	attempt to differentiate and obtain a value for $\frac{dy}{dx}$ using $y = \frac{\pi}{4}$ appropriately and do not condone clear use of an unchanged $\frac{dx}{dy}$ in the line equation. A1: Correct x-coordinate of Q. Requires all previous marks.	
		(Total 6 marks)

Question Number	Scheme		Marks
7	**"In this question you must show all stages of your working. Solutions relying entirely on calculator technology are not acceptable."** $P_C = 7+16e^{-0.1t}$ $P_V = 4+me^{-0.2t}$ $0 \leqslant t \leqslant 15$		
(a)	$7+16e^{-0.1T}=15 \Rightarrow e^{-0.1T}=...$	Sets $7+16e^{-0.1T}=15$ and obtains $e^{-0.1T}=k$	**M1**
	$e^{-0.1t}=\frac{8}{16} \Rightarrow T=\frac{\ln(0.5)}{-0.1}=$ awrt 6.93	**d**M1: Finds a positive value for T - allow slips & $T \geqslant 15$ but must be correct ln work A1: awrt 6.93 May use t or x	**dM1 A1**
			(3)
(b)	$\frac{dP_C}{dt}=-1.6e^{-0.1t}$ or $-\frac{8}{5}e^{-0.1t} \Rightarrow -1.6e^{-0.1\times 5}=$ awrt -0.97 M1: Differentiates to the form $Ae^{-0.1t}$, $A \neq 16$, substitutes in $t=5$ and obtains a decimal value. There must be some indication of an appropriate method but accept the derivative (with or without substitution) followed by a value. A1: awrt -0.97 **Answer only is M0A0**		**M1 A1**
			(2)
(c)(i)	$\{m=\}$ 32	Correct value. Ignore any labelling. Not 32000 and not both 32 and 32000 unless one is rejected	**B1**
(ii)	$36(000)-23(000)=13(000)$ M1: "36"-23 or $36000-23000$ either way round with their positive "36" $= m+4$ or "36000" $= m+4000$ as necessary (no inconsistent units in the subtraction) A1: $\{£\}\pm 13000$ or 13 thousand (not 13 on its own or with 13000)		**M1 A1**
			(3)
(d)	$4+"32"e^{-0.2\alpha}=7+16e^{-0.1\alpha} \Rightarrow 32e^{-0.2\alpha}-16e^{-0.1\alpha}-3=0$ or e.g., $3e^{0.2\alpha}+16e^{0.1\alpha}-32=0$ Sets $4+"32"e^{-0.2\alpha}=7+16e^{-0.1\alpha}$ and obtains a 3TQ in $e^{\pm 0.1\alpha}$ (terms may not be on one side). May use any variable or a substitution e.g. $\beta=e^{-0.1\alpha} \Rightarrow 32\beta^2-16\beta-3=0$ The 3TQ and the "=" could be implied by an attempt to solve a 3TQ in $e^{-0.1\alpha}$ or $e^{+0.1\alpha}$		**M1**
	$\Rightarrow e^{-0.1\alpha}=\frac{16\pm\sqrt{16^2-4(32)(-3)}}{2(32)}\left\{\Rightarrow \frac{2+\sqrt{10}}{8}\right\}$ or $e^{0.1\alpha}=\frac{-16\pm\sqrt{16^2-4(3)(-32)}}{2(3)}\left\{\Rightarrow \frac{-8+4\sqrt{10}}{3}\right\}$ Solves their three term quadratic in $e^{\pm 0.1\alpha}$ or "β" (usual rules apply but must get a real answer (could be negative) via formula or CTS and not factorisation). Allow going straight to a consistent calculator answer provided there has been some (minimal) algebra. If decimal it must be correct to 2sf		**dM1**
	$e^{-0.1\alpha}=\frac{2+\sqrt{10}}{8} \Rightarrow \{\alpha=\}\frac{\ln\left(\frac{2+\sqrt{10}}{8}\right)}{-0.1}=$ awrt 4.38 or $e^{0.1\alpha}=\frac{-8+4\sqrt{10}}{3} \Rightarrow \{\alpha=\}\frac{\ln\left(\frac{-8+4\sqrt{10}}{3}\right)}{0.1}=$ awrt 4.38 **dd**M1: Obtains a valid positive decimal value (not just changed from a negative) - may be slips but must involve correct application of lns. Accept 4.38 following a value for $e^{-0.1\alpha}$ or $e^{+0.1\alpha}$ A1: awrt 4.38. Allow if unlabelled or mislabelled e.g., "a", "x", "t"		**ddM1 A1**

	Minimum work: $4+"32"e^{-0.2\alpha}=7+16e^{-0.1\alpha}$, $e^{-0.1\alpha}=\frac{2+\sqrt{10}}{8}$, $\alpha=4.3806365...$ 4.38 without the root and an equation will score no marks.	
		(4)
		(Total 12 marks)