Question	Scheme		Marks	AOs
9(a)	$y=\frac{1}{x^x}\Rightarrow \ln y=\ln 1-\ln x^x$	$y=x^{-x}\Rightarrow \ln y=\ln x^{-x}$	M1	1.1b
	$\ln y=-x\ln x$ *		A1*	2.1
			(2)	
(b)	$\ln y\rightarrow \frac{1}{y}\frac{dy}{dx}$		M1	1.1b
	$-x\ln x\rightarrow -\ln x-1$		M1	1.1b
	$\frac{1}{x^{-x}}\frac{dy}{dx}=-\ln x-1\Rightarrow \frac{dy}{dx}=-x^{-x}(\ln x+1)$ *		A1*	2.1
			(3)	
(c)	Sets $-x^{-x}(\ln x+1)=0$ proceeding to $x=e^{-1}$		M1	3.1a
	Attempts $y=\frac{1}{\left(e^{-1}\right)^{e^{-1}}}$		dM1	1.1b
	$\left(e^{-1},e^{e^{-1}}\right)$ or $\left(\frac{1}{e},e^{\frac{1}{e}}\right)$		A1	2.5
			(3)	
(d)	Either $g(x)\ldots 0$ or $g(x)\ldots e^{e^{-1}}$		M1	2.2a
	$0<g(x)\leqslant e^{e^{-1}}$		A1	2.5
			(2)	
			(10 marks)	

Notes:

(a)

M1: Way 1: Takes logs of both sides and uses the subtraction law correctly;

Way 2: Rewrites $\frac{1}{x^x}$ as x^{-x} and takes logs of both sides.

A1*: Proceeds to the given result with a valid method and no errors.
Must see ln in at least one step prior to the given answer.

(b)

M1: Differentiates the left hand side implicitly to the form $\frac{...}{y}\frac{dy}{dx}$

M1: Differentiates the right hand side using the product rule to the form $-...\ln x-...$

A1*: Proceeds to the given result with a valid method and no errors. x^{-x} must be seen substituted before the given answer is seen unless e.g. $\frac{dy}{dx}=-y(\ln x+1)$ seen instead.

(c)

M1: Sets $\{-x^{-x}\}\left(\ln x+1\right)=0$ proceeding to $x=\ldots$

dM1: Substitutes their x into $y=x^{-x}$ or $y=\dfrac{1}{x^x}$

A1: Correct coordinates in exact form as in the main scheme. Allow $x=\ldots$ and $y=\ldots$

(d)

M1: Either "end" found. Ignore inequalities for this mark.

A1: $0<\mathrm{g}\left(x\right)\leqslant \mathrm{e}^{\mathrm{e}^{-1}}$ o.e. e.g. $0<\mathrm{g}\left(x\right)\leqslant \mathrm{e}^{\frac{1}{\mathrm{e}}}$