A-level Use of Mathematics Pilot

Mathematics

USE3 – Mathematical Comprehension

Mark scheme

9360
June 2015

Version/Stage: Version 1.0 Final

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this Mark Scheme are available from aqa.org.uk

Key to mark scheme abbreviations

M	mark is for method
m or dM	mark is dependent on one or more M marks and is for method
A	mark is dependent on M or m marks and is for accuracy
B	mark is independent of M or m marks and is for method and accuracy
E	mark is for explanation
√or ft or F	follow through from previous incorrect result
CAO	correct answer only
CSO	correct solution only
AWFW	anything which falls within
AWRT	anything which rounds to
ACF	any correct form
AG	answer given
SC	special case
OE	or equivalent
A2,1	2 or 1 (or 0) accuracy marks
–*x* EE	deduct *x* marks for each error
NMS	no method shown
PI	possibly implied
SCA	substantially correct approach
c	candidate
sf	significant figure(s)
dp	decimal place(s)

No Method Shown

Where the question specifically requires a particular method to be used, we must usually see evidence of use of this method for any marks to be awarded.

Where the answer can be reasonably obtained without showing working and it is very unlikely that the correct answer can be obtained by using an incorrect method, we must award **full marks**. However, the obvious penalty to candidates showing no working is that incorrect answers, however close, earn **no marks**.

Where a question asks the candidate to state or write down a result, no method need be shown for full marks.

Where the permitted calculator has functions which reasonably allow the solution of the question directly, the correct answer without working earns **full marks**, unless it is given to less than the degree of accuracy accepted in the mark scheme, when it gains **no marks**.

Otherwise we require evidence of a correct method for any marks to be awarded.

Q	Solution	Mark	Total	Comment
1	4 generations so time = $4\times15=60$ minutes = 1 hour	M1 A1	2	SC1 90 minutes
	Total		**2**	
2(a)	$N=N_0 2^{\frac{t}{G}}$ $12000=4500\times2^{\frac{30}{G}}$ $\frac{12000}{4500}=2^{\frac{30}{G}}$ $\ln\frac{12000}{4500}=\frac{30}{G}\ln 2$ $G=\frac{30\ln 2}{\ln\frac{12000}{4500}}=21.2$	M1 M1 A1	3	SC2 2.21 (use of N=1 at t=0)
2(b)	$k=\frac{\ln 2}{G}=\frac{\ln 2}{21.2}=0.0327$ $N=4500\mathrm{e}^{0.0327t}$	M1, A1ft A1ft	3	
	Total		**6**	
3(a)	General shape of curve Asymptotic to both k and G axes	B1 B1	2	
3(b)	As G increases k decreases For very small values of G, k is very large For very large values of G, k is very small	B1 B1	2	
	Total		**4**	

Q	Solution	Mark	Total	Comment
4	$\frac{dN}{dt} = kN$			
	$\int \frac{dN}{N} = \int k\,dt$	M1		
	So, $\ln N = kt + c$	A1		
	$N = N_0$ when $t = 0$			
	So, $\ln N_0 = c$	A1		
	Therefore, $\ln N = kt + \ln N_0$			
	$\ln N - \ln N_0 = kt$	M1		
	$\ln \frac{N}{N_0} = kt$			
	$\frac{N}{N_0} = e^{kt}$			
	$N = N_0 e^{kt}$	A1	5	
	Total		**5**	
5(a)(i)	$\frac{dP}{dt} = 2.2 \times 0.029 e^{0.029t}$	M1, A1		In either part
	$= 0.0638 e^{0.029t}$			Alternative $\frac{dP}{dt} = 0.029P = 0.029 \times 3.6 = 0.1044$ (M1, A1)
	At t = 16, $\frac{dP}{dt} = 0.101$	A1		SC1 3.50
(a)(ii)	At t = 96, $\frac{dP}{dt} = 1.033$	A1		SC1 35.6 $\frac{dP}{dt} = 0.029P = 0.029 \times 36 = 1.044$ (M1, A1)
			4	
(b)(i)	Average growth rate $r = \frac{N_2 - N_1}{t_2 - t_1}$	M1,		Method mark can be gained in either part
	$r = \frac{6.0 - 2.2}{32} = \frac{3.8}{32} = 0.119$	A1		
(b)(ii)	$r = \frac{51.0 - 22.7}{112 - 80} = \frac{28.3}{32} = 0.884$	A1	3	
	Total		**7**	

Q	Solution	Mark	Total	Comment
6	when t = 0, $\ln P_0 = 3.045$, so $P_0 = 21.0$ $\frac{dP}{dt} = 0.214 = kP_0 = k \times 21.0$ so $k = \frac{0.214}{21} = 0.0102$	M1, A1 M1 A1ft	4	
	Total		**4**	
7	For t = 90 to t = 210 when the relative growth rate is approximately constant	B1 B1	2	Allow within range 90-240
	Total		**2**	
8(a)	16.8 7.5	B1 B1	2	
(b)	when n = 180 29th June	B1 B1	2	allow between 28th and 30th
(c)	$\frac{7.5}{16.8} \times 100 = 44.6\%$	M1, A1ft	2	Ft from (a)
	Total		**6**	
9	$\overline{s}_{\text{March}} = \frac{1}{31}\int_{59}^{90} 4.5 + 3\sin\left(\frac{n\pi}{180} - \frac{\pi}{2}\right) dn$ $= \frac{1}{31}\left[4.5n - \frac{3\times 180}{\pi}\cos\left(\frac{n\pi}{180} - \frac{\pi}{2}\right)\right]_{59}^{90}$ $= 3.71$	M1 A1 A1	3	SC2 using 58 and 89 leading to 3.66 SC2 using 60 and 91 leading to 3.76
	Total		**3**	

Q	Solution	Mark	Total	Comment
10	The sine wave is centred on $s = 4.5$, because of symmetry with the areas enclosed by the function and the line $s = 4.5$, above and below the line, are the same.	E1 E1	2	
	Total		**2**	
11	$s = 4.5 + 3\sin\left(\frac{n\pi}{180} - \frac{\pi}{2}\right)$ $\frac{ds}{dn} = \frac{3\pi}{180}\cos\left(\frac{n\pi}{180} - \frac{\pi}{2}\right)$ s is decreasing most rapidly when $\frac{ds}{dn}$ has its greatest negative value, that is when $\cos\left(\frac{n\pi}{180} - \frac{\pi}{2}\right) = -1$ $\frac{n\pi}{180} - \frac{\pi}{2} = \pi$ $\frac{n\pi}{180} = \frac{3\pi}{2}$ $n = 270$	M1 A1 M1 A1	4	
	Total		**4**	