Year 12 FM
October Pre Half Term Review
Mr Chan and Ms Fahmida's Math-magicians
Pure and Mechanics

This exam has 10 questions, for a total of 85 marks.

Topic List

Pure

- Coordinate Geometry (Lines and Circles)
- Differentiation
- Integration
- Curve Fitting
- Linear Transformations
- Binomial Expansions

Mechanics

- Kinematics
- Forces (vertical pulleys)

Question:	1	2	3	4	5	6	7	8	9	10	Total
Marks	5	6	8	9	8	6	9	13	7	14	85
Score:											

- Advised to print in "A3-booklets", this will allow all questions to be on the left hand side.
- You can also print in A4, double-sided, and two staples on the left
- If instead you print in 2-in-1 settings, first print the second page up to the last page, then print the cover page separately (to allow all questions on the left)

Andrew Chan
3rd November 2023

1. Welcome Math-magicians, please see five nice 1 mark multiple choice questions to start:

(a) Three of the following points lie on the same straight line.

Which point does **not** lie on this line?

Tick **one** box.

☐ $(-2, 14)$

☐ $(-1, 8)$

☐ $(1, -3)$

☐ $(2, -10)$

(1)

(b) Zakiyyah says:

"A person's weight on Earth is directly proportional to their mass."

Andrew says:

"A person's weight on Earth is different to their weight on the moon."

Only one of the statements below is correct.

Identify the correct statement.

Tick **one** box.

☐ Zakiyyah and Andrew are both wrong.

☐ Zakiyyah is right but Andrew is wrong.

☐ Zakiyyah is wrong but Andrew is right.

☐ Zakiyyah and Andrew are both right.

(1)

(c) Which of the following equations has/have equal roots?

I. $x^2 = x$

II. $x^2 + 2x + 1 = 0$

III. $(x + 3)^2 = 1$

A. II only

B. III only

C. I and II only

D. I and III only

(1)

(d) If a and b are real numbers greater 1, which of the following statements is/are true?

I. $\sqrt{a+b} = \sqrt{a} + \sqrt{b}$

II. $\left(\frac{1}{a} + \frac{1}{b}\right)^{-1} = a + b$

III. $a^2 b^3 = (ab)^6$

A. I only

B. II only

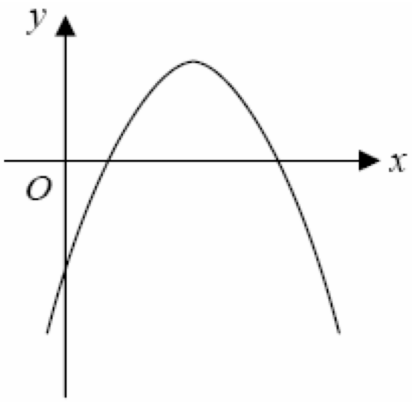
C. III only

D. I and II only

E. None of them

(1)

(e)



The graph of $y = ax^2 + bx + c$ is given as shown.

Which of the following is/are true?

I. $a < 0$

II. $b < 0$

III. $c < 0$

A. I only

B. I and II only

C. I and III only

D. II and III only

E. I, II and III only

(1)

(Total for Question 1 is 5 marks)

2. June 2018 - Paper 1 AQA (A) Maths AS-level Q15

A cyclist, Ms Fahmida, is travelling in a straight line on a horizontal road at a constant speed of 25 kmh^{-1}.

A second cyclist, Mr Chan, is riding closely and directly behind Ms Fahmida. He is also moving with a constant speed of 25 kmh^{-1}.

(a) Explain why the driving force applied by Mr Chan is likely to be less than the driving force applied by Ms Fahmida.

(1)

Mr Chan has a problem and stops, but Ms Fahmida continues at the same constant speed.

Ms Fahmida sees an accident 40 m ahead, so she stops pedalling and applies the brakes.

She experiences a total resistance force of 40 N.

Ms Fahmida and her cycle have a combined mass of 64 kg.

(b) Determine whether Ms Fahmida stops before reaching the accident.
Fully justify your answer.

(4)

(c) State one assumption you have made that could affect your answer to part (b).

(1)

Question 2 continued

(Total for Question 2 is 6 marks)

3. June 2018 - Paper 1 OCR (MEI) Maths AS-level Q8

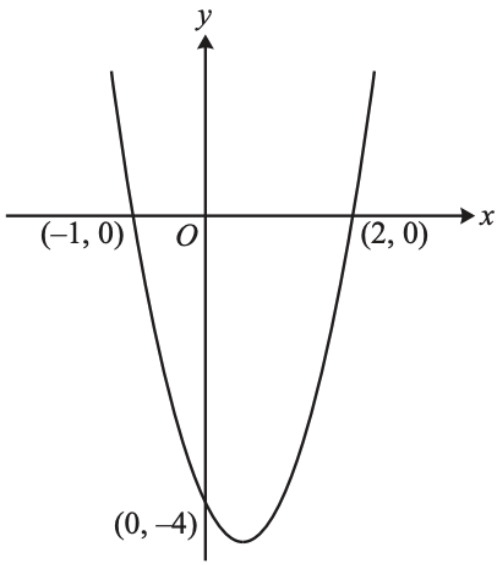


Figure 1

Figure 1 shows the graph of a quadratic function. The graph crosses the axes at the points $(-1, 0)$, $(0, -4)$ and $(2, 0)$.

Find the area of the finite region bounded by the curve and the x-axis.

(8)

Question 3 continued

(Total for Question 3 is 8 marks)

4. June 2018 - Paper 1 OCR (MEI) Maths AS-level Q9

The curve $y = (x-1)^2$ maps onto the curve C_1 following a stretch of scale factor $\frac{1}{2}$ in the x-direction.

(a) Show that the equation of C_1 can be written as $y = 4x^2 - 4x + 1$.

(2)

The curve C_2 is a translation of $y = \frac{17}{4}x - x^2$ by $\begin{pmatrix} 0 \\ -3 \end{pmatrix}$.

(b) Show that the normal to the curve C_1 at the point $(0, 1)$ is a tangent to the curve C_2.

(7)

Question 4 continued

(Total for Question 4 is 9 marks)

5. (a) Find the binomial expansion of

$$(2 + kx)^4$$

(3)

It is given that

$$(1 - 2x)^2(2 + kx)^4 \equiv A + Bx - 104x^2 + \ldots$$

where k, A and B are non zero constants.

(b) Determine the two possible values of B.

(5)

Question 5 continued

(Total for Question 5 is 8 marks)

6. The lines $y = \frac{1}{2}x$ and $y = -\frac{1}{2}x$ are tangents to a circle at $(2, 1)$ and $(-2, 1)$ respectively.

Find the equation of the circle in the form $x^2 + y^2 + ax + by + c = 0$, where a, b and c are constants.

(6)

Question 6 continued

(Total for Question 6 is 6 marks)

7. June 2020 - Paper 1 AQA Maths AS-level Q16

A simple lifting mechanism comprises a light inextensible wire which is passed over a smooth fixed pulley.

One end of the wire is attached to a rigid triangular container of mass 2 kg, which rests on horizontal ground.

A load of m kg is placed in the container. The other end of the wire is attached to a particle of mass 5 kg, which hangs vertically downwards.

The mechanism is initially held at rest as shown in Figure 2 below.

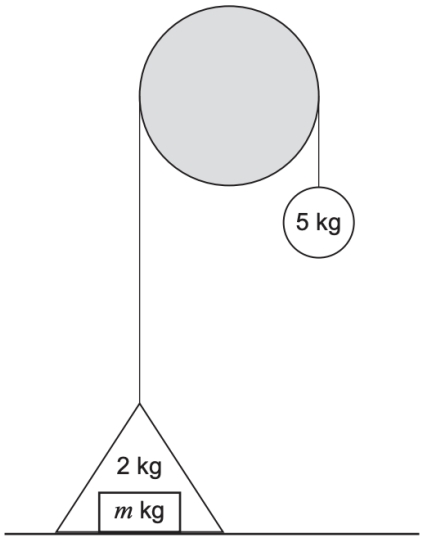


Figure 2

The mechanism is released from rest, and the container begins to move **upwards** with acceleration a ms^{-2}.

The wire remains taut throughout the motion.

(a) Show that

$$a = \left(\frac{3-m}{m+7}\right)g$$

(4)

(b) State the range of possible values of m.

(1)

The load reaches a height of 2 metres above the ground 1 second after it is released.
In this part use g = 9.8 ms^{-2}

(c) Find the mass of the load.

(4)

Question 7 continued

(Total for Question 7 is 9 marks)

8. June 2020 - Paper 1 OCR (A) Maths AS-level Q7

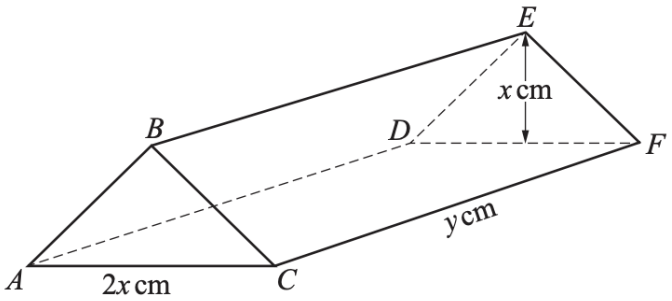


Figure 3

Figure 3 shows a model for the roof of a building.

The roof is in the form of a solid triangular prism $ABCDEF$. The base $ACFD$ of the roof is a horizontal rectangle, and the cross-section ABC of the roof is an isosceles triangle with $AB = BC$.

The lengths of AC and CF are $2x$ cm and y cm respectively, and the height of BE above the base of the roof is x cm.

The total surface area of the **five** faces of the roof is 600 cm^2 and the volume of the roof is V cm^3.

(a) Show that $V = kx(300 - x^2)$, where $k = \sqrt{a} + b$, where a and b are integers to be determined.

(6)

(b) Use differentiation to determine the value of x for which the volume of the roof is a maximum.

(4)

(c) Find the maximum volume of the roof.
Give your answer in cm^3, correct to the nearest integer.

(1)

(d) Explain why, for this roof, x must be less than a certain value, which you should state.

(2)

Question 8 continued

(Total for Question 8 is 13 marks)

9. June 2019 - Paper 1 OCR (MEI) Maths AS-level Q10

In this question you must show all stages of your working.
Solutions relying on calculator technology are not acceptable.

(a) Sketch the gradient function for the curve $y = 24x - 3x^2 - x^3$.

(5)

(b) Determine the set of values of x for which the curve $y = 24x - 3x^2 - x^3$ is decreasing.

(2)

Question 9 continued

(Total for Question 9 is 7 marks)

10. Q07 Edexcel International AS-Levels Mechanics WME01/01, Jan 2017

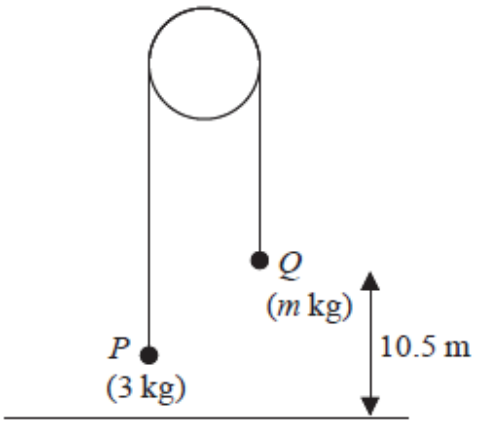


Figure 4

Two particles P and Q have masses 3 kg and m kg respectively ($m > 3$).

The particles are connected by a light inextensible string which passes over a smooth light fixed pulley.

The system is held at rest with the string taut and the hanging parts of the string vertical.

The particle Q is at a height of 10.5 m above the horizontal ground, as shown in Figure 4.

The system is released from rest and Q moves downwards.

In the subsequent motion P does not reach the pulley.

After the system is released, the tension in the string is 33.6 N.

(a) Show that the magnitude of the acceleration of P is 1.4 ms^{-2}.

(3)

(b) Find the value of m.

(3)

The system is released from rest at time $t = 0$.

At time T_1 seconds after release, Q strikes the ground and does not rebound.

The string goes slack and P continues to move upward.

(c) Find the value of T_1

(3)

At time T_2 seconds after release, P comes to instantaneous rest.

(d) Find the value of T_2

(3)

At time T_3 seconds after release ($T_3 > T_1$) the string becomes taut again.

(e) Sketch a velocity-time graph for the motion of P in the interval $0 \leq t \leq T_3$

(2)

Question 10 continued

Question 10 continued

Question 10 continued

Question 10 continued

(Total for Question 10 is 14 marks)

Total for paper is 85 marks

Year 12 FM October Pre Half Term Review
Mr Chan and Ms Fahmida's Math-magicians
Pure and Mechanics
Marking Schemes

November 3, 2023

Question 1

(a) $(1, -3)$

(b) "Zakiyyah and Andrew are both right."

(c) A. II only

(d) E. None of them

(e) C. I and III only

Question 2

Q	Marking Instructions	AO	Marks	Typical Solution
15(a)	States that the resistance is less for the second rider so the force required for equilibrium is also less, or mention of slipstreaming OE	AO2.4	E1	Jason experiences less air resistance than Laura.
15(b)(i)	Models situation by using given mass and total resistance force to form equation of motion PI	AO3.3	M1	As $F = ma$ then a = - 0.625 m s^{-2}
	Uses appropriate suvat formula. May include $u = 25$.	AO3.4	M1	u = 25 km/h = 6.944 m s^{-1} v = 0; use $v^2 = u^2 + 2as$ so that $0 = 6.944^2 + 2 \times (-0.625) \times s$
	States correct value for s (AWFW 38.5 to 38.6) **Or** maximum $u = 7.07$ m s^{-1} or 25.5 km/h (AWRT) **Or** a needs to be < -0.603 (AWRT) **Or** Resistance needs to be >38.5 N (AWFW 38.4 to 38.6) **Or** v^2 is -1.8 (AWRT) when $s = 40$	AO1.1b	A1	s = 38.6 m
	Makes appropriate comparison to conclude that Laura stops in time. Not necessary to see 38.6 < 40, but comparison for other variables must be clear.	AO3.2a	E1	So Laura stops before reaching the accident
15(b)(ii)	States an assumption that, if incorrect, would **contradict** the conclusion in **(i).** (eg reaction time, diminishing resistive force as speed drops OE)	AO3.5a	E1F	Taking account of reaction time would mean she travelled a distance before starting to brake.
	Total		**6**	

Question 3

Question			Answer	Marks	AOs		Guidance
8			EITHER			**DR**	
			Equation of the form $y = k(x+1)(x-2)$	**M1**	**1.1a**	Allow with $k = 1$ and without $y =$	Ignore = 0 if seen
			$(0, -4)$ on curve so $k = 2$	**M1**	**3.1a**	Attempt to find $k \neq 1$	
				A1	**1.1b**	All correct	
			OR				
			Equation of the form $y = ax^2 + bx + c$				
			$(0, -4)$ on curve $c = -4$	**(M1)**		Uses one point to form an equation	Allow for $c = -4$ seen
			$(-1, 0)$ on the curve $0 = a - b - 4$ $(2, 0)$ on the curve $0 = 4a - 2b - 4$	**(M1)**		Uses both other points and attempts to solve simultaneous equations	
			Solving simultaneous equations $a = 2,\ b = -2$	**(A1)**		All correct	
			BOTH				
			Area $= \int_{-1}^{2}(2x^2 - 2x - 4)\,dx$				
			$\left[\frac{2x^3}{3} - x^2 - 4x\right]_{-1}^{2}$	**M1** **A1**	**1.1a** **1.1b**	Integration – allow without limits – condone one error FT their quadratic	
			$\left(\frac{2\times 2^3}{3} - 2^2 - 4\times 2\right) - \left(\frac{2\times(-1)^3}{3} - (-1)^2 - 4\times(-1)\right)$	**M1**	**1.1a**	Substitution of limits clearly seen Complete argument leading to exact answer.	
			$= -\frac{20}{3} - \frac{7}{3} = -9$	**A1**	**2.1**	Allow for 9 if there is an argument to explain the change of sign even if -9 not seen.	
			Area is 9 below the x-axis.	**E1** **[8]**	**2.4**	Must give modulus and explain the change of sign. FT if their definite integral is negative.	"Area must be positive" is not sufficient explanation.

Question 4

Question			Answer	Marks	AOs		Guidance
9	(i)		Using $y=f\left(\frac{x}{a}\right)$ $y=\left(\frac{x}{\frac{1}{2}}-1\right)^2=(2x-1)^2$ $=4x^2-4x+1$	M1 A1 [2]	1.1a 2.1	Allow for 2 instead of ½ used for method mark or attempt to write equation of quadratic that touches axis at (0.5, 0) **AG** Must be a convincing argument that references either stretch or $f(2x)$ or similar	$(2x-1)^2$ seen is sufficient for M1
	(ii)		EITHER C_2 is $y=4.25x-x^2-3$	B1	3.1a	Finding the equation of C_2. Any form	
			Normal to $y=4x^2-4x+1$ $\frac{dy}{dx}=8x-4$	M1	1.1a	Finding the derivative	
			At (0.1) $\frac{dy}{dx}=-4$ Gradient of normal is $\frac{1}{4}$	M1	1.1b	Finding negative reciprocal of their gradient	
			(0, 1) on line so equation of normal is $y=\frac{1}{4}x+1$	A1	1.1a	FT their value for derivative	
			Intersection of normal and C_2 $\frac{1}{4}x+1=4.25x-x^2-3$	M1	3.1a	Attempt to solve simultaneous equations	
			$4x^2-16x+16=0$ EITHER $(x-2)^2=0$	A1	1.1b	Repeated factor or root, or zero discriminant seen.	
			OR discriminant $16^2-4\times4\times16=0$ Repeated root so the normal is a tangent to C_2	E1 [7]	3.2a	Must interpret their solution in the context.	

Question			Answer	Marks	AOs		Guidance
			OR C_2 is $y=4.25x-x^2-3$	B1		Finding the equation of C_2. Any form	
			Normal to $y=4x^2-4x+1$ $\frac{dy}{dx}=8x-4$	M1		Finding the derivative	
			At (0.1) $\frac{dy}{dx}=-4$ Gradient of normal is $\frac{1}{4}$	M1		Finding negative reciprocal of their gradient	
			Equation of normal is $y=\frac{1}{4}x+1$	A1		FT their value for derivative	
			Point on C_1 where gradient is $\frac{1}{4}$ $\frac{dy}{dx}=4.25-2x=\frac{1}{4}$	M1		Attempting to find the point on C_1 where tangent parallel to the normal found.	
			giving $x=2$ $y=1.5$	A1		Both coordinates required	
			EITHER So the equation of the tangent is $y-\frac{3}{2}=\frac{1}{4}(x-2)$ Which is the same equation as the normal to C_1	E1		Correct equation for the tangent in form that makes it clear it is the same line as the normal.	
			OR show that point (2, 1.5) lies on normal So the normal to C_1 is a tangent to C_2	(E1) [7]			

Question 4 - Special Case

Question			Answer	Marks	AOs		Guidance
			SPECIAL CASE when the candidate tries to show that the normal to C_2 is a tangent to C_1 C_2 is $y = 4.25x - x^2 - 3$	**B1**		Finding the equation of C_2. Any form	
			Normal to $y = 4.25x - x^2 - 3$ $\frac{dy}{dx} = 4.25 - 2x$ At (0, 1) $\frac{dy}{dx} = 4.25$	**M1**		Finding the derivative	
			Gradient of normal is $-\frac{4}{17}$	**A1**		Finding negative reciprocal of their gradient	
			Equation of normal is $y = -\frac{4}{17}x + 1$	**A0**			(0, 1) does not lie on C_2
			EITHER point of intersection with C_1 $4x^2 - 4x + 1 = -\frac{4}{17}x + 1$	**M1**		Attempt to solve simultaneous equations	
			OR Attempt to find both coordinates of the point on C_1 with gradient $-\frac{4}{17}$ $\frac{dy}{dx} = 8x - 4 = -\frac{4}{17}$	**(M1)**		Attempting to find the point on C_1 where tangent parallel to the normal found. **No further marks are available** **4/7 maximum**	

Question 5

PROCEED AS FOLLOWS

$$(1-2x)^2(2+kx)^4 \equiv A + Bx - 104x^2 + \dots$$

$$(1-4x+4x^2)\left[\binom{4}{0}2^4(kx)^0 + \binom{4}{1}2^3(kx)^1 + \binom{4}{2}2^2(kx)^2 + \dots\right] \equiv A + Bx - 104x^2$$

$$(1-4x+4x^2)(16 + 32kx + 24k^2x^2 + \dots) \equiv A + Bx - 104x^2 + \dots$$

MULTIPLY OUT UP TO x^2

$$\left.\begin{aligned} &16 + 32kx + 24k^2x^2 + \dots \\ &-64x - 128kx^2 + \dots \\ &\qquad 64x^2 + \dots \end{aligned}\right\} \equiv A + Bx - 104x^2 + \dots$$

$$16 + (32k-64)x + (24k^2-128k+64)x^2 \equiv A + Bx - 104x^2 + \dots$$

$\therefore A = 16$ (NOT NEEDED)

$$\Rightarrow 24k^2 - 128k + 64 = -104$$
$$\Rightarrow 24k^2 - 128k + 168 = 0$$
$$\Rightarrow 3k^2 - 16k + 21 = 0$$
$$\Rightarrow (3k-7)(k-3) = 0$$

$$k = \begin{cases} 3 \\ 7/3 \end{cases}$$

$$32k - 64 = B$$

$$B = \begin{cases} 32\times 3 - 64 = 32 \\ 32\times\frac{7}{3} - 64 = \frac{32}{3} \end{cases}$$

Question 6

Question			Answer	Mks	AO	Guidance	
8			**DR** $y - 1 = -2(x - 2)$ | or $y = -2x + c$ & sub (2, 1) $y = -2x + 5$ | $c = 5$ Centre is (0, 5) $r = \sqrt{2^2 + 4^2}$ $= \sqrt{20}$ $x^2 + (y - 5)^2 = 20$ oe $x^2 + y^2 - 10y + 5 = 0$	**M1** **A1** **A1** **M1** **M1** **A1** **[6]**	**3.1a** **1.1** **3.2a** **1.1a** **1.2** **1.1**	**If no wking seen, no marks** or $y - 1 = 2(x - (-2))$ or solve $y = -2x + 5$ & $y = 2x + 5$ $y = 2x + 5$ or $c = 5$ stated or implied or $r^2 = 2^2 + 4^2$ or ft their centre $= 20$ or $a = 0$, $b = -10$, $c = 5$ ft their centre and rad^2 ($\neq 0$), however found cao	Alt method using proportion: Centre is on y-axis, not (0, 1) (may be implied) M1 $\frac{c-1}{2} = 2$ or $c = 1 + 2 \times 2$ $c = 5$ A1 Centre is (0, 5) A1

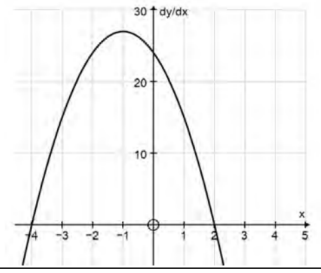
Question 7

Q	Marking Instructions	AO	Marks	Typical Solution
16(a)	Models the motion of the container and load with at least one side of the equation correct.	3.3	M1	$T-(m+2)g=(m+2)a$
	Forms fully correct equation	1.1b	A1	
	Forms fully correct equation for particle	3.3	B1	$5g-T=5a$
	Completes a rigorous argument by eliminating T and rearranging to express a in terms of m. AG	2.1	R1	$5g-(m+2)g=(5+2+m)a$ $(3-m)g=(7+m)a$ $\therefore a=\left(\frac{3-m}{m+7}\right)g$
	Subtotal		**4**	
16(b)	Deduces correct limits Condone $0\leq m<3$	2.2a	B1	$0<m<3$
	Subtotal		**1**	
16(c)	Uses appropriate constant acceleration equation to find the acceleration	3.4	M1	$s=ut+\frac{1}{2}at^2$
	Calculates correct value for a	1.1b	A1	Using $s=2, u=0$ and $t=1$ $a=4$
	Forms equation for a in terms of m using their a value	3.4	M1	$4=\left(\frac{3-m}{m+7}\right)g$
	Solves to find m. AWRT 0.10 Condone 0.1	3.2a	A1	$m=\frac{3g-28}{4+g}=0.10$ kg
	Subtotal		**4**	
16(d)	Describes any valid assumption not related to those assumptions already stated in the question. Eg The particle is at least 2m above the ground Eg The particle does not collide with the load	3.5b	E1	I assumed that the top of the container does not reach the pulley
	Subtotal		**1**	
	Question Total		**10**	

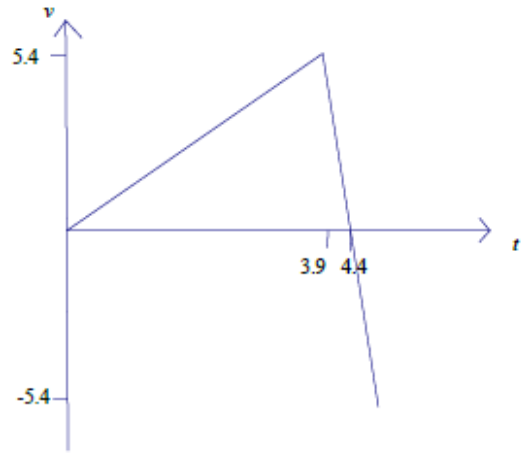
Question 8

Question			Answer	Marks	AO	Guidance	
7	(a)		$(V=)\frac{1}{2}x(2x)y=x^2y$	**B1**	**1.1**	Correct simplified expression for the volume	
			Slant height of the roof is $x\sqrt{2}$	**B1**	**3.1a**	Allow $\sqrt{2x^2}$	
			$(S=)2xy+2\left(\frac{1}{2}(2x)x\right)+2\left(yx\sqrt{2}\right)$	**M1***	**2.1**	Attempt at surface area with at least three of the five faces correct – can be unsimplified	
			$y=\frac{600-2x^2}{2x\left(1+\sqrt{2}\right)}\Rightarrow V=x^2\left(\frac{300-x^2}{x\left(1+\sqrt{2}\right)}\right)$	**M1dep***	**3.3**	Rearranges and makes y the subject and substitutes to give an expression for V in terms of x only	
			$V=x(300-x^2)\left(\frac{\left(1-\sqrt{2}\right)}{(1+\sqrt{2})(1-\sqrt{2})}\right)$	**M1**	**1.1**	Rationalises the denominator correctly	
			$V=x(300-x^2)\left(\frac{1-\sqrt{2}}{1-2}\right)=\left(\sqrt{2}-1\right)x(300-x^2)$	**A1**	**2.2a**	$a=2,\ b=-1$	
				[6]			
7	(b)		$\frac{dV}{dx}=k(300-3x^2)$	**M1***	**1.1**	**M1** for attempt at differentiation – both powers reduced by 1	Allow full marks ft their values of a and b
				A1	**1.1**		
			$(k)(300-3x^2)=0\Rightarrow x=...$	**M1dep***	**1.1**	Sets $\frac{dV}{dx}=0$ and attempts to find x	
			$x=10$ cm	**A1**	**1.1**		
				[4]			
7	(c)		$V=828\text{cm}^3$	**B1**	**3.4**	cao	828.4271247…
				[1]			
7	(d)		V (or y) must be positive or $300-x^2>0$	**M1**	**3.5b**	Explanation for constraint on x	
			so x cannot exceed $\sqrt{300}$ cm	**A1**	**1.1**	Correct value; accept e.g. 17.3 or better	
				[2]			

Question 9

10	(a)		**DR** $\frac{dy}{dx} = 24 - 6x - 3x^2$ When $x = 0$, $\frac{dy}{dx} = 24$ When $\frac{dy}{dx} = 0$, $-3(x^2 + 2x - 8) = 0 \Rightarrow (x+4)(x-2) = 0$ $x = -4,\ 2$  	**M1** **A1** **M1** **A1** **B1** **[5]**	**1.1a** **1.1** **1.1a** **3.1a** **1.1**	Expression for derivative seen May be shown on graph or in the working Method for solving their quadratic equation (allow any algebraic method) Must be seen on graph Correct shape. Maximum point should be to the left of the y-axis but need not be exact.	
10	(b)		**DR** Decreasing function when $\frac{dy}{dx} < 0$ $\{x : x < -4\} \cup \{x : x > 2\}$	**M1** **A1** **[2]**	**1.1a** **2.5**	Attempt to give the values of x for which $\frac{dy}{dx} < 0$ from their graph FT their graph if quadratic Condone use of $\leq$ for M mark Allow for "$x < -4$ or $x > 2$" Must be correct use of language or set notation here.	Do not allow A1 for $x < -4,\ x > 2$ $x < -4$ **and** $x > 2$ $-4 > x > 2$

Question 10

Question Number	Scheme	Marks
a	Motion of P: $T-3g=3a$	M1
	$33.6-3g=3a$	A1
	$a=1.4\,(\text{m s}^{-2})$ ***Given Answer***	A1
		(3)
b	Motion of Q: $mg-T=ma$	M1
	$mg-33.6=1.4m$	A1
	$m=4$	A1
		(3)
c	Use of $s=(ut+)\frac{1}{2}at^2$: $10.5=\frac{1}{2}\times1.4\times t^2$	M1A1
	$T_1=\sqrt{15}=3.9$ or better	A1
		(3)
d	Use $v^2=(u^2+)2as$ to find speed of particles when Q hits ground: $v=\sqrt{2\times1.4\times10.5}\ (=\sqrt{29.4})$	M1
	Use $v=u+at$ to find additional time for P to come to rest: $0=\sqrt{29.4}-gt$	**DM1**
	Total time : $T_2=\sqrt{15}+\frac{\sqrt{29.4}}{9.8}=4.4$ or 4.43	A1
		(3)
e		B1 Shape **DB1 ft** their values for 5.4, -5.4, 3.9, 4.4 (or T_1 T_2) (2)
		[14]

Question 10 - Notes

Question Number	Scheme	Marks
	Notes	
a	M1 for equation of motion for P with T not substituted, condone sign errors First A1 for a correct equation in a only (allow $\pm a$) Second A1 for **given answer** (units not needed)	
b	M1 for equation of motion for Q with neither T nor a substituted, condone sign errors First A1 for a correct equation in m only Second A1 for $m = 4$ **N.B.** Whole system equn: $mg - 3g = a(m + 3)$ may be used	
c	M1 for a complete method to find T_1 (M0 if g used) First A1 for a correct equation (or equations) Second A1 for $\sqrt{15}$, 3.9 or better $v = \sqrt{29.4}$ (5.4) may be found in this part but only gets credit if it appears in part (d)	
d	First M1 for a complete method to find the speed of particles when Q hits the ground (M0 if using g) Second M1 **dependent** on first M1 for a complete method to find the additional time for P to come to rest (must be using g) A1 for 4.4 or 4.43	
e	First B1 (generous) for shape. Graph does not need to go down as far as it goes up and ignore gradients. (B0 if it goes outside the range $0 \leq t \leq T_3$ or if a continuous vertical line is included) Second B1, **dependent** on first B1, **ft** on their $\sqrt{29.4}$, T_1 and T_2 Allow T_1 and T_2 entered on the graph (rather than their numerical values)	