1. (a) attempt to form composite (in any order) *(M1)*

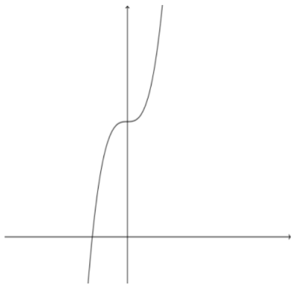
eg $f\left(x^3\right)$, $\left(2x+3\right)^3$

$(f \circ g)(x) = 2x^3 + 3$, $2\left(x\right)^3 + 3$ ***A1*** ***N2***

[2 marks]

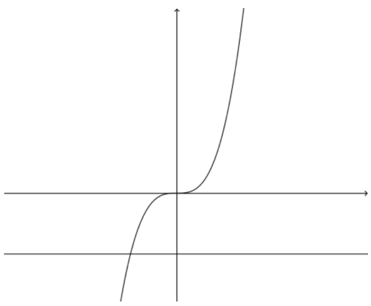
(b) evidence of appropriate approach *(M1)*

eg $2x^3 = -3$, sketch



correct working *(A1)*

eg $x^3 = \frac{-3}{2}$, sketch



-1.14471

$x = \sqrt[3]{\frac{-3}{2}}$ (exact), -1.14 $[-1.15, -1.14]$ ***A1*** ***N3***

[3 marks]

Total [5 marks]

2. (a) evidence of set up *(M1)*

eg correct value for r (or for a or b, seen in (b))

0.996010

$r = 0.996$ [0.996, 0.997] ***A1*** ***N2***

[2 marks]

(b) $a = 3.15037$, $b = -15.4393$

$a = 3.15$ [3.15, 3.16], $b = -15.4$ [−15.5, −15.4] ***A1A1*** ***N2***

[2 marks]

(c) substituting 26 into **their** equation *(M1)*

eg $y = 3.15(26) - 15.4$

66.4704

66.5 $[66.4, 66.5]$ ***A1*** ***N2***

[2 marks]

Total [6 marks]

3. (a) evidence of choosing cosine rule *(M1)*

eg $AC^2 = AB^2 + BC^2 - 2(AB)(BC)\cos(A\hat{B}C)$

correct substitution into the right-hand side *(A1)*

eg $6^2 + 10^2 - 2(6)(10)\cos 100^\circ$

$AC = 12.5234$

$AC = 12.5$ (cm) ***A1*** ***N2***

[3 marks]

(b) evidence of choosing a valid approach *(M1)*

eg sine rule, cosine rule

correct substitution *(A1)*

eg $\dfrac{\sin(B\hat{C}A)}{6} = \dfrac{\sin 100^\circ}{12.5}$, $\cos(B\hat{C}A) = \dfrac{(AC)^2 + 10^2 - 6^2}{2(AC)(10)}$

$B\hat{C}A = 28.1525$

$B\hat{C}A = 28.2^\circ$ ***A1*** ***N2***

[3 marks]

Total [6 marks]

4. (a) 11 terms *A1* *N1*

[1 mark]

(b) evidence of binomial expansion *(M1)*

eg $\binom{n}{r}a^{n-r}b^{r}$, attempt to expand

evidence of choosing correct term *(A1)*

eg 8^{th} term, $r=7$, $\binom{10}{7}$, $(x)^3(3)^7$

correct working *(A1)*

eg $\binom{10}{7}(x)^3(3)^7$, $\binom{10}{3}(x)^3(3)^7$,

$262440x^3$ (accept $262000x^3$) *A1* *N3*

[4 marks]

Total [5 marks]

5. (a) $r=-4$ *A2* *N2*

Note: Award ***A1*** for $r=4$.

[2 marks]

(b) (i) evidence of valid approach *(M1)*

eg $\dfrac{\max y \text{ value} - \min y \text{ value}}{2}$, distance from $y=10$

$p=8$ *A1* *N2*

(ii) valid approach *(M1)*

eg period is 24, $\dfrac{360}{24}$, substitute a point into **their** $f(x)$

$q=\dfrac{2\pi}{24}$ $\left(\dfrac{\pi}{12}, \text{exact}\right)$, 0.262 (do not accept degrees) *A1* *N2*

[4 marks]

(c) valid approach *(M1)*

eg line on graph at $y=7$, $8\cos\left(\dfrac{2\pi}{24}(x-4)\right)+10=7$

$x=11.46828$

$x=11.5$ (accept (11.5, 7)) *A1* *N2*

[2 marks]

Note: Do not award the final ***A1*** if additional values are given. If an incorrect value of q leads to multiple solutions, award the final ***A1*** only if **all** solutions within the domain are given.

Total [8 marks]

6. (a) (i) correct substitution into arc length formula *(A1)*

eg 0.7×5

arc length $= 3.5$ (cm) ***A1*** ***N2***

(ii) valid approach *(M1)*

eg $3.5 + 5 + 5$, $\text{arc} + 2r$

perimeter $= 13.5$ (cm) ***A1*** ***N2***

[4 marks]

(b) correct substitution into area formula *(A1)*

eg $\frac{1}{2}(0.7)(5)^2$

area $= 8.75\,(\text{cm}^2)$ ***A1*** ***N2***

[2 marks]

Total [6 marks]

7. (a) correct substitution into formula *(A1)*
eg $12e^{0.4(0)}$

12 bacteria in the dish ***A1*** ***N2***
[2 marks]

(b) correct substitution into formula *(A1)*
eg $12e^{0.4(4)}$

59.4363 *(A1)*

59 bacteria in the dish (integer answer only) ***A1*** ***N3***
[3 marks]

(c) correct equation *(A1)*
eg $A(t) = 400$, $12e^{0.4t} = 400$

valid attempt to solve *(M1)*
eg graph, use of logs

8.76639

8.77 (hours) ***A1*** ***N3***
[3 marks]

(d) valid attempt to solve *(M1)*
eg $n(4) = 60$, $60 = 24e^{4k}$, use of logs

correct working *(A1)*
eg sketch of intersection, $4k = \ln 2.5$

$k = 0.229072$

$k = \frac{\ln 2.5}{4}$ (exact), $k = 0.229$ ***A1*** ***N3***

[3 marks]

continued …

(e) **METHOD 1**

setting up an equation or inequality (accept any variable for n) ***(M1)***

eg $A(t) > B(t)$, $12e^{0.4n} = 24e^{0.229n}$, $e^{0.4n} = 2e^{0.229n}$

correct working ***(A1)***

eg sketch of intersection, $e^{0.171n} = 2$

4.05521 (accept 4.05349) ***(A1)***

$n = 5$ (integer answer only) ***A1*** ***N3***

METHOD 2

$A(4) = 59,\ B(4) = 60$ (from earlier work)

$A(5) = 88.668,\ B(5) = 75.446$ ***A1A1***

valid reasoning ***(R1)***

eg $A(4) < B(4)$ **and** $A(5) > B(5)$

$n = 5$ (integer answer only) ***A1*** ***N3***

[4 marks]

Total [15 marks]

8. (a) (i) 50 (g) *A1* *N1*

(ii) 65 rats weigh less than 70 grams *(A1)*

attempt to find a percentage *(M1)*

eg $\frac{65}{80}$, $\frac{65}{80} \times 100$

81.25 (%) (exact), 81.3 *A1* *N3*

[4 marks]

(b) (i) $p = 10$ *A2* *N2*

(ii) subtracting to find q *(M1)*

eg $75 - 45 - 10$

$q = 20$ *A1* *N2*

[4 marks]

(c) evidence of mid-interval values *(M1)*

eg 15, 45, 75, 105

$\bar{x} = 52.5$ (exact), $\sigma = 22.5$ (exact) *A1A1* *N3*

[3 marks]

(d) 0.781650

78.2 (%) *A2* *N2*

[2 marks]

(e) recognize binomial probability *(M1)*

eg $X \sim \mathrm{B}(n,\, p)$, $\begin{pmatrix} 5 \\ r \end{pmatrix} \times 0.782^{r} \times 0.218^{5-r}$

valid approach *(M1)*

eg $\mathrm{P}(X \le 3)$

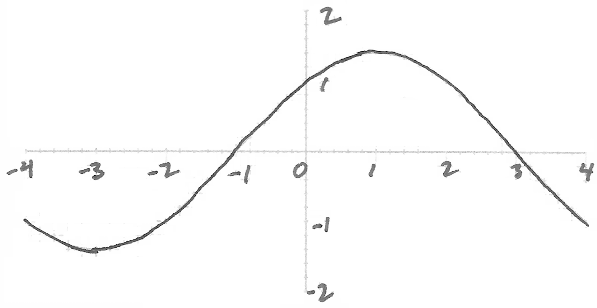
0.30067

0.301 *A1* *N2*

[3 marks]

Total [16 marks]

9. (a)



A1A1A1 *N3*

> **Note:** Award ***A1*** for approximately correct sinusoidal shape.
> **Only** if this ***A1*** is awarded, award the following:
> ***A1*** for correct domain,
> ***A1*** for approximately correct range.

[3 marks]

(a) recognizes decreasing to the left of minimum or right of maximum,
eg $f'(x) < 0$ ***(R1)***

x-values of minimum and maximum (may be seen on sketch in part (a)) ***(A1)(A1)***
eg $x = -3$, $(1, 1.4)$

two correct intervals ***A1A1*** ***N5***
eg $-4 < x < -3$, $1 \le x \le 4$; $x < -3$, $x \ge 1$

[5 marks]

(c) (i) recognizes that a is found from amplitude of wave ***(R1)***

y-value of minimum or maximum ***(A1)***
eg $(-3, -1.41)$, $(1, 1.41)$

$a = 1.41421$
$a = \sqrt{2}$, (exact), 1.41, ***A1*** ***N3***

continued ...

Question 9 continued

(ii) **METHOD 1**

recognize that shift for sine is found at x-intercept **(R1)**

attempt to find x-intercept **(M1)**

eg $\cos\left(\frac{\pi}{4}x\right)+\sin\left(\frac{\pi}{4}x\right)=0$, $x=3+4k$, $k\in\mathbb{Z}$

$x=-1$ **(A1)**

$c=1$ **A1** **N4**

METHOD 2

attempt to use a coordinate to make an equation **(R1)**

eg $\sqrt{2}\sin\left(\frac{\pi}{4}c\right)=1$, $\sqrt{2}\sin\left(\frac{\pi}{4}(3-c)\right)=0$

attempt to solve resulting equation **(M1)**

eg sketch, $x=3+4k$, $k\in\mathbb{Z}$

$x=-1$ **(A1)**

$c=1$ **A1** **N4**

[7 marks]

Total [15 marks]