A1	As $h\to 0,\ h+2\to 2$ Gradient of tangent = 2
	Deduces that, as h approaches 0 the limit of $\frac{f(3+h)-f(3)}{h}$ is 2 (Must not simply say $h=0$ but accept words rather than limit notation) FT 'their' gradient provided M1 has been awarded	AO2.2a	R1	
	Total		**5**	

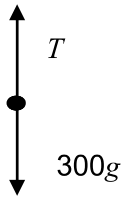
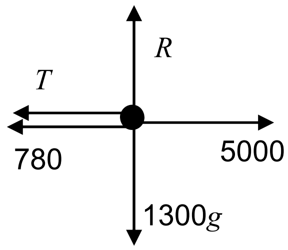
Q	Marking Instructions	AO	Marks	Typical Solution
10(a)	Obtains (at least four) correct $\log_{10} y$ values, in table or plotted	AO1.1a	M1	(1, 1.1) (2, 1.7) (3, 2.1) (4, 3.0) (5, 3.1) (6, 3.5)
	Plots **all** points correctly	AO1.1b	A1	(Points above plotted on grid)
(b)	Identifies $y = 1100$ and gives correct reason	AO2.2b	B1	(4, 1100), as it is not on the line that the other points are close to
(c)	Uses laws of logs. (May earn in part **(a)** if laws of logs were used there)	AO1.1a	M1	$\log_{10} y = \log_{10} k + x \log_{10} b$ Vertical intercept c = 0.68 (=$\log_{10} k$) Therefore from intercept: $k = 10^{0.68}$ Gradient m = 0.48 = $\log_{10} b$ Therefore from gradient: $b = 10^{0.48}$
	Draws straight line **and** calculates/measures the vertical intercept c and attempts 10^c **or** calculates/measures gradient m and attempts 10^m Alternatively uses regression line from calculator to get intercept and gradient	AO1.1a	M1	
	Finds correct value of b from 'their' gradient, provided 0.45< 'their' gradient < 0.51	AO1.1b	A1F	k = 4.8
	Finds correct value of k from 'their' intercept, provided 0.6 ≤ 'their' intercept ≤ 0.8	AO1.1b	A1F	b = 3.0
	Total		**7**	

Q	Marking Instructions	AO	Marks	Typical Solution
11	Obtains $\frac{dy}{dx}$ for both the given curves – at least one term must be correct for each curve	AO3.1a	M1	$\frac{dy}{dx} = 6x^2 + 12x - 12$ $\frac{dy}{dx} = 60 - 12x$
	States both derivatives correctly	AO1.1b	A1	
	Translates problem into an inequality	AO3.1a	M1	Chris's claim is **incorrect** when $6x^2 + 12x - 12 \le 60 - 12x$ $2x^2 + 8x - 24 \le 0$ $x^2 + 4x - 12 \le 0$ $(x + 6)(x - 2) \le 0$
	States a correct quadratic inequality FT from an incorrect $\frac{dy}{dx}$ provided both M1 marks have been awarded	AO1.1b	A1	Critical values are $x = -6$ and 2 region: $x < -6$ / $-6 < x < 2$ / $x > 2$ sign: $+$ / $-$ / $+$
	Determines a solution to 'their' inequality	AO1.1a	M1	$-6 \le x \le 2$ Chris's claim is incorrect for values of x in the range $-6 \le x \le 2$, so he is wrong
	Obtains correct range of values for x Must be correctly written with both inequality signs correct	AO1.1b	A1	
	Interprets final solution in context of the original question, must refer to Chris's claim	AO3.2a	R1	
	Total		**7**	

Q	Marking Instructions	AO	Marks	Typical Solution
12(a)	Rewrites given expression with a fractional power and negative power – at least one index form must be correct	AO1.1a	M1	$y = 6x^{\frac{3}{2}} + 32x^{-1}$
	Both terms correct	AO1.1b	A1	
	Differentiates 'their' rewritten expression – at least one term correct	AO1.1a	M1	$\frac{dy}{dx} = 6 \times \frac{3}{2} \times x^{\frac{1}{2}} - 32x^{-2}$ $= 9\sqrt{x} - \frac{32}{x^2}$
	Both terms correct for 'their' expression	AO1.1b	A1F	
(b)	Finds the equation of the tangent, a clear attempt must be seen	AO3.1a	M1	When $x = 4$,
	Evaluates 'their' $\frac{dy}{dx}$ (from part **(a)**) correctly (when $x = 4$)	AO1.1b	A1F	$\frac{dy}{dx} = 9 \times 2 - \frac{32}{16} = 16$ and
	Obtains correct y value (when $x = 4$)	AO1.1b	A1	$y = 6 \times 4 \times 2 + \frac{32}{4} = 56$
	Obtains correct form of the equation of a straight line using 'their' values for y and $\frac{dy}{dx}$	AO1.1b	A1F	Tangent: $y - 56 = 16(x - 4)$
	Deduces value required at x-axis is when y equals 0 (follow through from 'their' equation) Both coordinates needed, any form	AO2.2a	A1F	When $y = 0$, $x = 4 - \frac{56}{16} = 0.5$ (0.5, 0)
	Total		**9**	

Q	Marking Instructions	AO	Marks	Typical Solution
13(a)	Circles correct answer	AO1.1b	B1	29
(b)	Circles correct answer	AO2.2a	B1	$90° < \theta < 135°$
	Total		**2**	
14	Applies Newton's 2nd Law to form a 3 term equation Award mark even if signs not correct	AO1.1a	M1	$F - 80 \times 10 = -80 \times 1.5$
	Obtains a correct 3 term equation.	AO1.1b	A1	$F - 800 = -120$
	Obtains correct reaction force. Must be given to 1 sf FT from incorrect 3 term equation provided M1 mark was awarded (condone omission of units)	AO1.1b	A1F	$F = 680 = 700$ (N) to 1 sf
	Total		**3**	
15(a)	Finds correct acceleration	AO1.1b	B1	0.5 m s^{-2}
(b)	Identifies $5T$ as the distance travelled after the first 15 seconds	AO3.4	B1	Distance at constant speed $= 5T$ Distance in first 15 secs = $\frac{1}{2} \times (3 + 8) \times 10 + \frac{1}{2} \times (8 + 5) \times 5$ $= 55 + 32.5 = 87.5$ $5T + 87.5 = 120$ So $T = 6.5$
	Uses the information given to form an equation to find T (award mark for either trapezium expression separate, totalled or implied)	AO3.1b	M1	
	Correctly calculates the distance for the first 15 secs	AO1.1b	A1	
	Deduces the values of T from the mathematical models applied	AO2.2a	A1	
	Total		**5**	

Q	Marking Instructions	AO	Marks	Typical Solution
16(a)	Differentiates, with at least one term correct	AO1.1a	M1	$\frac{dv}{dt} = 12t - 36t^2$
	Selects and applies $F = ma$ to 'their' derivative Condone use of 400 for mass	AO1.1a	M1	$F = ma = 0.4\ (12t - 36t^2)$
	Obtains correct expression for force FT from 'their' $F = ma$ equation, provided the first M1 has been awarded (may be in factorised form)	AO1.1b	A1F	$= 4.8t - 14.4t^2$
(b)	Integrates v to find r, with at least one term correct	AO3.1b	M1	$r = \int\left(6t^2 - 12t^3\right)dt$
	Obtains correct integral (condone absence of c)	AO1.1b	A1	$r = 2t^3 - 3t^4 + c$
	Deduces the value of c using initial conditions FT use of 'their' integral provided M1 awarded	AO2.2a	A1F	When $t = 0$, $r = 0$ so $0 = 2\times 0^2 - 3\times 0^4 + c$ so $c = 0$
	Forms and solves an equation for t (condone numerical slip)	AO1.1a	M1	$0 = 2t^3 - 3t^4$ $= t^3(2 - 3t)$ $t = 0$ or $t = \frac{2}{3}$
	Interprets solution, realising that the non-zero time is required (Must include units) FT use of 'their' equation for t provided both M1 marks have been awarded	AO3.2a	A1F	Next at O at $\frac{2}{3}$ seconds
	Total		**8**	

Q	Marking Instructions	AO	Marks	Typical Solution
17(a)(i)	Draws correct force diagram for crate from information given to use as a model in this context Must introduce a variable to represent the tension in the string	AO3.3	B1	
(a)(ii)	Draws correct force diagram for van from information given to use as a model in this context Must introduce a variable to represent the tension in the string	AO3.3	B1	
(b)	Applies Newton's 2nd Law ($F = ma$) to the crate	AO3.4	M1	For crate $T - 300g = 300a$
	Applies Newton's 2nd Law ($F = ma$) to the van ($F = ma$ 'round the corner' scores 0)	AO3.4	M1	For van $5000 - T - 780 = 1300a$ $(4220 - T = 1300a)$
	Solve their simultaneous equations	AO1.1a	M1	$4220 - 300g = 1600a$
	Finds the value of a correctly **AG**	AO1.1b	A1	$a = 1280 \div 1600 = 0.80$ m s^{-2} **(AG)**
(c)	Uses $a = 0.80$ in either of their two equations in **(b)**	AO3.4	M1	$T = 300 \times 0.80 + 300g$
	Finds the correct value for T (condone omission of units) Possibly done in **(b)**	AO1.1b	A1	$= 3180$ $= 3200$ (N) (2 sf)
(d)	Explains that the model could be refined by including air resistance	AO3.5c	E1	Resistance will increase with speed
	Total		**9**	
	TOTAL		**80**	