

1.

Question			Answer	Marks
	(i)		When $t = 0, M = 300$	B1
			$300e^{-0.05t} = 150$ $e^{-0.05t} = 0.5$ $-0.05t = \ln 0.5$	M1
			$t = 13.9$ (minutes)	A1
				[3]
	(ii)		$M_2 = 400e^{kt}$	B1
			$320 = 400e^{10k}$ $k = 0.1\ln 0.8$	M1
			$M_2 = 400e^{-0.0223t}$	A1
			Substance 1: $\frac{dM_1}{dt} = -15e^{-0.05t}$	M1
			Substance 2: $\frac{dM_2}{dt} = -8.93e^{-0.0223t}$	A1ft

Question			Answer	Marks
			$-15e^{-0.05t} = -8.93e^{-0.0223t}$ $e^{0.0277t} = 1.681$	M1
			$0.0277t = 0.519$	M1
			time = 18.75 minutes	A1

2.

Question			Answer	Marks
	(i)		$(a \Rightarrow) 75$	B1 [1]
	(ii)		25 is the value that T approaches after a long time So therefore it is the ambient temperature	B1 [1]
	(iii)		$-ake^{-kt}$ $-ak = -15$ $k = \frac{1}{5}$	B1 M1 A1ft [3]
	(iv)		$45 = 25 + 75e^{-\frac{1}{5}t} \Rightarrow 75e^{-\frac{1}{5}t} = 20$ $(\text{eg}) -\frac{1}{5}t = \ln\left(\frac{4}{15}\right) \Rightarrow t = \dots$ After 6.6 mins	M1 M1 A1 [3]
	(v)		Decrease the value of a	B1 [1]

3.

Question		Answer	Marks
	(i)	$A = 500$ $k = 1.044$	B1 B1 [2]
	(ii)	500×1.044^{10} $= 769.1$ which is not close to 650 so not consistent	M1 A1 [2]
	(iii)	exponential growth oe	B1 [1]
	(iv)	$t = 0, N = 500$ $t = 10, N = 650.37 \approx 650$ model predicts number of fruit flies tends to 750 in the long run	B1 B1 B1 [3]
	(v)	(A) Oscillations	B1 [1]
		(B) cosine or sine oe	B1 [1]

4.

Question		Answer	Marks
	(i)	$\log_{[10]} n = \log_{[10]} a + kt \log_{[10]} 2$ This is of form $y = mx + c$ [with $\log_{[10]} n$ as y and t as x]	M1 E1 [2]
	(ii)	Reasonable line of best fit drawn (by eye) Suitable method leading to a value eg use of intercept leading to $0.9 < \log a < 1.2$ So $7.4 < a < 15.85$ Suitable method leading to k value eg $k \log_{10} 2 = \text{gradient} \approx 0.33$ k in range $0 < k < 1.25$ and a in range $7.4 < a < 15.85$	B1 M1 M1 A1 [4]
	(iii)	$500000 = 10 \times 2^{1.1t}$ $1.1t \log 2 = \log 50000$ $t = 14.2$ $t = 14$ is $1/3/18$ So $1/4/18$	M1 A1 M1 A1 [4]

	(iv)	Suitable reason e.g. The data are only for a short time scale and cannot extrapolate e.g. There will not be enough people for the growth to continue	E1 [1]
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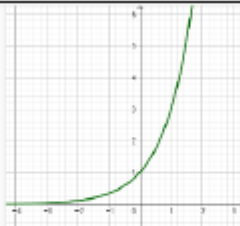
5.

Question	Answer	Marks									
i	$y = kx^n$	B1 [1]									
ii	$\ln y = \ln(kx^n)$ $\ln y = \ln k + \ln(x^n) = \ln k + n \ln x$	M1 E1 [2]									
iii	<table border="1"> <thead> <tr> <th></th><th>$\ln x$</th><th>$\ln y$</th></tr> </thead> <tbody> <tr> <td>Mercury</td><td>-1.179</td><td>9.575</td></tr> <tr> <td>Jupiter</td><td>1.599</td><td>4.022</td></tr> </tbody> </table>		$\ln x$	$\ln y$	Mercury	-1.179	9.575	Jupiter	1.599	4.022	B1 B1 [2]
	$\ln x$	$\ln y$									
Mercury	-1.179	9.575									
Jupiter	1.599	4.022									
iv	EITHER $b = \frac{9.575 - 4.022}{-1.179 - 1.599} = -1.999 \text{ (-2.00 to 3sf)}$ $a = 7.218$	M1 A1 A1 [3]									
	OR $9.575 = a - 1.179b$ $4.022 = a + 1.599b$ Giving $a = 7.218$ $b = -1.999 \text{ (-2.00 to 3sf)}$	M1 A1 A1 [3]									
v	$y = 1363x^{-2.00}$	B1 B1 [2]									
vi		B1 B1 [2]									
vii	Earth $x = 1$, $y = 1363 \times 1^{-2} = 1360 \text{ W m}^{-2} \text{ (3sf)}$	B1 [1]									

6.

Question	Scheme	Marks
(a)	For a correct equation in p or q $p = 10^{4.8}$ or $q = 10^{0.05}$	M1
	For $p = \text{awrt } 63100$ or $q = \text{awrt } 1.122$	A1
	For correct equations in p and q $p = 10^{4.8}$ and $q = 10^{0.05}$	dM1
	For $p = \text{awrt } 63100$ and $q = \text{awrt } 1.122$	A1
		(4)
(b)	(i) The value of the painting on 1st January 1980	B1
	(ii) The proportional increase in value each year	B1
		(2)
(c)	Uses $V = 63100 \times 1.122^{30}$ or $\log V = 0.05 \times 30 + 4.8$ leading to $V =$	M1
	$= \text{awrt } (\pounds) 2000000$	A1
		(2)

7.

Question	Answer	Marks
(i)	A 	B1 [1]
(i)	B (0, 1)	B1 [1]
(ii)	$(f(x) =) \log_3 x$	B1 [1]

Question		Answer	Marks
	(i)	$C = 2$ $A = 62$ $B = 10$	B1 B1 B1 [3]
	(ii)	substitution of 0.75 in $p = 62 - 10(t - 2)^2$ 46	M1 A1 [2]
	(iii)	<i>their</i> $62 - 10(t - 2)^2 = 0$ $[t =]$ 4 hours 29 minutes or 4 hours 30 minutes	M1 A1 [2]
	(iv)	substitution of $t = 1, 3$ and 5 awrt $59.4 \approx 59$ awrt $83.8 \approx 84$ awrt $88.8 \approx 89$	M1 A1 [2]
	(v)	$p \rightarrow 90$ as $t \rightarrow$ large or when $t = 12$ $p = 89.99539 \dots$ rounded to 2 or more sf comparison with value of p for $t = 5$ eg model predicts $p = 89$ for $t = 5$ and $p = 90$ for $t = 12$ so not good advice	B1 B1 [2]

Question	Scheme	Marks
(a)	(i) Method to find p Eg. Divides $32000 = Ap^4$ by $50000 = Ap^{11}$ $p^7 = \frac{50000}{32000} \Rightarrow p = \sqrt[7]{\frac{50000}{32000}} = \dots$	M1
	$p = 1.0658$	A1
	(ii) Substitutes their $p = 1.0658$ into either equation and finds A $A = \frac{32000}{1.0658^4} \text{ or } A = \frac{50000}{1.0658^{11}}$	M1
	$A = 24795 \rightarrow 24805 \approx 24\,800^*$	A1*
		(4)
(b)	A / (£) 24 800 is the value of the car on 1st January 2001	B1
	$p / 1.0658$ is the factor by which the value rises each year. Accept that the value rises by 6.6 % a year (ft on their p)	B1
		(2)
(c)	Attempts $100000 = 24800 \times 1.0658^t$	
	$1.0658^t = \frac{100000}{24800}$	M1
	$t = \log_{1.0658} \left(\frac{100000}{24800} \right)$	dM1
	$t = 21.8 \text{ or } 21.9$	A1
	cso 2022	A1
		(4)

10.

Q	Marking Instructions	AO	Marks	Typical Solution
(a)	Reads graph and uses $10^{\log P}$ or $10^{\log V}$ to get either P or V	AO3.4	M1	$\log_{10} P = 2.18$ $P = 151$
	Correctly obtains P and V AWRT 150 and AWRT 0.71	AO1.1b	A1	$\log_{10} V = -0.15$ $V = 0.708$
(b)	Calculates value of gradient to find d Condone use of $\log d = \text{gradient}$ Or uses a value of c plus a P/V pair to find d	AO3.4	M1	$\log_{10} P = \log_{10} c + d \log_{10} V$
	Obtains correct value for d AWRT -1.4 Not necessarily a decimal	AO1.1b	A1	Gradient = $d = -1.4$
	Calculates value of intercept to find $\log_{10} c$ Or uses a value of d plus a P/V pair to find c	AO3.4	M1	Intercept = $\log_{10} c$
	Calculates correct value for c AWRT 93	AO1.1b	A1	$c = 93.3$
(c)	Uses their values of c and d in the formula $P = cV^d$	AO1.1a	M1	$P = 93.3 \times 2^{-1.4}$
	Obtains P value, including units AWFW 30 to 40	AO3.2a	A1	= 35.4 kilopascals