A-level
MATHEMATICS
7357/2

Paper 2

Mark scheme

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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.

No student should be disadvantaged on the basis of their gender identity and/or how they refer to the gender identity of others in their exam responses.

A consistent use of 'they/them' as a singular and pronouns beyond 'she/her' or 'he/him' will be credited in exam responses in line with existing mark scheme criteria.

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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
ISW	ignore subsequent working
PI	possibly implied
sf	significant figure(s)
dp	decimal place(s)

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.

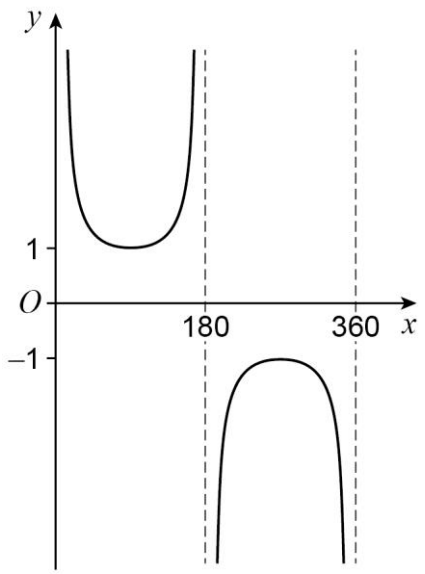
Work erased or crossed out

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	Ticks the first box	2.2a	R1	Stretch, scale factor 2, parallel to the y-axis
	Question 1 Total		**1**	

Q	Marking instructions	AO	Marks	Typical solution
2	Ticks the top left box	1.2	B1	
	Question 2 Total		**1**	

Q	Marking instructions	AO	Marks	Typical solution
3	Ticks second box	2.5	B1	$x \in (-\infty, -2) \cup (7, \infty)$
	Question 3 Total		**1**	

Q	Marking instructions	AO	Marks	Typical solution
4	Takes logs with the same base of both sides. Can be any base **Or** Writes 20 as a power of 5. E.g. $5^{\text{AWRT 1.9}}$	1.1a	M1	$\log_5 5^{x-1} = \log_5 20$ $x-1 = \log_5 20$ $x = \log_5 20 + 1$
	Obtains the correct exact value ACF	1.1b	A1	
	Question 4 Total		**2**	

Q	Marking instructions	AO	Marks	Typical solution
5	Recalls the formula for the area of a sector $A = \frac{1}{2}r^2\theta$ **Or** Recalls $A = \frac{\theta}{360}\pi r^2$ **and** changes their angle to AWRT 80.2^o	1.2	M1	$A = \frac{1}{2} \times 8^2 \times 1.4$ $= 44.8 \text{ cm}^2$
	Obtains $\frac{224}{5}$ OE Condone missing or incorrect units If units are converted the value must be correct.	1.1b	A1	
	Question 5 Total		**2**	

Q	Marking instructions	AO	Marks	Typical solution
6(a)(i)	Obtains AWFW [7.2154, 7.2155] May be seen in the table	1.1b	B1	7.2155
	Subtotal		**1**	

Q	Marking instructions	AO	Marks	Typical solution
6(a)(ii)	States or uses h = 0.8 OE	1.1b	B1	$h = \frac{8-4}{5}$ $A = \frac{0.8}{2}\left(\begin{array}{l}7.3891+10.9196+\\2\left(6.1240+6.3249+7.2155+8.7139\right)\end{array}\right)$ $= 30.026$
	Substitutes all the given y values and their answer from 6(a)(i) to achieve $7.3891+10.9196+$ $2\left(6.124+6.3249+7.2155+8.7139\right)$ FT their 7.2155 PI 75.0653 Accept correct exact values or values to more than 4 decimal places. Condone omission of the bracket after 8.7139	1.1a	M1	
	Obtains AWRT 30.026	1.1b	A1	
	Subtotal		**3**	

Q	Marking instructions	AO	Marks	Typical solution
6(b)	States that the curve is **convex** or **concave upwards** Accept **concave up** **Or** States that $\frac{d^2y}{dx^2} > 0$	2.4	E1	The curve is convex, so the trapezium rule gives an over-estimate. Therefore, the student is incorrect.
	Explains that the trapezium rule gives an **over-estimate** **and** deduces that the student is incorrect	2.4	E1	
	Subtotal		**2**	

	Question 6 Total		**6**	

Q	Marking instructions	AO	Marks	Typical solution
7(a)	Substitutes $x = -5$ and $y = 37$ into $y = x^3 + px^2 + qx + 12$ PI $37 = -125 + 25p - 5q + 12$	3.1a	M1	$37 = (-5)^3 + (-5)^2 p + (-5)q + 12$ $37 = -125 + 25p - 5q + 12$ $150 = 25p - 5q$ $5p - q = 30$
	Completes reasoned argument to show $5p - q = 30$ There must be at least one intermediate step after $(-5)^3$ and $(-5)^2$ evaluated AG	2.1	R1	
	Subtotal		**2**	

Q	Marking instructions	AO	Marks	Typical solution
7(b)	Differentiates x^3 and 12 correctly	1.1b	B1	$\frac{dy}{dx} = 3x^2 + 2px + q$ $0 = 3 \times (-5)^2 - 10p + q$ $10p - q = 75$
	Differentiates px^2 correctly or differentiates qx correctly **and** equates their $\frac{dy}{dx}$ to zero	3.1a	M1	
	Completes reasoned argument by substituting $x = -5$ into a correct $\frac{dy}{dx}$ to obtain $10p - q = 75$ AG	2.1	R1	
	Subtotal		**3**	

Q	Marking instructions	AO	Marks	Typical solution
7(c)	Obtains $p = 9,\ q = 15$	1.1b	B1	$5p - q = 30$ $10p - q = 75$ $p = 9,\ q = 15$
	Subtotal		**1**	

Q	Marking instructions	AO	Marks	Typical solution
7(d)	Solves $3x^2 + 2px + q\ (= 0)$ for their p and q Condone $x^2 + 2px + q\ (= 0)$	3.1a	M1	Stationary points occur when $\frac{dy}{dx} = 0$ $\frac{dy}{dx} = 3x^2 + 18x + 15 = 0$ $x = -5$ *or* -1 At *B*, $x = -1$ Therefore, stationary point is $(-1, 5)$
	Obtains $x = -1$ from $3x^2 + 18x + 15\ (= 0)$ OE	1.1a	A1	
	Completes reasoned argument to obtain $(-1, 5)$ Must have obtained $x = -5$ and $x = -1$ when solving $\frac{dy}{dx} = 0$ **and** explained that stationary points occur when $\frac{dy}{dx} = 0$ OE	2.1	R1	
	Subtotal		**3**	

	Question 7 Total		**9**	

Q	Marking instructions	AO	Marks	Typical solution
8(a)	States the value 1	1.2	B1	1
	Subtotal		**1**	

Q	Marking instructions	AO	Marks	Typical solution
8(b)	Expands the given brackets to obtain at least three of the following four terms $15\sec^2 x$ $25\sec x\tan x$ $-9\sec x\tan x$ $-15\tan^2 x$ OE	3.1a	M1	$(3\sec x+5\tan x)(5\sec x-3\tan x)-\frac{16\tan x}{\cos x}$ $=15\sec^2 x-9\sec x\tan x+25\sec x\tan x$ $-15\tan^2 x-16\sec x\tan x$ $=15\left(\sec^2 x-\tan^2 x\right)$ $=15$
	Expands the given brackets to obtain $15\sec^2 x+25\sec x\tan x-9\sec x\tan x-15\tan^2 x$ or $15\sec^2 x+16\sec x\tan x-15\tan^2 x$ OE	1.1b	A1	
	Evaluates $15\sec^2 x-15\tan^2 x$ to 15 **Or** Evaluates $16\sec x\tan x-\frac{16\tan x}{\cos x}$ to 0	2.2a	B1	
	Completes reasoned argument to obtain 15 Argument must include a conversion of $16\sec x\tan x$ or $\frac{16\tan x}{\cos x}$ to a common form before cancellation CSO	2.1	R1	
	Subtotal		**4**	

Q	Marking instructions	AO	Marks	Typical solution
8(c)	Obtains 90 and 270 CAO	2.2a	R1	$x=90$, $x=270$
	Subtotal		**1**	

	Question 8 Total		**6**	

Q	Marking instructions	AO	Marks	Typical solution
9(a)	States (12, 2)	1.1b	B1	(12, 2)
	Subtotal		**1**	

Q	Marking instructions	AO	Marks	Typical solution
9(b)	States (12, –8)	2.2a	R1	(12, –8)
	Subtotal		**1**	

Q	Marking instructions	AO	Marks	Typical solution
9(c)	Forms an equation for x or a by Substituting $y = 10$ into $(x-12)^2+(y-2)^2=100$ or $y=\lvert 3x-36\rvert-8$ **Or** Substitutes $\pm(3x-36)-8$ for y in the circle equation **Or** Forms a right-angled triangle with a hypotenuse of 10 and a shorter side of 8 **and** uses an appropriate process to find the length of the third side PI by a 6, 8, 10 right-angled triangle	3.1a	M1	$(a-12)^2+(10-2)^2=100$ $a=6$ or 18 $6<18$ $\therefore a=6$
	Solves their equation to find a value of x or a **Or** Identifies 6, 8 and 10 as a Pythagorean triple PI by a 6, 8, 10 right-angled triangle	1.1a	M1	
	Completes reasoned argument to obtain $a = 6$ with a fully correct solution If a 6, 8, 10 approach is used we must see 12 – 6 = a, 12 – 6 = 6 or 12 – a = 6 Accept (6, 10) NMS scores M0M0R0	2.1	R1	
	Subtotal		**3**	

Q	Marking instructions	AO	Marks	Typical solution
9(d)(i)	Uses an appropriate trigonometric equation to find angle ADB or $\frac{1}{2}ADB$ such as $\arctan\frac{6}{18}$ or $\arctan\frac{6}{8}$ OE PI by AWRT 18.4^o or 36.9^o	3.1a	M1	$\tan\frac{\theta}{2}=\frac{6}{18}$ $\theta=0.644$
	Obtains AWRT 0.644	1.1b	A1	
	Subtotal		**2**	

Q	Marking instructions	AO	Marks	Typical solution
9(d)(ii)	Uses $l=r\theta$ with either $r=10$ or $\theta=2\times$their 0.644 OE Condone angle in degrees	3.1a	M1	$l=10\times(2\times0.644)$ $=12.9$
	Obtains AWFW [12.8,12.9]	1.1b	A1	
	Subtotal		**2**	

	Question 9 Total		**9**	

Q	Marking instructions	AO	Marks	Typical solution
10(a)	Uses the product rule with one term correct Condone vu' – uv' or v'u – u'v	3.1a	M1	$\frac{\mathrm{d}y}{\mathrm{d}x} = kx^{k-1}\ln x + x^k \times \frac{1}{x}$ $\frac{\mathrm{d}y}{\mathrm{d}x} = kx^{k-1}\ln x + x^{k-1}$ $\frac{\mathrm{d}y}{\mathrm{d}x} = x^{k-1}\left[1+k\ln x\right]$
	Obtains $kx^{k-1}\ln x + x^k \times \frac{1}{x}$	1.1b	A1	
	Simplifies $x^k \times \frac{1}{x} = x^{k-1}$	1.1b	A1	
	Completes reasoned argument to show $\frac{\mathrm{d}y}{\mathrm{d}x} = x^{k-1}\left[1+k\ln x\right]$ Argument must include $x^k \times \frac{1}{x}$ or $\frac{x^k}{x}$ before x^{k-1} seen	2.1	R1	
	Subtotal		**4**	

Q	Marking instructions	AO	Marks	Typical solution
10(b)	Equates the given expression for $\frac{\mathrm{d}y}{\mathrm{d}x}$ to zero. PI $1+k\ln x = 0$ **and** Solves to obtain a non-zero value for x	1.1a	M1	$x^{k-1}\left[1+k\ln x\right] = 0$ $\Rightarrow 1+k\ln x = 0$ or $x^{k-1} = 0$ $\ln x = -\frac{1}{k}$ $x = \mathrm{e}^{-\frac{1}{k}}$ Since $x > 0$, $x^{k-1} \neq 0$ $y = \left(\mathrm{e}^{-\frac{1}{k}}\right)^k \times \ln \mathrm{e}^{-\frac{1}{k}}$ $y = \frac{1}{\mathrm{e}} \times \left(-\frac{1}{k}\right)$ $= -\frac{1}{k\,\mathrm{e}}$
	Gives a correct reason for rejecting $x = 0$	2.4	E1	
	Deduces $x = \mathrm{e}^{-\frac{1}{k}}$ Accept $x = \mathrm{e}^{-\frac{A}{k}}$	2.2a	A1	
	Substitutes their value for x into equation of C.	1.1a	M1	
	Completes reasoned argument to show the given result. Must see $\left(\mathrm{e}^{-\frac{1}{k}}\right)^k$ simplified to e^{-1} or $\frac{1}{\mathrm{e}}$ **and** $\ln \mathrm{e}^{-\frac{1}{k}}$ simplified to $-\frac{1}{k}$ before the final answer AG	2.1	R1	
	Subtotal		**5**	

Q	Marking instructions	AO	Marks	Typical solution
10(c)	States 1	1.1b	B1	1
	Subtotal		**1**	

Q	Marking instructions	AO	Marks	Typical solution
10(d)	Differentiates $\frac{dy}{dx} = x^{k-1}[1 + k\ln x]$ where their $k > 0$ accept $\frac{d^2y}{dx^2}$ in terms of A and/or k	3.1a	M1	When $k = 1$ $\frac{dy}{dx} = 1 + \ln x$ If there is a point of inflection $\frac{d^2y}{dx^2} = 0$ $\frac{d^2y}{dx^2} = \frac{1}{x} \neq 0$ Therefore, *C* has no point of inflection.
	Obtains $\frac{d^2y}{dx^2} = \frac{1}{x}$	1.1a	A1	
	Completes reasoned argument by comparing $\frac{1}{x}$ with zero **and** concludes that there is no point of inflection.	2.1	R1	
	Subtotal		**3**	

	Question 10 Total		**13**	

Q	Marking instructions	AO	Marks	Typical solution
11	Circles the second answer	3.3	B1	0.32
	Question 11 Total		**1**	

Q	Marking instructions	AO	Marks	Typical solution
12	Circles the second answer	2.2a	B1	0
	Question 12 Total		**1**	

Q	Marking instructions	AO	Marks	Typical solution
13(a)	Substitutes $a = 2$ $s = 225$, $v = 30$ and u into $v^2 = u^2 + 2as$ OE	3.3	M1	$a = 2$ $s = 225$, $v = 30$ $v^2 = u^2 + 2as$ $30^2 = u^2 + 2 \times 2 \times 225$ $900 = u^2 + 900$ $u^2 = 0$ $u = 0\,m\,s^{-1}$ Therefore, the car is at rest at point A.
	Completes reasoned argument, with at least one intermediate step after the initial substitution, to obtain $u = 0$ or $u^2 = 0$ **and** concludes the car starts from rest AG Accept making u the subject of $v^2 = u^2 + 2as$ before substitution as the intermediate step	2.1	R1	
	Subtotal		**2**	

Q	Marking instructions	AO	Marks	Typical solution
13(b)	Explains why the model becomes invalid, eg: • That acceleration is unlikely to remain constant Or gives a contextual reason as to why the car may have to slow down or stop, eg: • That the car reaches its maximum speed • The road will not remain straight or there will be an obstacle • The car will run out of fuel	3.5b	E1	A car's acceleration is unlikely to stay at the same rate.
	Subtotal		**1**	

	Question 13 Total		**3**	

Q	Marking instructions	AO	Marks	Typical solution
14	Substitutes $u = 25,\ a = \pm 9.8$ and $s = \pm 2.5$ into $v^2 = u^2 + 2as$ PI $\begin{bmatrix} k \\ 674 \end{bmatrix}$ or $\begin{bmatrix} \sqrt{k} \\ \sqrt{674} \end{bmatrix}$ **Or** Substitutes $u = 25,\ a = -9.8$ and $s = -2.5$ into $s = ut + \frac{1}{2}at^2$ to find t **and** substitutes their t into $v = u + at$	3.3	M1	$v^2 = 25^2 + 2 - 9.8 \times -2.5$ $v^2 = 674$ Speed $= \sqrt{40^2 + 674}$ Speed $= 47.7\, m\,s^{-1}$ Speed $= 48\, m\,s^{-1}$
	Obtains correct $v^2 = 674$ or $v = \sqrt{674}$ If inconsistent signs are used for u, a and s score A0 PI AWRT ± 25.96 If vector form is used, both components must be correct	1.1b	A1	
	Finds the magnitude of the resultant vector of their vertical component of velocity and 40 Do not allow 25 for their vertical component of velocity	1.1a	M1	
	Obtains the correct speed of the arrow. Accept AWRT 48 If inconsistent signs are used for u, a and s score A0	1.1b	A1	
	Question 14 Total		**4**	

Q	Marking instructions	AO	Marks	Typical solution
15(a)	Resolves horizontally or vertically to find a correct expression for one of the **i** or **j** components of the resultant force. **Or** Uses the cosine rule with $b = 17$ and $c = 26$	3.3	M1	Horizontally: $17 - 26\cos(40)$ $= -2.917...$ Vertically: $26\sin(40)$ $= 16.712...$ $\sqrt{(-2.917)^2 + 16.712^2} = 16.97\text{N}$ $\approx 17.0\text{N}$
	Resolves horizontally and vertically to find a correct expression for both **i** and **j** components of the resultant force PI by H: AWRT ± 2.9 V: AWRT ± 16.7 **Or** Uses the cosine rule to obtain a^2 = AWRT 287.8	1.1b	A1	
	Finds the magnitude of the resultant vector of their horizontal and vertical components **Or** Finds the square root of their expression for $b^2 + c^2 - 2bc\text{CosA}$ PI by AWFW [16.96, 16.97]	1.1a	M1	
	Completes reasoned argument showing a full method to obtain AWFW [16.96, 16.97] and concludes that the magnitude of **R** is 17.0 Condone 17 AG	2.1	R1	
	Subtotal		**4**	

Q	Marking instructions	AO	Marks	Typical solution
15(b)	Uses an appropriate trigonometric equation using their components for **R** **Or** Deduces that the two 17N forces make this an isosceles triangle, eg: 180 – (2 x 40) PI AWRT 79 or 80	3.1a	M1	$\tan^{-1}\left(\frac{16.712}{2.917}\right) = 80^{o}$ $180 - 80 = 100^{o}$
	Obtains any of the following angles AWRT 100, 101, ± 259, ± 260	1.1b	A1	
	Subtotal		**2**	

Q	Marking instructions	AO	Marks	Typical solution
15(c)(i)	States 17.0 PI by AWRT 17	2.2a	B1	17.0 N
	Subtotal		**1**	

Q	Marking instructions	AO	Marks	Typical solution
15(c)(ii)	States 170° PI by AWRT 170	2.2a	B1	170°
	Subtotal		**1**	

	Question 15 Total		**8**	

Q	Marking instructions	AO	Marks	Typical solution
16(a)	Obtains $10g\sin 20$ OE	3.1b	B1	$10g\sin 20 + 15 = \mathbf{T}\cos 30$
	Resolves parallel to the path to form a three-term equation with at least two correct terms	3.3	M1	$\mathbf{T} = 56.02$
	Obtains $10g\sin 20 + 15 = \mathbf{T}\cos 30$ OE	1.1b	A1	$\mathbf{T} = 56\ N$
	Obtains AWRT 56 Condone missing units.	1.1b	A1	
	Subtotal		**4**	

Q	Marking instructions	AO	Marks	Typical solution
16(b)	Uses $\mathbf{F} = \mu\mathbf{R}$	1.1b	B1	$\mathbf{R} + 54\sin 30 = 10g\cos 20$
	Obtains $10g\cos 20$ OE	1.1b	B1	$\mathbf{R} = 65.0899\ N$
	Resolves perpendicular to the plane to form a three-term dimensionally correct equation with at least two terms correct.	3.3	M1	$54\cos 30 - \mu\mathbf{R} - 10g\sin 20 = 10a$
	Obtains a correct expression or value for **R** AWRT 65 PI by friction = AWRT ± 13.02	1.1b	A1	$a = \dfrac{54\cos 30 - 0.2\times 65.0899 - 98\sin 20}{10}$
	Uses $\mathbf{F} = ma$ to form a four-term dimensionally correct equation, excluding a 15N force, with at least three terms correct. FT their **R** value Condone inclusion of a 15N force from **16(a)** as a 5th term	3.4	M1	$a = 0.023\ ms^{-2}$
	Forms fully correct equation in a for the particle with all values substituted. FT their **R** value Note this alone obtains B1B1M1A1M1A1	1.1b	A1F	
	Obtains AWRT 0.023 m s^{-2}	1.1b	A1	
	Subtotal		**7**	

Q	Marking instructions	AO	Marks	Typical solution
16(c)	States the sledge is modelled as a particle If more than one assumption is stated E0	3.5a	E1	The sledge is modelled as a particle.
	Subtotal		**1**	

	Question 16 Total		**12**	

Q	Marking instructions	AO	Marks	Typical solution
17(a)(i)	Obtains $\begin{bmatrix} 8 \\ -1 \\ -3 \end{bmatrix}$ ACF	1.1b	B1	$\overrightarrow{AB} = \begin{bmatrix} 8 \\ -1 \\ -3 \end{bmatrix}$
	Subtotal		**1**	

Q	Marking instructions	AO	Marks	Typical solution
17(a)(ii)	Finds the magnitude of their $\overrightarrow{AB}$ AWRT 8.6	1.1b	B1F	$\lvert AB \rvert = \sqrt{64+1+9} = \sqrt{74}$
	Subtotal		**1**	

Q	Marking instructions	AO	Marks	Typical solution
17(b)	Uses vector geometry to work out $\overrightarrow{OC}-\overrightarrow{OA}$ or $\overrightarrow{OC}-\overrightarrow{OB}$ OE PI $\pm\begin{bmatrix}4\\-6\\-1\end{bmatrix}$ or $\pm\begin{bmatrix}-4\\-5\\2\end{bmatrix}$ Condone missing arrows Condone missing or incorrect labels	1.1a	M1	$\overrightarrow{AC}=\begin{bmatrix}1\\-1\\0\end{bmatrix}-\begin{bmatrix}-3\\5\\1\end{bmatrix}=\begin{bmatrix}4\\-6\\-1\end{bmatrix}$ $\overrightarrow{BC}=\begin{bmatrix}1\\-1\\0\end{bmatrix}-\begin{bmatrix}5\\4\\-2\end{bmatrix}=\begin{bmatrix}-4\\-5\\2\end{bmatrix}$ $\lvert AB\rvert=\sqrt{74}$ $\lvert BC\rvert=\sqrt{16+25+4}=\sqrt{45}$ $\lvert AC\rvert=\sqrt{53}$ All sides are different in length. Therefore, triangle *ABC* is a scalene triangle.
	Obtain the correct vectors for $\overrightarrow{AC}$ or $\overrightarrow{CA}$ **and** $\overrightarrow{BC}$ or $\overrightarrow{CB}$ The vectors must be correctly labelled Condone missing arrows	1.1b	A1	
	Find the magnitude of their $\overrightarrow{AC}$ or $\overrightarrow{BC}$ OE PI $\sqrt{53}$ or $3\sqrt{5}$ OE AWRT 7.3 or 6.7 If $3\sqrt{5}$ is obtained from $\overrightarrow{OB}$ score M0	3.1a	M1	
	Obtains $\sqrt{53}$ and $3\sqrt{5}$ OE from correct vectors. AWRT 7.3 and 6.7	1.1b	A1	
	Completes reasoned argument to obtain the three lengths: $\lvert BC\rvert=\sqrt{45}$ $\lvert AC\rvert=\sqrt{53}$ OE $\lvert AB\rvert=\sqrt{74}$ **and** Concludes that *ABC* is a **scalene triangle** with no incorrect reasoning. Must have scored M1A1M1A1 Must not equate a vector to a length. AG	2.1	R1	
	Subtotal		**5**	

	Question 17 Total		**7**	

Q	Marking instructions	AO	Marks	Typical solution
18(a)	Obtains one of the following moments about A. $\pm 2.3\times 30g$ OE $\pm 1.25\times 400$ OE PI AWRT 1960 or AWRT 1983	3.3	B1	clockwise: $2.3\times 30\times 9.81+1.25\times 400$ anticlockwise: $0.6\mathbf{R}$ $0.6\mathbf{R}=2.3\times 30\times 9.81+1.25\times 400$ $\mathbf{R}=\dfrac{2.3\times 30\times 9.81+1.25\times 400}{0.6}$ $\mathbf{R}=1960\ N$
	Forms a three term moments equation about A with at least one correct term. Must be dimensionally correct. PI $0.6\mathbf{R}$ = AWFW [1176, 1177] or $0.6\mathbf{R}$ = 1190	3.3	M1	
	Forms a fully correct moments equation about A. PI AWRT 1960 or AWRT 1983	1.1b	A1	
	Obtains $1960\ N$ Must include units	3.2a	A1	
	Subtotal		**4**	

Q	Marking instructions	AO	Marks	Typical solution
18(b)(i)	States that the reaction force **decreases** with no other incorrect reasoning.	3.5a	E1	As the child walks towards *B* the reaction force at *B* decreases.
	Subtotal		**1**	

Q	Marking instructions	AO	Marks	Typical solution
18(b)(ii)	States that the tension in the chain does not change.	3.5a	E1	The tension in the chain does not change.
	Subtotal		**1**	

	Question 18 Total		**6**	

Q	Marking instructions	AO	Marks	Typical solution
19(a)	Uses $\mathbf{v} = \frac{\mathrm{d}\mathbf{s}}{\mathrm{d}t}$ with one component correct	3.4	M1	$\mathbf{v} = \frac{\mathrm{d}\mathbf{s}}{\mathrm{d}t} = 6t^2\mathbf{i} + (4t+q)\mathbf{j}$
	Obtains $6t^2\mathbf{i} + (4t+q)\mathbf{j}$ OE	1.1b	A1	
	Subtotal		**2**	

Q	Marking instructions	AO	Marks	Typical solution
19(b)	Uses $\mathbf{v} = \int \mathbf{a}\,\mathrm{d}t$ with one component correct Ignore c	3.4	M1	$\mathbf{a} = \frac{\mathrm{d}\mathbf{v}}{\mathrm{d}t}$, $\mathbf{v} = \int 6t\mathbf{i} + 7\mathbf{j}\,\mathrm{d}t$ $\mathbf{v} = 3t^2\mathbf{i} + 7t\mathbf{j} + c_1\mathbf{i} + c_2\mathbf{j}$ When $t = 0, \mathbf{v} = 4\mathbf{j}$, $c_2 = 4$ $\mathbf{v} = 3t^2\mathbf{i} + (7t + 4)\mathbf{j}$ When $t = 2$, $\mathbf{v}_p = 24\mathbf{i} + (8+q)\mathbf{j}$ $\mathbf{v}_q = 12\mathbf{i} + 18\mathbf{j}$ $\therefore \mathbf{v}_p = 2\mathbf{v}_q$ $36 = 8 + q$ $q = 28$
	Substitutes t = 0 into a velocity vector and equates to $4\mathbf{j}$ to obtain a value or values for their constant of integration. PI by $3t^2\mathbf{i} + (7t + 4)\mathbf{j}$	3.4	M1	
	Obtains $3t^2\mathbf{i} + (7t + 4)\mathbf{j}$	1.1b	A1	
	Finds their $\mathbf{v}_p$ and their $\mathbf{v}_q$ when $t = 2$. Must come from use of calculus Condone missing brackets for $8 + q$	1.1b	B1F	
	Uses $\mathbf{v}_p = k\mathbf{v}_q$ Where $k \neq 1$ **Or** Compares the ratios of the components of their $\mathbf{v}_p$ and their $\mathbf{v}_q$ Must come from use of calculus	3.3	M1	
	Obtains 28	1.1b	A1	
	Subtotal		**6**	

	Question 19 Total		**8**	

	Question Paper Total		**100**	