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Mark Scheme (Results)

January 2014

Pearson Edexcel International GCSE
Further Pure Mathematics (4PM0/01)
Paper 1

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- 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 may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.
- **Types of mark**
    - M marks: method marks
    - A marks: accuracy marks. Can only be awarded if the relevant method mark(s) has (have) been gained.
    - B marks: unconditional accuracy marks (independent of M marks)
- **Abbreviations**
    - cao – correct answer only
    - ft – follow through
    - isw – ignore subsequent working
    - SC - special case
    - oe – or equivalent (and appropriate)
    - dep – dependent
    - indep – independent
    - eeoo – each error or omission
- **No working**

  If no working is shown then correct answers may score full marks.

  If no working is shown then incorrect (even though nearly correct) answers score no marks.

- **With working**

  If there is a wrong answer indicated always check the working and award any marks appropriate from the mark scheme.

  If it is clear from the working that the “correct” answer has been obtained from incorrect working, award 0 marks.

  Any case of suspected misread which does not significantly simplify the question loses two A (or B) marks on that question, but can gain all the M marks. Mark all work on follow through but enter A0 (or B0) for the first two A or B marks gained.

  If working is crossed out and still legible, then it should be given any appropriate marks, as long as it has not been replaced by alternative work.

  If there are multiple attempts shown, then all attempts should be marked and the highest score on a single attempt should be awarded.

- **Follow through marks**

  Follow through marks which involve a single stage calculation can be awarded without working since you can check the answer yourself, but if ambiguous do not award.

  Follow through marks which involve more than one stage of calculation can only be awarded on sight of the relevant working, even if it appears obvious that there is only one way you could get the answer given.

- **Ignoring subsequent work**

  It is appropriate to ignore subsequent work when the additional work does not change the answer in a way that is inappropriate for the question: eg. incorrect cancelling of a fraction that would otherwise be correct.

  It is not appropriate to ignore subsequent work when the additional work essentially shows that the candidate did not understand the demand of the question.

- **Linear equations**

  Full marks can be gained if the solution alone is given, or otherwise unambiguously indicated in working (without contradiction elsewhere). Where the correct solution only is shown substituted, but not identified as the solution, the accuracy mark is lost but any method marks can be awarded.

- **Parts of questions**

  Unless allowed by the mark scheme, the marks allocated to one part of the question CANNOT be awarded in another

General Principles for Further Pure Mathematics Marking

(but note that specific mark schemes may sometimes override these general principles)

Method mark for solving a 3 term quadratic equation:

1. Factorisation:

$$(x^2 + bx + c) = (x + p)(x + q) \text{ where } |pq| = |c|$$

$$(ax^2 + bx + c) = (mx + p)(nx + q) \text{ where } |pq| = |c| \text{ and } |mn| = |a|$$

2. Formula:

Attempt to use the **correct** formula (shown explicitly or implied by working) with values for a, b and c, leading to

3. Completing the square:

$$\text{Solving } x^2 + bx + c = (x \pm \frac{b}{2})^2 \pm q \pm c \text{ where } q \neq 0$$

Method marks for differentiation and integration:

1. Differentiation

Power of at least one term decreased by 1. $S_{25} - S_{24}$

2. Integration:

Power of at least one term increased by 1.

Use of a formula:

Generally, the method mark is gained by

either quoting a correct formula and attempting to use it, even if there are mistakes in the substitution of values

or, where the formula is not quoted, the method mark can be gained by implication

from the substitution of correct values and then proceeding to a solution.

Answers without working:

The rubric states "Without sufficient working, correct answers may be awarded no marks".

General policy is that if it could be done "in your head" detailed working would not be required. (Mark schemes may override this eg in a case of "prove or show...."

Exact answers:

When a question demands an exact answer, all the working must also be exact. Once a candidate loses exactness by resorting to decimals the exactness cannot be regained.

Rounding answers (where accuracy is specified in the question)

Penalise only once per question for failing to round as instructed - ie giving more digits in the answers. Answers with fewer digits are automatically incorrect, but the isw rule may allow the mark to be awarded before the final answer is given.

Question Number	Answer	Notes	Marks
1	$\sum_{r=4}^{40}(7r-2)=\frac{37}{2}(26+278)$ $=5624$	B1 M1A1 A1	**(4)**

Notes

Method 1

B1 for $n=37$

M1 attempts to use their a and d in either $S_n=\frac{n}{2}(2a+(n-1)d)$,

or a and l in $S_n=\frac{n}{2}(\mathrm{a}+l)$ with their n, where n = 36 or 37 only

A1 for a fully correct expression for S_n

A1 for 5624 cso.

Method 2

B1 correct limits of r in $\sum_{r=1}^{40}(7r-2)-\sum_{r=1}^{3}(7r-2)$

M1 attempts to use their a and d in either $S_n=\frac{n}{2}(2a+(n-1)d)$,

or a and l in $S_n=\frac{n}{2}(\mathrm{a}+l)$ where the upper limit for n is n = 40 and 4 or 3 respectively only, **AND** subtracts the two summations.

A1 for a fully correct expression for S_n

A1 for 5624 cso.

***S* = 5624 seen with no working or a list achieves full marks**

Question Number	Answer	Notes	Marks
2	(a)		
	$2x^2-8x+5=$		
	$=2\left(\left(x-2\right)^2-2^2\right)+5$ | $a\left(x-b\right)^2+c=ax^2-2ab+ab^2+c$	M1	
	$=2\left(x-2\right)^2-3$ | $a=2,\ \ b=2,\ \ c=-3$	A2,1,0	
	(b) (i) min $=-3$, (ii) $x=2$	B1, B1	**(5)**

Notes

Method 1

(a)

M1 for taking out a factor of 2 and completing the square.

A1 for two correct of *a*, *b*, or *c*. Accept embedded values in $2\left(x-2\right)^2-3$

A1 for fully correct *a*, *b*, or *c*, or $2\left(x-2\right)^2-3$.

(b)

B1ft for (i) a value of -3 follow through their value of *c*

B1ft for (ii) a value of 2. Follow through their value of *b*.

Do not accept a value of 2 for (i) or -3 for (ii).

If part (b) is completed by differentiation, then it must be fully correct for B marks to be awarded.

Method 2

(a)

M1 for an attempt at expanding $a\left(x-b\right)^2+c$ to give $ax^2-2ab+ab^2+c$ AND setting the expanded expression equal to $2x^2-8x+5$.

A1 for two correct of *a*, *b*, or *c*. Accept embedded values in $2\left(x-2\right)^2-3$

A1 for fully correct *a*, *b*, or *c*, or $2\left(x-2\right)^2-3$.

(b)

As in Method 1

Question Number	Answer	Notes	Marks
3	(a) $y = e^{3x}(5x-7)^2$ $\frac{dy}{dx} = 3e^{3x}(5x-7)^2 + 10e^{3x}(5x-7)$ (b) $y = \frac{\cos 2x}{x+9}$ $\frac{dy}{dx} = \frac{-2\sin 2x(x+9) - \cos 2x}{(x+9)^2}$	M1A1 A1 M1A1 A1	**(6)**

Notes

(a)

M1 for an attempt at product rule. There must be two terms added.

A1ft for one term correct

A1 for both terms correct, ignore any further simplification

Allow e^{3x} as the derivative for e^{3x} for the method mark

(b)

M1 for an attempt at quotient rule. The denominator must be squared. There must be two terms in the numerator irrespective of order and signs.

A1 for one term correct in the numerator

A1 for a fully correct differentiated expression, ignore any further simplification.

If candidates use $(x+9)^{-1}\cos 2x$ as an alternative to quotient rule please mark as in (a) given a correct $(x+9)^{-2}$

Question Number	Answer	Notes	Marks
4	(a) $2\times 4=8$ (b) $S_2=2a+d=4\times 5$ $d=4$ (c) 25th term $=a+24d=8+24\times 4=104$	B1 M1A1 A1 M1A1	**(6)**

Notes

(a)

B1 for 8 seen

(b)

Alt 1

M1 for $S_2=2a+d$ or $S_2=2\times 8+d$ or $2\times 8+d=2\times 2(2+3)$ oe seen with their a . This must be an attempt at a **complete method** to find *d*.

A1 for a fully correct method to find *d*.

A1 $d=4$

Alt 2

By comparing coefficients

$\{\frac{n}{2}(2a+(n-1)d)=2n(n+3)\Rightarrow 2a+dn-d=4n+12\Rightarrow 16-d+dn=12+4n\Rightarrow d=4\}$

M1 for setting $\frac{n}{2}(2a+(n-1)d)=2n(n+3)$

A1 for a correct expressions as far as substituting the correct value for *a* to give: $16-d+dn=12+4n$

A1 $d=4$

(c)

M1 attempts to use a correct $U_n=a+(n-1)d$ with $n=25$ only. Ft their *d* provided it is a numerical value. Or any other correct method eg., $S_{25}-S_{24}$ etc.

A1 $U_{25}=104$

Question Number	Answer	Notes	Marks
5	(a) $\log_7(2x-3)=2 \Rightarrow (2x-3)=7^2$ $2x=52 \quad x=26$ (b) (i) $2x(\ln 3x-2)-4(\ln 3x-2)$ $=(2x-4)(\ln 3x-2)$ or $2(x-2)(\ln 3x-2)$ or $(x-2)(2\ln 3x-4)$ (ii) $2x-4=0 \quad x=2$ $\ln 3x=2 \quad 3x=\text{e}^2, \quad x=\frac{1}{3}\text{e}^2$	 M1 A1 M1A1 B1 M1,A1	**(7)**

Notes

(a)

M1 for $(2x-3)=7^2$

A1 for $x=26$

(b)

(i)

M1 for an attempt at factorising any pair.

A1 for a fully correct factorisation seen. (alternatives above).

(ii)

B1 $x=2$

M1 for $\ln 3x=2 \Rightarrow 3x=e^2$

A1 for $x=\frac{e^2}{3}$

Question Number	**Answer**	**Notes**	**Marks**
6	(a) $7^2 = x^2 + (5x-6)^2 - 2x(5x-6)\cos 60$ $49 = x^2 + 25x^2 - 60x + 36 - 5x^2 + 6x$ $21x^2 - 54x - 13 = 0$ $x = \dfrac{54 \pm \sqrt{54^2 + 4\times 21\times 13}}{42}$, $x = 2.793...$ $x = 2.79$ (b) $\dfrac{\sin C}{2.79} = \dfrac{\sin 60}{7}$ $C = 20.2$ (using 2.793 also gives 20.2)	M1A1 A1 M1,A1 M1A1 A1	**(8)**

Notes

(a)

M1 for an attempt at substituting x, ($5x - 6$), 7 and cos 60 into a correct cosine rule. The correct formula must be seen if there are errors in substitution.

A1 a fully correct substitution

A1 for a correct 3TQ

M1 for an attempt to solve their 3TQ (usual rules) This is an independent M mark.

A1 for a correct value of $x = 2.79$ (2.793….)

Some candidates are using graphic calculators to solve this quadratic. M1 A1 for 2.79 only.

$x = 2.793$… without working gets M1A0, and then penalise further rounding errors in the usual way.

(b)

M1ft for an attempt to use Sine rule correctly (or any other acceptable trigonometry) to find angle BCA. Follow through their numerical value of x.

A1ft for a fully correct Sine rule. Follow through their value of x.

A1 $C = 20.2$ (*rounding subject to general principles*)

<table>
<tr><th>Question Number</th><th>Answer</th><th>Notes</th><th>Marks</th></tr>
<tr><td>7</td><td>(a)<table><tr><td>x</td><td>0.8</td><td>1</td><td>1.5</td><td>1.7</td><td>2</td><td>2.5</td><td>3</td><td>4</td></tr><tr><td>y</td><td>5.41</td><td>3</td><td>1.22</td><td>1.13</td><td>1.25</td><td>1.8</td><td>2.56</td><td>4.31</td></tr></table></td><td>B2</td><td></td></tr>
<tr><td></td><td>(b) Draw graph</td><td>B1 points
B1 curve</td><td></td></tr>
<tr><td></td><td>(c) $2x-4+\frac{5}{x^2}=2$
$x=1.2$ or 1.1 $(1.168...)$, 2.6 or 2.7 (2.642....)</td><td>M1
A1</td><td></td></tr>
<tr><td></td><td>(d) $2x-4+\frac{5}{x^2}=-2x+8$
Draw $y=-2x+8$
$x=2.8$ or 2.9 $(2.846...)$</td><td>M1A1
M1
A1</td><td>(10)</td></tr>
</table>

Notes

(a)

B2 for all four correct values, or

B1 for two or three correct values (allow y = 3.00 for x = 1)

(b)

B1ft for **their** points plotted correctly to within half of a square

B1ft All their points joined in a smooth curve drawn through their points within half a square accuracy. Do not accept sharp points or straight lines

(c)M1 for rearranging $2x+\frac{5}{x^2}=6$ to give $2x-4+\frac{5}{x^2}=2$ (or for line (or for line y = 2 seen on the graph)

A1 for x = 1.1 or 1.2 AND x = 2.6 or 2.7

(d)

M1 for attempting to rearrange $4x+\frac{5}{x^2}=12$ to give $2x-4+\frac{5}{x^2}=\ ax\pm b$

A1 for a fully correct equation $2x-4+\frac{5}{x^2}=-2x+8$

M1d for attempting to draw their $y=-2x+8$, provided it is in the form $y=ax\pm b$, where a or $b\neq 0$

{ $y=-2x+8$ goes through points (4,0) (3,2) (2,4) (1,6) (0,8)}

A1 for x = 2.8 or 2.9 (2.846…)

Question Number	Answer	Notes	Marks
8	(a) $4\sin x\cos\alpha + 4\cos x\sin\alpha = 7\sin x\cos\alpha - 7\cos x\sin\alpha$		
	$\tan A = \dfrac{\sin A}{\cos A}$	M1A1	
	$11\cos x\sin\alpha = 3\sin x\cos\alpha$	M1	
	$3\dfrac{\sin x}{\cos x} = 11\dfrac{\sin\alpha}{\cos\alpha}$ $11\tan\alpha = 3\tan x$	M1A1	
	(b) $3\tan 3y = 11\tan 45,\ = 11$	M1,A1	
	$\tan 3y = \dfrac{11}{3}$		
	$3y = 74.74,\ 254.74,\ 434.74,$	M1(any one)	
	$y = 24.9,\ 84.9,\ 144.9$	A1A1ft A1ft (intervals of 60)	**(11)**

Notes

(a)

M1 for a correct expansion of either $4\sin(x+\alpha)$ OR $7\sin(x-\alpha)$ AND set equal to each other

A1 for fully correct $4\sin x\cos\alpha + 4\cos x\sin\alpha = 7\sin x\cos\alpha - 7\cos x\sin\alpha$

M1ft for collecting like terms in **their** $\cos x\sin\alpha$ **and** $\cos\alpha\sin x$

M1d for using the identity $\tan A = \dfrac{\sin A}{\cos A}$ in their equation (dependant on both first M marks)

A1 for $11\tan\alpha = 3\tan x$ cso **Note this is a show question**. Sufficient working must be seen to award marks.

(b)

M1 for using the result in (a) only to give $3\tan 3y = 11\tan 45$. Or can start again from the original equation to give $3\tan 3y = 11\tan 45$.

A1 for using tan 45 = 1 to give $\tan 3y = \dfrac{11}{3}$ oe

M1ft for a correct method to find a solution for $3y$

A1 24.9 follow through their values of (74.74 + any multiple of 180) ÷3 for first A1 only
A1ft 84.9 their 24.9 + (a multiple of 60 within the range)
A1ft 144.9
(*rounding subject to general principles*)

For any extra values within the given range deduct one mark for each up to a maximum of 3 marks. Ignore extra values given outside of the range.

Question Number	Answer	Notes	Marks
9	(a) $s = t(t^2 - 6t + 5) = 0$ $= t(t-1)(t-5)$ $t = 0,\ 1,\ 5$	 M1 A2,1,0	
	(b) $v = 3t^2 - 12t + 5$ $t = 0 \quad v = 5$ $t = 1 \quad v = 3 - 12 + 5 = -4, \quad \text{Speed} = 4$ $t = 5 \quad v = 75 - 60 + 5 = 20$	 M1 A1 A1, A1 A1	
	(c) $\frac{dv}{dt} = 6t - 12 \quad (\text{or } \frac{d_2 s}{dt^2} = 6t - 12)$ Max/min $\frac{dv}{dt} = 0 \quad t = 2$ $t = 2 \quad v = 12 - 24 + 5 = -7$ from (b) $t = 5 \Rightarrow v = 20$ $\therefore$ max speed in interval is 20 m/s	 M1 A1 A1 A1ft	**(12)**

Notes

(a)

M1 for setting $s = 0$, taking t out as a common factor, and attempting to solve the quadratic $t^2 - 6t + 5$

A1 for a correct complete factorisation of s to give $t(t-1)(t-5) = 0$

A1 for $t = 0,1,5$

(b)

M1 for an attempt to differentiate $\frac{ds}{dt}$

A1 for a fully correct $v = 3t^2 - 12t + 5$

A1 for $v = 5$

A1 for $v = -4 \Rightarrow$ speed $= 4$

A1 for $v = 20$

Award 3 A marks for all three correct, 2 marks for two and 1 mark for only one correct speed. Order not important (One mark for each correct speed)

(c)

EITHER

M1 for differentiating their v wrt t to give $\frac{\mathrm{d}v}{\mathrm{d}t} = 6t - 12$ (or $\frac{\mathrm{d}_2 s}{\mathrm{d}t^2} = 6t - 12$)

A1 for setting their $\frac{\mathrm{d}v}{\mathrm{d}t} = 0$ for a max/min and solving $6t - 12 = 0$ so $t = 2$

A1 when $t = 2$ $v = -7$

A1ft therefore max speed in interval is 20 (ms^{-1}) or their '20' in part (a)

OR

M1 for an attempt at completing the square on $v = 3t^2 - 12t + 5$ (usual rules)

A1 for a fully correct expression for $v = 3(t-2)^2 - 7$

A1 for $v = -7$

A1ft therefore max speed in interval is 20 (ms^{-1}) or their '20' in part (a).

Question Number	Answer	Notes	Marks
10	(a)		
	$\alpha+\beta=-(k-3) \qquad \alpha\beta=4$	B1	
	$\alpha^2+\beta^2=(\alpha+\beta)^2-2\alpha\beta$	M1	
	$=(k-3)^2-8$	A1	
	(b) $\frac{1}{\alpha^2}+\frac{1}{\beta^2}=\frac{\alpha^2+\beta^2}{\alpha^2\beta^2}, \quad =\frac{7}{4}$	M1,A1	
	$\frac{1}{\alpha^2\beta^2}=\frac{1}{16}$	B1	
	Eqn: $x^2-\frac{28}{16}x+\frac{1}{16}\ (=0)$	M1	
	$16x^2-28x+1=0$	A1ft	
	(c)		
	$4(k^2-6k+1)=7\times16$	M1A1	
	$k^2-6k-27=0$		
	$(k-9)(k+3)=0$	M1d	
	$k=9 \ \ k=-3$	A1A1	
			(13)

Notes

(a)

B1 for BOTH $\alpha+\beta=-(k-3)$ oe, AND $\alpha\beta=4$

M1 for the correct algebra on $(\alpha+\beta)^2$ to give $\alpha^2+\beta^2=(\alpha+\beta)^2-2\alpha\beta$ oe

A1 for $\alpha^2+\beta^2=(k-3)^2-8$ or $\alpha^2+\beta^2=k^2-6k+1$
Simplification not required

(b)

M1 for an attempt at a sum of roots $\frac{1}{\alpha^2}+\frac{1}{\beta^2}=\frac{\alpha^2+\beta^2}{\alpha^2\beta^2}$

A1 for sum $=\frac{7}{4}$ oe

B1	for correct product $= \frac{1}{16}$
M1	for using $x^2 -$ their sum × x + their product (= 0 not required for this mark) The sum and product must be numerical values only.
A1ft	for $16x^2 - 28x + 1 = 0$ oe integer values (follow through their values for this mark) Note: = 0 must be seen, but simplification is not required for this mark.

(c)

M1	for using 4 × (their $\alpha^2 + \beta^2$) = 7 × their $\alpha^2\beta^2$
A1	for $k^2 - 6k - 27 = 0$
M1d	for attempting to solve their 3TQ (usual rules) this is dependant on first M mark being awarded
A1	for **either** $k = 9$ or $k = -3$
A1	for **both** $k = 9$ or $k = -3$

Question Number	**Answer**	**Notes**	**Marks**
11	(a)		
	Through $(p,8)$ $40=4\left(p^2+1\right)$	M1	
	$10=p^2+1$ $p=3$	A1	
	At P $(3,8)$ $40-72+q=0$	M1	
	$q=32$	A1	
	(b) $5\dfrac{\mathrm{d}y}{\mathrm{d}x}=8x$, $p=3$ $\dfrac{\mathrm{d}y}{\mathrm{d}x}=\dfrac{24}{5}$	M1,A1	
	grad normal $=-\dfrac{5}{24}$	A1ft	
	Eqn. normal: $y-8=-\dfrac{5}{24}(x-3)$	M1	
	$24y+5x=207$ o.e.	A1	
	(c)		
	normal meets x-axis at $\dfrac{207}{5}$ tangent meets x-axis at $\dfrac{32}{24}$ $\left(=\dfrac{4}{3}\right)$	M1	
	Area of $\Delta=\dfrac{1}{2}\left(\dfrac{207}{5}-\dfrac{4}{3}\right)\times 8=160\dfrac{4}{15}$	M1A1	
	(d)		
	Vol of curve $=\pi\int_0^3\left[\dfrac{4}{5}\left(x^2+1\right)\right]^2\mathrm{d}x$	M1	
	$=\dfrac{16}{25}\pi\int_0^3\left(x^4+2x^2+1\right)\mathrm{d}x=\dfrac{16}{25}\pi\left[\dfrac{x^5}{5}+\dfrac{2}{3}x^3+x\right]_0^3$	M1	
	$=\dfrac{16}{25}\pi\left[\dfrac{3^5}{5}+\dfrac{2}{3}\times 3^3+3\right]$	A1	
	Cone $=\dfrac{1}{3}\pi\times 8^2\left(3-\dfrac{4}{3}\right)$	B1	
	Reqd. vol $=\dfrac{16}{25}\pi\left[\dfrac{3^5}{5}+\dfrac{2}{3}\times 3^3+3\right]-\dfrac{1}{3}\pi\times 8^2\times\dfrac{5}{3}$, $=28$	M1,A1	
			(18)

Notes

(a)

(i)

M1 for substituting coordinates $\left(p,8\right)$ to get $40=4\left(p^2+1\right)$ (or $40=4\left(x^2+1\right)$)

A1 for solving $40=4\left(p^2+1\right)$ to give $p=3$ Note: this is a show question, all working must be seen.

(ii)

M1 for using (3 , 8) in line l to give $40-72+q=0$

A1 for q = 32

(b)

Either Method 1

M1 for an attempt at differentiating $5y=4(x^2+1)$ to give $5\frac{dy}{dx}=8x$ oe.

A1 for $\frac{24}{5}$ (accept $\frac{24}{5}$ embedded in the equation of the line provided it is used correctly later for the gradient of the normal = $-\frac{5}{24}$

A1ft for the gradient of the normal $-\frac{5}{24}$ or their negative inverted gradient of tangent.

M1 for an attempt at the equation of the normal using their gradient of the normal, which must be a numerical value, and which must be a changed value from the gradient of the tangent. The formula must be seen first if there are errors in substitution.
Or, as above for the gradient using a complete method for $y=mx+c$ to achieve a value for c.

A1 for $24y+5x=207$ oe.

Or Method 2

M1 for dividing through by 5 and extracting the gradient

A1 for $m=\frac{24}{5}$ (accept $\frac{24}{5}$ embedded in the equation of the line provided it is used correctly later for the gradient of the normal = $-\frac{5}{24}$

A1ft for the gradient of the normal $-\frac{5}{24}$ or their negative inverted gradient of tangent.

M1 for an attempt at the equation of the normal using their gradient of the normal, which must be a numerical value, and which must be a changed value from the gradient of the tangent. The formula must be seen first if there are errors.
Or, as above for the gradient using a complete method for $y=mx+c$ to achieve a value for c.

A1 for $24y+5x=207$ oe.

(c)

M1 for using their equations for line *l* and their normal to substitute $y = 0$ to find the intersections with the x axis at $\frac{32}{24}$ and $\frac{207}{5}$ respectively.

M1ft for using Area of $\Delta = \frac{1}{2}\left(\frac{207}{5} - \frac{4}{3}\right) \times 8 = 160\frac{4}{15}$ follow through their values, but the value of 8 for the height must be used.

A1 for area = $160\frac{4}{15}$ or $\frac{2404}{15}$ oe

(d)

M1 for the correct expression of the Volume of revolution of the given curve. Volume $= \int \pi y^2 \mathrm{d}x$. Limits must be seen (not necessarily correct) for this mark.

M1 for an attempt at squaring and integrating the given curve. Ignore missing π

A1 for a correct integration and attempt at evaluation, (simplification not required) of

$$= \frac{16}{25}\pi\left[\frac{3^5}{5} + \frac{2}{3} \times 3^3 + 3\right]$$ oe π may be missing.

(Volume of revolution of curve = $\frac{5568}{125}\pi$)

B1 for using a correct formula for the volume of a cone and values for x of $x = 3$ and their intersection of the tangent with the x axis, with a height of 8.

M1 for the required volume $= \frac{16}{25}\pi\left[\frac{3^5}{5} + \frac{2}{3} \times 3^3 + 3\right] - \frac{1}{3}\pi \times 8^2 \times \frac{5}{3}$

A1 for Volume = 28 (2sf) 28.23803103..

Alternative

M1 for the expression of the Volume of revolution of the region using the given equation in Volume $= \int_0^3 \pi\left[\frac{4}{5}(x^2 + 1)\right]^2 \mathrm{d}x - \int_{\frac{4}{3}}^{3} \pi\left[\frac{1}{5}(24x - 32)\right]^2 \mathrm{d}x$

Limits must be seen (not necessarily correct) for this mark, **although the limits for the curve and line must be different.** The correct expression for volume must be used. ie.,Volume of revolution $= \pi\int y^2 \mathrm{d}x$

M1 for an attempt at squaring and integrating the **given curve**. A combined expression for the curve and line gets M0 even if there is some correct integration. Ignore missing π

A1 for a fully correct integration of **either** the curve or the line.

$$\text{Vol} = \frac{16}{25}\pi\left[\frac{x^5}{5} + \frac{2}{3}x^3 + x\right]_0^3 - \frac{\pi}{25}\left[192x^3 - 768x^2 + 1024x\right]_{\frac{4}{3}}^{3}$$

B1 For a fully correct integration of the volume of revolution of **both** the curve and line.

M1d for substitution of x values (into integrated expressions) **of the curve and line separately** and an attempt at evaluation.
(Volume = $\frac{5568}{125}\pi - \frac{320}{9}\pi$)

A1 for Volume = 28 (2sf) 28.23803103..

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