(c)	Identifies that one of the gradients is $\sqrt{"4"}$ or that one of the gradients is $\frac{1}{\sqrt{"4"}}$ **or** Identifies that one of the gradients is 2 or that one of the gradients is $\frac{1}{2}$	B1ft
	At A: $y-"\frac{\pi}{4}"="2"x$ **and** At B: $y-"\frac{7\pi}{12}"="\frac{1}{2}"x$	M1
	$"2"x+"\frac{\pi}{4}"="\frac{1}{2}"x+"\frac{7\pi}{12}"\Rightarrow x=...$	**d**M1
	$x=\frac{2\pi}{9}$	A1
		(4)
		Total 11

Note that in this part the question says to use the answer to part (b) i.e. their $\frac{1}{p-qx^2}$

If they use their $\frac{1}{p-qx^2}$ then the ft is available as shown.

If candidates "start again" or e.g. use their $\frac{dx}{dy}$ or $\frac{dy}{dx}$ in terms of *y* with their *y* values from part (a) then the value(s) must be <u>correct</u>.

B1ft: Using the answer to part (b):

Award this mark for **one** gradient identified as $\sqrt{p}$ **or** $\frac{1}{\sqrt{p}}$ where p is their value from part (b).

or not using the answer to part (b):

One gradient identified as 2 **or** $\frac{1}{2}$

M1: Correct straight line method for the equation of the normal at *A* **and** the tangent at *B*.
They must have

- 2 values for *y* from part (a) (ignore how these were labelled)
- both gradients **positive**

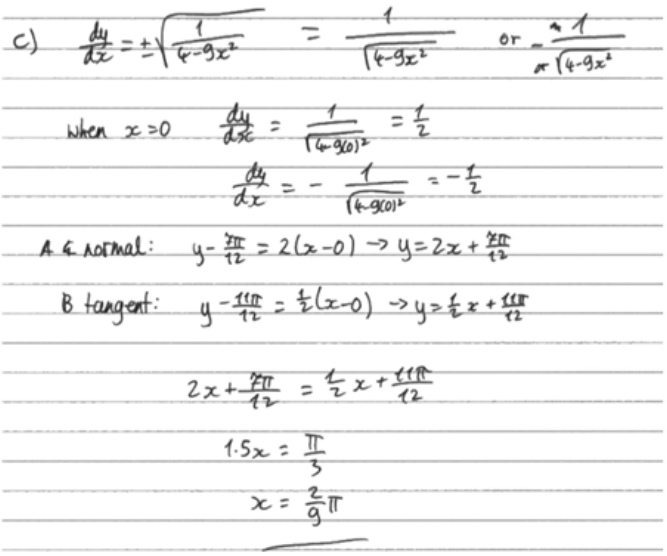
For the **normal at *A*** this requires a gradient of $\sqrt{p}$ or 2 with $x = 0$ and their smaller value of *y* from part (a)
If they use $y = mx + c$ they must proceed as far as $c = \ldots$

For the **tangent at *B*** this requires a gradient of $\frac{1}{\sqrt{p}}$ or $\frac{1}{2}$ with $x = 0$ and their larger value of *y* from part (a)
If they use $y = mx + c$ they must proceed as far as $c = \ldots$

dM1: Correct method for both lines as defined above and solves simultaneously (may be via a calculator) to find the *x* coordinate of *D*.
Depends on the previous mark.

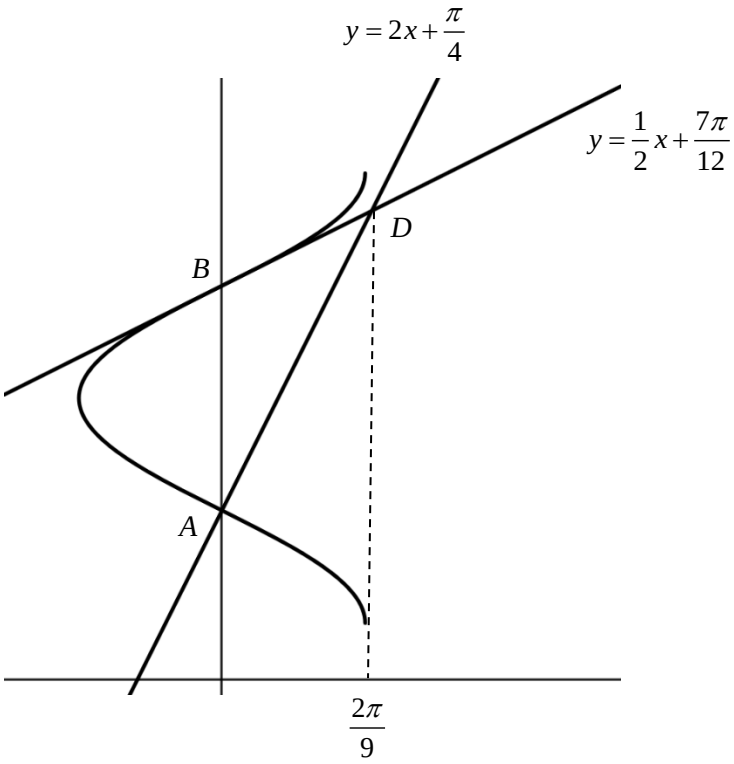
A1: Cso. Correct value $x=\frac{2\pi}{9}$.
Ignore any attempts to find the *y* coordinate.
If they use part (b) then full marks can be awarded following an incorrect value for *q* provided all the other work is correct.

Beware: It is possible to obtain the correct answer in (c) from incorrect values in (a) e.g.



This scores B1M1dM1A0

Diagram for reference:



Question Number	Scheme	Marks
10(a)(i)	$(y=)10+k$	B1
(ii)	$x=\frac{10}{k}$ **or** $y=k$	B1
	$x=\frac{10}{k}$ **and** $y=k$	B1
		(3)

Remember to look for answers written within the question and on Figure 3.
If there is any contradiction, answers in the body of the script take precedence.

(a)(i)

B1: Correct expression. The "y =" is not required and condone $x = 10 + k$ or $A = 10 + k$

Allow e.g. $(0, 10+k)$ and condone $(10+k, 0)$

Do **not** allow $(y=)|-10|+k$

(a)(ii)

B1: One correct coordinate. May be seen as $x = \ldots$ or $y = \ldots$ or in coordinate form e.g. $\left(\frac{10}{k}, ...\right)$ or $(..., k)$

Condone missing brackets e.g. $\frac{10}{k}$, ... or ..., k

Do not condone e.g. $P = k$ unless k is clearly identified as the y coordinate.
Do not condone coordinates the wrong way round unless they are correctly assigned first and then apply isw.

B1: Both correct. May be seen as $x = \ldots$ and $y = \ldots$ or as e.g. $\left(\frac{10}{k}, k\right)$ and no other points.

Condone missing brackets e.g. $\frac{10}{k}$, k

Do not condone coordinates the wrong way round unless they are correctly assigned first and then apply isw

(b)	$kx-10+k=2k \Rightarrow x=...$ **or** $-kx+10+k=2k \Rightarrow x=...$	M1
	$kx-10+k=2k \Rightarrow x=...$ **and** $-kx+10+k=2k \Rightarrow x=...$	dM1
	$x \leqslant \frac{10-k}{k}$ or $x \geqslant \frac{10+k}{k}$ oe	A1
		(3)

	(b) Alternative by squaring.	
	$\lvert kx-10\rvert+k=2k \Rightarrow \lvert kx-10\rvert=k \Rightarrow k^2x^2-20kx+100=k^2$ $\Rightarrow k^2x^2-20kx+100-k^2=0$	M1
	$k^2x^2-20kx+100-k^2=0 \Rightarrow x=\frac{20k\pm\sqrt{400k^2-4k^2\left(100-k^2\right)}}{2k^2}$ $=\frac{10\pm k}{k}$	dM1
	$x \leqslant \frac{10-k}{k}$ or $x \geqslant \frac{10+k}{k}$ oe	A1

(b)

M1: Attempts to solve one of these equations to find one of the limits in terms of k.
Condone use of any inequality for either equation e.g. $kx-10+k...\ 2k$ where … is any inequality or "="
May be implied by one correct limit.

dM1: Attempts to solve both of these equations to find both limits.
Condone use of any inequality for either equation e.g. $kx-10+k...\ 2k$ where … is any inequality or "=".
May be implied by both correct limits.

A1: Correct range. Allow equivalent notation e.g. the inequalities written separately or e.g. $x \leqslant \frac{10-k}{k},\ x \geqslant \frac{10+k}{k}$ or $\left(-\infty,\frac{10-k}{k}\right],\left[\frac{10+k}{k},\infty\right)$ Condone $x \leqslant \frac{10-k}{k}$ and $x \geqslant \frac{10+k}{k}$ but **not** $x \leqslant \frac{10-k}{k} \cap x \geqslant \frac{10+k}{k}$

Do not allow e.g. $\frac{10+k}{k}, \leqslant x \leqslant \frac{10-k}{k}$ unless e.g. $x \leqslant \frac{10-k}{k},\ x \geqslant \frac{10+k}{k}$ is seen first then apply isw.

Allow equivalent correct expressions for the limits

e.g. $\frac{10}{k}-1, -\frac{k-10}{k}, \frac{k-10}{-k}$ for $\frac{10-k}{k}$ and $\frac{10}{k}+1$ for $\frac{10+k}{k}$ etc.

Alternative by squaring:

M1: Isolates the $\lvert kx-10\rvert$, squares both sides, obtaining at least 3 terms on the lhs and collects terms to obtain a 3TQ = 0

dM1: Attempts to solve their 3TQ using a correct method to find both limits.

A1: Correct range as above.

(c)	$k > 3$	B1
	Maximum value of k occurs when $y = 3x + 1$ passes through vertex e.g. when $"k" = 3\times"\frac{10}{k}"+1 \Rightarrow k = ...$ **See below for alternative approaches.**	M1
	$k^2 - k - 30 = 0 \Rightarrow (k+5)(k-6) = 0 \Rightarrow k = 6$ So **maximum** k is 6	A1
	$3 < k < 6$	A1
		(4)
		Total 10

B1: For the correct **minimum** value for k.
Condone k …3 or "minimum value is 3".
This may be seen embedded in an inequality but it must be identified as the **minimum** value.

M1: Correct strategy for the maximum value of k.
E.g. sets $f(x) = 3x+1$, substitutes their $x = \frac{10}{k}$ and $y = k$ or their y from (a)(ii) and attempts to solve for k.
An equivalent approach would be to substitute their $x = \frac{10}{k}$ and $y = k$ or their y from (a)(ii) into $y = 3x+1$ and attempt to solve for k
For this mark the value obtained may not be the maximum value for their range.
See below for alternative methods for finding the maximum value of *k*.

A1: For the correct **maximum** value for k
Condone k ,, 6
This may be seen embedded in an inequality but it must be the **maximum** value.

A1: Correct range in terms of k. Allow equivalent notation e.g. $k > 3$ and $k < 6$ or $(3, 6)$ but **not** $k > 3$ or $k < 6$ or $k > 3$, $k < 6$