Question Number	Scheme	Marks
5 (a)	$9x^3-10x^2+x=x\left(9x^2-10x+1\right)=x(ax\pm1)(bx\pm1)$ with $ab=9$	M1
	$=x(9x-1)(x-1)$	A1
		(2)
(b)	States or implies that $x=3^y$ AND sets = to their 1 or $\frac{1}{9}$	M1
	Solves their $3^y=$"1" or $3^y=$"$\frac{1}{9}$"	dM1
	$y=0,-2$	A1
		(3)
		(5 marks)

THIS IS A NON- CALCULATOR QUESTION.

(a)

M1: Takes out (or divides by) a common factor of x and attempts to factorise the quadratic factor.
In most cases this will be

- either $9x^3-10x^2+x=x\left(9x^2-10x+1\right)=x(ax\pm1)(bx\pm1)$ with $ab=9$
- or $9x^2-10x+1=(ax\pm1)(bx\pm1)$ with $ab=9$

Other methods exist such as $9x^3-10x^2+x=(x-1)\left(9x^2-x\right)$ but the method is only scored when the factor of x is taken from the second bracket

It would be very difficult to score following an attempt to find the roots of $9x^2-10x+1=0$

A1: $x(9x-1)(x-1)$ o.e such as $(9x-1)(x-1)(x-0)$, $x(-9x+1)(-x+1)$ or $9x\left(x-\frac{1}{9}\right)(x-1)$ following the award of the M1 mark. **This must be done in part (a) but use review if unsure**

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Watch out for these.

Example 1: If you see $9x^3-10x^2+x=0\Rightarrow x=0,1,\frac{1}{9}$ followed by $x(9x-1)(x-1)$ it is M0 A0
(calculator use)

Example 2: If you see $9x^3-10x^2+x=x\left(x-\frac{1}{9}\right)(x-1)$ it is M0 A0
(Incorrect and probable calculator use)

Special case:

If you see $9x^3-10x^2+x=x(9x-1)(x-1)$ or $9x\left(x-\frac{1}{9}\right)(x-1)$ without any other working it is SC M1 A0

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(b) If a candidate has just written down the roots of part (a) =0 without having factorised it, then allow all marks to be scored here. So, 00 111 is possible.

M1: This is awarded for linking the equation in *y* with the roots of the part (a)

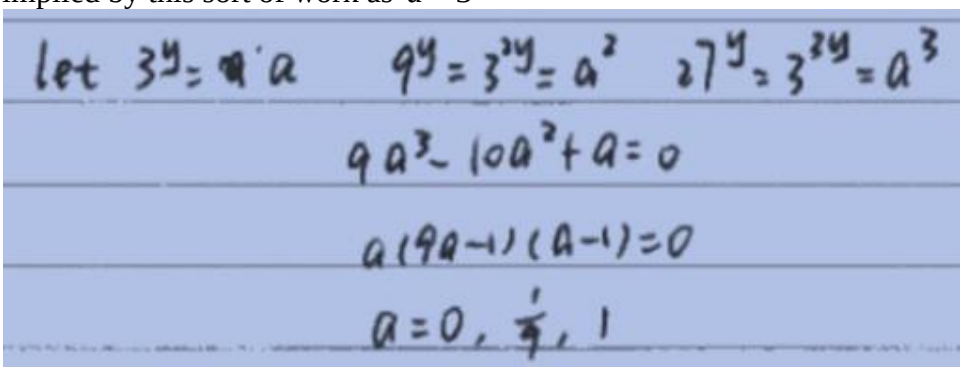
Score for stating that $x = 3^y$ **AND** setting *x* or 3^y = one of the non-zero roots of their $x(9x-1)(x-1)=0$

It is important to note that it is not just for the non-zero roots of their $x(9x-1)(x-1)=0$

This can be implied by setting $3^y = 1$ OR $\frac{1}{9}$ if they write down the roots of part (a) as 0, 1 and $\frac{1}{9}$

Can be implied by $x = 1$ OR $\frac{1}{9}$ followed by a correct *y* value.

It is also implied by this sort of work as $a = 3^y$



dM1: Solves their $3^y = "1"$ or $3^y = "\frac{1}{9}"$.

To score this, the root must be either correct or else a power of 3

A1: CSO $y = 0, -2$ only.

The solutions must follow M1, dM1. Candidates cannot just state $y = 0$ without any working and score marks.

Condone use of 'or' between the values.

Condone the use of logs in proceeding to an answer. E.g. $3^y = \frac{1}{9} \Rightarrow y = \log_3 \frac{1}{9} = -2$

Question Number	Scheme	Marks
6 (a)	Angle $AFB = \dfrac{\pi - 2.275}{2} = 0.433$ *	B1*
		(1)
(b)	Attempts $r\theta = 6.2 \times 2.275 = (14.105)$	M1
	Attempts $\left(x^2\right) = 6.4^2 + 6.2^2 - 2 \times 6.4 \times 6.2 \cos(0.433) = (7.36)$ or $(x = 2.71)$	M1
	Correct attempt = $2x + r\theta + 12.8 = 2 \times 2.714 + 14.105 + 12.8 = 32.3\,(\text{m})$	dM1, A1
		(4)
(c)	Attempts $\dfrac{1}{2} r^2 \theta = \dfrac{1}{2} \times 6.2^2 \times 2.275 = (43.7255)$	M1
	Attempts $\dfrac{1}{2} ab \sin C = \dfrac{1}{2} \times 6.2 \times 6.4 \times \sin 0.433 = (8.325)$	M1
	Correct attempt = $2 \times 8.325 + 43.7255 = 60.4\left(\text{m}^2\right)$	dM1, A1
		(4)
		(9 marks)

(a)

B1*: Shows that angle $AFB = 0.433$ radians.

You may see the angle labelled θ or BFA. This is not an issue, just look for the calculation

It is a "show that" so it is important to see either $\dfrac{\pi - 2.275}{2}$ or decimal equivalent with at least this accuracy $\dfrac{3.1416 - 2.275}{2}$ before we see 0.433 written down. The bracketing if required must be correct. So $(\pi - 2.275) \div 2$ is correct but $\pi - 2.275 \div 2$ is not. Condone a more accurate answer being written down and left without rounding to 3 decimal places. E.g. $\dfrac{\pi - 2.275}{2}$ = 0.433296327

(b)

M1: Attempts $r\theta = 6.2 \times 2.275$. Implied by sight of awrt 14.1

Sight of $2 \times 6.2 \times 2.275$ would be M0 as this would imply an incorrect formula. There are not two arc lengths within the perimeter of the tunnel.

M1: Attempts to apply the cosine rule to find *AB* or *DE*.

Can be achieved for an attempt at $6.4^2 + 6.2^2 - 2 \times 6.4 \times 6.2 \cos(0.433)$ irrespective of the LHS.

Condone a larger calculation that includes $2 \times \left(\sqrt{6.4^2 + 6.2^2 - 2 \times 6.4 \times 6.2 \cos(0.433)}\right)$ or even $2 \times \left(6.4^2 + 6.2^2 - 2 \times 6.4 \times 6.2 \cos(0.433)\right)$ as both *AB* and *DE* are part of the perimeter.

The angle used must be 0.433 or a more accurate version of this

This can be implied by, for example, by sight of $AB^2 = 7.36...$ OR $AB = 2.71...$

Condone $\cos 0.433 = \dfrac{6.2^2 + 6.4^2 - AB^2}{2 \times 6.2 \times 6.4}$ leading to a value for AB^2 or *AB*

Attempts via right angled triangles and incorrect cosine rules, e.g. $\left(c^2\right) = a^2 + b^2 - ab \cos C$ are M0

dM1: Full attempt to find the perimeter of the tunnel. $2 \times$"2.714"+"14.105"+12.8

It is dependent upon both M's and a correct attempt at the cosine rule by square rooting their answer to $6.4^2 + 6.2^2 - 2 \times 6.4 \times 6.2 \cos(0.433)$ o.e.

A1: awrt $32.3\,(\text{m})$