AQA

# AS MATHEMATICS 7356/1

Paper 1

**Mark scheme**

June 2023

Version: Final 1.1

236A7356/1/MS

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 Examiner.

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 |
| R | mark is for reasoning |
| A | mark is dependent on M marks and is for accuracy |
| B | mark is independent of 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 |
| sf | significant figure(s) |
| dp | decimal place(s) |
| ISW | Ignore Subsequent Workings |

# AS/A-level Maths/Further Maths assessment objectives

| AO | | Description |
|---|---|---|
| **AO1** | AO1.1a | Select routine procedures |
| | AO1.1b | Correctly carry out routine procedures |
| | AO1.2 | Accurately recall facts, terminology and definitions |
| **AO2** | AO2.1 | Construct rigorous mathematical arguments (including proofs) |
| | AO2.2a | Make deductions |
| | AO2.2b | Make inferences |
| | AO2.3 | Assess the validity of mathematical arguments |
| | AO2.4 | Explain their reasoning |
| | AO2.5 | Use mathematical language and notation correctly |
| **AO3** | AO3.1a | Translate problems in mathematical contexts into mathematical processes |
| | AO3.1b | Translate problems in non-mathematical contexts into mathematical processes |
| | AO3.2a | Interpret solutions to problems in their original context |
| | AO3.2b | Where appropriate, evaluate the accuracy and limitations of solutions to problems |
| | AO3.3 | Translate situations in context into mathematical models |
| | AO3.4 | Use mathematical models |
| | AO3.5a | Evaluate the outcomes of modelling in context |
| | AO3.5b | Recognise the limitations of models |
| | AO3.5c | Where appropriate, explain how to refine models |

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, mark positively, awarding marks for all of the student's best attempts. Withhold marks for final accuracy and conclusions if there are conflicting complete answers or when an incorrect solution (or part thereof) is referred to in the final answer.

| Q | Marking instructions | AO | Marks | Typical solution |
|---|---|---|---|---|
| **1** | Circles correct answer | 1.1b | B1 | –0.1 |
| | **Question 1 Total** | | **1** | |

| Q | Marking instructions | AO | Marks | Typical solution |
|---|---|---|---|---|
| **2** | Circles correct answer | 1.1b | B1 | $\frac{125}{8x^3}$ |
| | **Question 2 Total** | | **1** | |

| Q | Marking instructions | AO | Marks | Typical solution |
|---|---|---|---|---|
| **3** | Obtains 15 as the binomial coefficient of the $(ax)^2$ term.<br>Can be unsimplified. | 1.1b | B1 | 15<br>$\frac{20}{3} = 15a^2$<br>$a = \pm\frac{2}{3}$ |
| | Forms an equation in $a^2$ for the coefficient of $x^2$ using their '15' | 1.1a | M1 | |
| | Obtains their correct ± pair of values for $a$<br>FT their '15'<br>ACF | 1.1b | A1F | |
| | **Question 3 Total** | | **3** | |

| Q | Marking instructions | AO | Marks | Typical solution |
|---|---|---|---|---|
| **4(a)** | Uses a trig identity, either<br>$\tan\theta = \frac{\sin\theta}{\cos\theta}$<br>or<br>$\sin^2\theta + \cos^2\theta = 1$<br>correctly to obtain an equation in a single trig function. | 1.1a | M1 | $5\cos^2\theta = 4\sin^2\theta$<br>$\frac{5}{4} = \frac{\sin^2\theta}{\cos^2\theta} = \tan^2\theta$<br>$\tan\theta = \pm\frac{\sqrt{5}}{2}$ |
| | Obtains $\tan^2\theta = \frac{5}{4}$ or $\sin^2\theta = \frac{5}{9}$<br>or $\cos^2\theta = \frac{4}{9}$<br>PI by one correct value for tan $\theta$ sin $\theta$ or cos $\theta$ | 1.1b | A1 | |
| | Obtains $\tan\theta = \pm\frac{\sqrt{5}}{2}$<br>OE Must be in exact form | 1.1b | A1 | |
| | **Subtotal** | | **3** | |

| Q | Marking instructions | AO | Marks | Typical solution |
|---|---|---|---|---|
| **4(b)** | Obtains at least two correct solutions in the range based on the value of their tan $\theta$, sin $\theta$ *or* cos $\theta$<br>OE | 1.1a | M1 | $\theta = 48.2, 131.8. 228.2, 311.8$ |
| | Obtains all 4 correct solutions and no further ones<br>AWRT 48, 132. 228, 312 | 1.1b | A1 | |
| | **Subtotal** | | **2** | |

| | | | | |
|---|---|---|---|---|
| | **Question 4 Total** | | **5** | |

| Q | Marking instructions | AO | Marks | Typical solution |
|---|---|---|---|---|
| **5(a)** | Expresses $x\sqrt{x}$ in index form.<br>PI by correct answer<br>ACF | 1.1a | M1 | $y = x^{\frac{3}{2}}$ |
| | Obtains the correct derivative.<br>ACF<br>ISW | 1.1b | A1 | $\frac{dy}{dx} = \frac{3}{2}x^{\frac{1}{2}}$ |
| | **Subtotal** | | **2** | |

| Q | Marking instructions | AO | Marks | Typical solution |
|---|---|---|---|---|
| **5(b)** | Rearranges the equation of the line to isolate the term in $y$ or $x$<br>PI by gradient = 3 | 1.1a | M1 | $6x - 2y + 5 = 0$<br>$2y = 6x + 5$<br>Gradient = 3 |
| | Obtains gradient of line = 3 | 1.1b | A1 | |
| | Equates their gradient of line to their expression for $\frac{dy}{dx}$ | 3.1a | M1 | $\frac{3}{2}x^{\frac{1}{2}} = 3$<br>$x = 4$ |
| | Solves their equation correctly using their $\frac{dy}{dx}$ to obtain their $x$ value of the contact point | 1.1a | M1 | From line $2y = 6 \times 4 + 5$<br>$y = 14.5$ |
| | Deduces $k = 6.5$ | .2.2a | A1 | $14.5 = 4 \times 2 + k$<br>$k = 6.5$ |
| | **Subtotal** | | **5** | |

| | | | | |
|---|---|---|---|---|
| | **Question 5 Total** | | **7** | |

| Q | Marking instructions | AO | Marks | Typical solution |
|---|---|---|---|---|
| **6(a)** | Obtains $a = 2$ | 1.1b | B1 | $y = 2(x^2 - 10x + 21)$ |
| | Obtains $b = 5$ | 1.1b | B1 | $y = 2(x^2 - 10x + 25 - 4)$ |
| | Obtains $c = -8$ | 1.1b | B1 | $y = 2((x-5)^2 - 4)$<br>$y = 2(x-5)^2 - 8$ |
| | **Subtotal** | | **3** | |

| Q | Marking instructions | AO | Marks | Typical solution |
|---|---|---|---|---|
| **6(b)** | Obtains correct coordinates of their minimum point.<br>FT their $b$ and $c$<br>Condone missing brackets. | 1.1b | B1F | (5, –8) |
| | **Subtotal** | | **1** | |

| Q | Marking instructions | AO | Marks | Typical solution |
|---|---|---|---|---|
| **6(c)** | Uses a stretch scale factor of $\frac{1}{2}$<br>FT $\pm$ their $\frac{-4}{c}$ ,do not FT $c = \pm 4$<br>PI by correct answer | 3.1a | M1 | $\text{scale factor} = \frac{-4}{-8} = \frac{1}{2}$<br>$y = 2(x-5)^2 - 8$<br>$y = \frac{1}{2}\left[2(x-5)^2 - 8\right]$ |
| | Deduces their correct equation using their vertical stretch factor.<br>ACF<br>FT their $c$ , do not FT $c = \pm 4$<br>ISW | 2.2a | A1F | $y = (x-5)^2 - 4$<br>$y = x^2 - 10x + 21$ |
| | **Subtotal** | | **2** | |

| | | | | |
|---|---|---|---|---|
| | **Question 6 Total** | | **6** | |

| Q | Marking instructions | AO | Marks | Typical solution |
|---|---|---|---|---|
| **7(a)** | Expands $(x + h)^4$, with correct powers of $x$ and $h$. | 1.1a | M1 | $(x+ h)^4$ |
| | Obtains fully correct expansion. | 1.1b | A1 | $= x^4 + 4x^3h + 6x^2h^2 + 4xh^3 + h^4$ |
| | **Subtotal** | | **2** | |

| Q | Marking instructions | AO | Marks | Typical solution |
|---|---|---|---|---|
| **7(b)** | Forms an expression for $\frac{\text{difference in } y}{\text{difference in } x}$ in terms of $x$ and $h$<br>ACF<br>FT their expression from part (a) | 1.1b | B1F | $\frac{x^4 + 4x^3h + 6x^2h^2 + 4xh^3 + h^4 - x^4}{h}$ |
| | **Subtotal** | | **1** | |

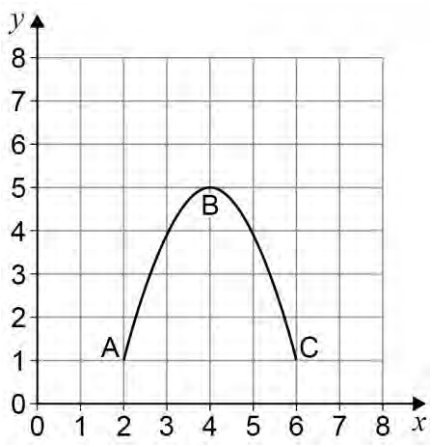
| Q | Marking instructions | AO | Marks | Typical solution |
|---|---|---|---|---|
| **7(c)** | Explains or shows that the answer to part (b) can be (expanded and) simplified.<br>FT their parts (a) and (b) where working is shown. | 1.1b | E1F | The expression from part (b) can be simplified by cancelling $h$<br><br>We then apply the limit as h tends to 0 to obtain the gradient. |
| | Explains that the gradient is found by letting $h$ tend to 0<br>or<br>Uses the limit as $h \to 0$ | 1.1b | E1 | |
| | **Subtotal** | | **2** | |

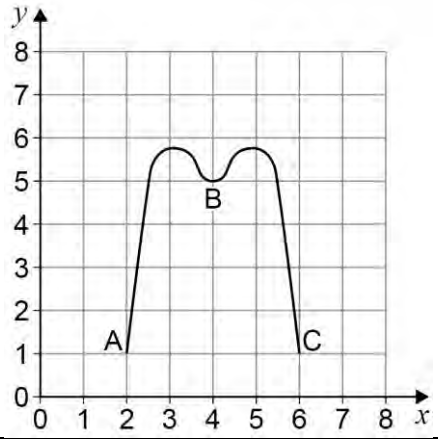
| | | | | |
|---|---|---|---|---|
| | **Question 7 Total** | | **5** | |

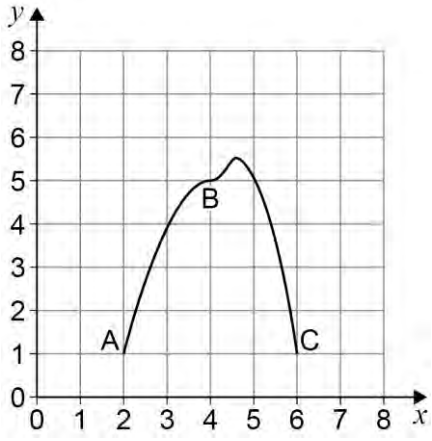
| Q | Marking instructions | AO | Marks | Typical solution |
|---|---|---|---|---|
| **8(a)** | Integrates with one term correct | 1.1a | M1 | $\int_1^a \left(6-\frac{12}{\sqrt{x}}\right)dx = \left[6x-24\sqrt{x}\right]_1^a$ |
| | Obtains fully correct integral | 1.1b | A1 | |
| | Substitutes limits and obtains the given answer.<br>AG | 2.1 | R1 | $= 6a-24\sqrt{a}-6+24$<br>$= 6a-24\sqrt{a}+18$ |
| | **Subtotal** | | **3** | |

| Q | Marking instructions | AO | Marks | Typical solution |
|---|---|---|---|---|
| **8(b)** | Explains or recognises that area is linked to integration | 2.4 | M1 | Equal areas, positive and negative, so integral 1 to $a = 0$<br>$6a - 24\sqrt{a} + 18 = 0$<br>$a - 4\sqrt{a} + 3 = 0$<br>We need $a = 9$ |
| | Equates the answer to part (a) to 0<br>or<br>Finds intersection point with the $x$ axis and evaluates an integral between 1 and their $x$ value.<br>NB Correct $x$ value is 4 | 3.1a | M1 | |
| | Solves $6a - 24\sqrt{a} + 18 = 0$ to obtain a value for $a$ or $\sqrt{a}$<br>or<br>Equates their **area** of $R_1$ to their integrated expression in term of $a$ for $R_2$<br>Must have used a positive value for the area of $R_1$<br>NB Correct expression for $R_2$ is $6a - 24\sqrt{a} + 24$ | 1.1a | M1 | |
| | Completes a reasoned argument with no errors to deduce $a = 9$ | 2.2a | R1 | |
| | **Subtotal** | | **4** | |

| | | | | |
|---|---|---|---|---|
| | **Question 8 Total** | | **7** | |

| Q | Marking instructions | AO | Marks | Typical solution |
|---|---|---|---|---|
| **9(a)** | Draws a graph through the given points with a maximum at (4, 5) | 1.1b | B1 |   |
| | **Subtotal** | | **1** | |

| Q | Marking instructions | AO | Marks | Typical solution |
|---|---|---|---|---|
| **9(b)** | Draws a graph through the given points with a minimum at (4, 5) | 2.2b | B1 |   |
| | **Subtotal** | | **1** | |

| Q | Marking instructions | AO | Marks | Typical solution |
|---|---|---|---|---|
| **9(c)** | Draws a graph through the given points with a stationary point at (4, 5) that is neither a maximum nor a minimum. | 2.2b | B1 |   |
| | **Subtotal** | | **1** | |

| | | | | |
|---|---|---|---|---|
| | **Question 9 Total** | | **3** | |

| Q | Marking instructions | AO | Marks | Typical solution |
|---|---|---|---|---|
| **10(a)** | States that Kaya is correct and/or Charlie is wrong | 2.3 | E1 | Charlie is wrong. |
| | Shows where the value £8000 has come from.<br><br>Ignore missing or incorrect £ sign. | 3.3 | B1 | Over the same time, the value goes down by the same proportion.<br><br>Two thirds of £18 000 is £12 000 so two thirds of £12 000 is £8 000 |
| | **Subtotal** | | **2** | |

| Q | Marking instructions | AO | Marks | Typical solution |
|---|---|---|---|---|
| **10(b)** | Uses 18 000 for value of $A$ | 3.1b | B1 | $12\,000 = 18\,000\,e^{-2k}$<br><br>$k = \frac{1}{2}\ln 1.5 = 0.203$<br><br>$10\,000 = 18\,000\,e^{-kt}$<br><br>$t = 2.9$ |
| | Substitutes 12 000 and 2 into model | 3.4 | M1 | |
| | Solves to find correct value of $k$, exact or AWRT 0.203 | 1.1b | A1 | |
| | Uses model with $V$ = 10 000 and their value of $k$ | 3.4 | M1 | |
| | Obtains the correct value of $t$ AWRT 2.9<br>Condone $t$ = 3 | 1.1b | A1 | |
| | **Subtotal** | | **5** | |

| Q | Marking instructions | AO | Marks | Typical solution |
|---|---|---|---|---|
| **10(c)** | Gives a reason in context why the model will not be suitable.<br>For example:<br>• Car will be worthless by then.<br>• Car will have been scrapped after 30 years.<br>• Model gives an unrealistic value of £41.<br>• Scrap value will be worth more than model suggests. | 3.5b | E1 | The car will probably have been scrapped by then. |
| | **Subtotal** | | **1** | |

| | | | | |
|---|---|---|---|---|
| | **Question 10 Total** | | **8** | |

| Q | Marking instructions | AO | Marks | Typical solution |
|---|---|---|---|---|
| **11(a)** | Obtains correct centre. | 1.1b | B1 | $x^2 - 10x + 25 + y^2 = 31$<br><br>$(x-5)^2 + y^2 = 31$<br><br>Centre is (5, 0) and radius $\sqrt{31}$ |
| | Obtains correct radius.<br>AWRT 5.6 | 1.1b | B1 | |
| | **Subtotal** | | **2** | |

| Q | Marking instructions | AO | Marks | Typical solution |
|---|---|---|---|---|
| **11(b)(i)** | Shows that origin is inside circle | 2.1 | R1 | Distance from centre to origin is 5 and 5 < $\sqrt{31}$ so vertex at origin is inside circle |
| | **Subtotal** | | **1** | |

| Q | Marking instructions | AO | Marks | Typical solution |
|---|---|---|---|---|
| **11(b)(ii)** | Selects an appropriate method to find the $y$ coordinate of at least one other vertex.<br>Condone one slip in the formation of the equation for the $y$ coordinate. | 3.1a | M1 | $\tan 30^\circ = \frac{y}{8}$ so $y = 8\tan 30^\circ$<br><br>The other vertices are $(8, \pm \frac{8}{\sqrt{3}})$<br><br>Distance from centre to other vertices is $\sqrt{(3^2 + \frac{64}{3})} = \sqrt{(\frac{91}{3})}$ < $\sqrt{31}$<br><br>Both vertices are inside circle<br><br>Complete triangle is inside circle |
| | Uses distance formula for distance from their centre to at least one vertex.<br>or<br>Find at least one $y$ value on the circle when $x$ = 8<br>NB Correct vales are $y = \pm\sqrt{22}$ | 3.1a | M1 | |
| | Compares $\sqrt{(\frac{91}{3})}$ with $\sqrt{31}$<br>AWRT 5.5 and 5.6<br>or<br>Compares $\frac{8}{\sqrt{3}}$ with $\sqrt{22}$<br>AWRT 4.6 and 4.7<br>**and**<br>Deduces that one other vertex is inside circle. | 2.2a | A1 | |
| | Completes proof that triangle is completely inside circle, either by proof for the third vertex or by reference to symmetry. | 2.1 | R1 | |
| | **Subtotal** | | **4** | |

| | | | | |
|---|---|---|---|---|
| | **Question 11 Total** | | **7** | |

| Q | Marking instructions | AO | Marks | Typical solution |
|---|---|---|---|---|
| **12** | Circles correct answer | 1.1b | B1 | 0.5 |
| | **Question 12 Total** | | **1** | |

| Q | Marking instructions | AO | Marks | Typical solution |
|---|---|---|---|---|
| **13** | Circles correct answer | 1.1b | B1 | 18 |
| | **Question 13 Total** | | **1** | |

| Q | Marking instructions | AO | Marks | Typical solution |
|---|---|---|---|---|
| **14(a)** | Selects an appropriate equation of constant acceleration.<br>and<br>states $u = 0$, $t = 4$ and $a = g$<br>PI by correct substitution | 1.1a | M1 | $s = ut + \frac{1}{2}at^2$<br><br>$u = 0$, $t = 4$ and $a = g$<br><br>$0.8h = \frac{1}{2}g \times 4^2$<br><br>$0.8h = 8g$<br><br>$h = 10g$ |
| | Substitutes $s = 0.8h$ | 1.1a | M1 | |
| | Completes reasoned argument to obtain given answer | 2.1 | R1 | |
| | **Subtotal** | | **3** | |

| Q | Marking instructions | AO | Marks | Typical solution |
|---|---|---|---|---|
| **14(b)** | Explains that $h$ will be less | 3.5a | E1 | Air resistance will cause $h$ to be lower |
| | **Subtotal** | | **1** | |

| | | | | |
|---|---|---|---|---|
| | **Question 14 Total** | | **4** | |

| Q | Marking instructions | AO | Marks | Typical solution |
|---|---|---|---|---|
| **15(a)** | Uses gradient for $0 \leq t < 4$ to show given acceleration value.<br>AG | 1.1b | B1 | $a = \frac{10 - -4}{4} = 3.5$ |
| | **Subtotal** | | **1** | |

| Q | Marking instructions | AO | Marks | Typical solution |
|---|---|---|---|---|
| **15(b)** | Selects a suitable method for calculating the displacement by working out an appropriate area.<br>or<br>Uses a constant acceleration equation and substitutes appropriate values. | 3.1a | M1 | $100 = 16 + 7s$<br>$s = 12$ m<br>Since displacement = area<br>When $t = 9$<br>$s = 12 + (9 - 4)10 = 62$ m |
| | Obtains a displacement of 12 when $t = 4$<br>or<br>Obtains a displacement of $\frac{-16}{7}$ when $t = \frac{8}{7}$<br>Allow area of triangle = $\frac{16}{7}$<br>or<br>Obtains a displacement of $\frac{100}{7}$ from $t = \frac{8}{7}$ to $t = 4$<br>or<br>Obtains a displacement of $\frac{450}{7}$ from $t = \frac{8}{7}$ to $t = 9$<br>OE | 1.1b | A1 | |
| | Completes reasoned argument with fully correct working to show the given displacement. Do not award if decimal values are repeatedly used throughout to only one decimal place.<br>AG | 2.1 | R1 | |
| | **Subtotal** | | **3** | |

| | | | | |
|---|---|---|---|---|
| | **Question 15 Total** | | **4** | |

| Q | Marking instructions | AO | Marks | Typical solution |
|---|---|---|---|---|
| **16(a)** | Differentiates to find expression for acceleration with at least one term correct.<br>PI by -0.08 or 0.08 | 3.4 | M1 | $a = 0.16 - 0.12t$ |
| | Obtains a fully correct expression for acceleration.<br>PI by -0.08 | 1.1b | A1 | |
| | Finds their acceleration of the boat when $t = 2$<br>FT their expression for $a$<br>Must have differentiated at least one term.<br>Correct units must be stated. | 3.2a | A1F | $a = -0.08$ ms$^{-2}$ |
| | **Subtotal** | | **3** | |

| Q | Marking instructions | AO | Marks | Typical solution |
|---|---|---|---|---|
| **16(b)** | Integrates $v$ with at least one term correct.<br>PI by 1.96 | 3.1b | M1 | $s = \int v \, \mathrm{d}t$ |
| | Obtains a fully correct integral.<br>Condone omission of constant<br>PI by 1.96 | 1.1b | A1 | $= \int 0.9 + 0.16t - 0.06t^2 \, \mathrm{d}t$<br>$s = 0.9t + 0.08t^2 - 0.02t^3 + c$ |
| | Substitutes $t = 0$ and $t = 2$ into their expression for $s$<br>Must have integrated at least one term.<br>PI by 1.96 | 1.1a | M1 | $s = 0$ when $t = 0$ so $c = 0$<br>$s = 0.9(2) + 0.08(4) - 0.02(8)$ |
| | Obtains displacement = 1.96 m<br><br>Condone omission of units | 1.1b | A1 | Displacement = 1.96 m |
| | **Subtotal** | | **4** | |

| | | | | |
|---|---|---|---|---|
| | **Question 16 Total** | | **7** | |

| Q | Marking instructions | AO | Marks | Typical solution |
|---|---|---|---|---|
| **17(a)** | Finds correct magnitude of force.<br><br>Condone omission of units | 1.1b | B1 | $\sqrt{12^2+9^2}=15$ N |
| | **Subtotal** | | **1** | |

| Q | Marking instructions | AO | Marks | Typical solution |
|---|---|---|---|---|
| **17(b)(i)** | Forms correct expression for $\overrightarrow{AB}$<br><br>Condone omission of units | 1.1b | B1 | $\overrightarrow{AB}=\begin{bmatrix}k-3\\k-8\end{bmatrix}$ metres |
| | **Subtotal** | | **1** | |

| Q | Marking instructions | AO | Marks | Typical solution |
|---|---|---|---|---|
| **17(b)(ii)** | Deduces $\overrightarrow{AB}$ is a scalar multiple of $\begin{bmatrix}12\\9\end{bmatrix}$ | 2.2a | M1 | Since direction of movement is in direction of force then $\overrightarrow{AB}$ is a scalar multiple of $\begin{bmatrix}12\\9\end{bmatrix}$ |
| | Deduces $k=23$<br><br>FT their answer to part (b)(i) | 2.2a | A1F | $\begin{bmatrix}k-3\\k-8\end{bmatrix}=\begin{bmatrix}12\lambda\\9\lambda\end{bmatrix}$<br><br>$9(k-3)=12(k-8)$<br><br>$9k-27=12k-96$<br><br>$k=23$ |
| | **Subtotal** | | **2** | |

| | | | | |
|---|---|---|---|---|
| | **Question 17 Total** | | **4** | |

| Q | Marking instructions | AO | Marks | Typical solution |
|---|---|---|---|---|
| **18(a)** | Uses $F = ma$ to form at least one equation modelling the van, car or both combined with at least three terms. | 3.3 | M1 | $D - R - T = 2780 \times 0.6$<br><br>$T - 0.6R = 1620 \times 0.6$<br><br>Eliminating $R$<br>$0.6D - 1.6T = 28.8$<br><br>$T = \frac{0.6}{1.6}(D - 48)$<br><br>$k = \frac{3}{8}$ |
| | Obtains a fully correct equation.<br>Other examples:<br>$D - R - T = 1668$<br>$T - 0.6R = 972$<br>$D - 1.6R = 2640$<br><br>NB $T$ may have been replaced by $kD - 18$ at any point. | 1.1b | A1 | |
| | Forms a second fully correct equation. | 3.3 | B1 | |
| | Eliminates $R$ to form an equation with $D$ and $T$ | 3.4 | M1 | |
| | Obtains $k = \frac{3}{8}$<br>OE | 1.1b | A1 | |
| | **Subtotal** | | **5** | |

| Q | Marking instructions | AO | Marks | Typical solution |
|---|---|---|---|---|
| **18(b)** | Describes any valid assumption.<br>For example:<br>• Tow bar has negligible mass.<br>• The car is directly behind the van.<br>• The masses include drivers.<br>• Tow bar is rigid.<br>• Tow bar is inextensible.<br>•<br>Do not accept any reference to resistances, tension being constant, tow bar breaks. | 3.5b | B1 | Tow bar is horizontal |
| | **Subtotal** | | **1** | |

| | | | | |
|---|---|---|---|---|
| | **Question 18 Total** | | **6** | |

| | | | | |
|---|---|---|---|---|
| | **Question Paper Total** | | **80** | |