

Exp and Log equations [28 marks]

1a.

[2 marks]

Markscheme

$$m = 3, n = 4 \quad \mathbf{A1A1} \quad \mathbf{N2}$$

[2 marks]

1b.

[4 marks]

Markscheme

attempt to apply $(2^a)^b = 2^{ab}$ (M1)

eg $6x + 3, 4(2x - 3)$

equating **their** powers of 2 (seen anywhere) M1

eg $3(2x + 1) = 8x - 12$

correct working A1

eg $8x - 12 = 6x + 3, 2x = 15$

$$x = \frac{15}{2} \quad (7.5) \quad \mathbf{A1} \quad \mathbf{N2}$$

[4 marks]

Total [6 marks]

2a.

[2 marks]

Markscheme

$$n = 800e^0 \quad (\mathbf{A1})$$

$$n = 800 \quad \mathbf{A1} \quad \mathbf{N2}$$

[2 marks]

2b.

[2 marks]

Markscheme

evidence of using the derivative (M1)

$$n'(15) = 731 \quad \mathbf{A1} \quad \mathbf{N2}$$

[2 marks]

2c.

[4 marks]

Markscheme

METHOD 1

setting up inequality (accept equation or reverse inequality) **A1**

e.g. $n'(t) > 10000$

evidence of appropriate approach **M1**

e.g. sketch, finding derivative

$k = 35.1226 \dots$ **(A1)**

least value of k is 36 **A1 N2**

METHOD 2

$n'(35) = 9842$, and $n'(36) = 11208$ **A2**

least value of k is 36 **A2 N2**

[4 marks]

3a.

[3 marks]

Markscheme

evidence of correct formula **(M1)**

eg $\log a - \log b = \log \frac{a}{b}$, $\log\left(\frac{40}{5}\right)$, $\log 8 + \log 5 - \log 5$

Note: Ignore missing or incorrect base.

correct working **(A1)**

eg $\log_2 8$, $2^3 = 8$

$\log_2 40 - \log_2 5 = 3$ **A1 N2**

[3 marks]

3b.

[4 marks]

Markscheme

attempt to write 8 as a power of 2 (seen anywhere) **(M1)**

eg $(2^3)^{\log_2 5}$, $2^3 = 8$, 2^a

multiplying powers **(M1)**

eg $2^{3\log_2 5}$, $a\log_2 5$

correct working **(A1)**

eg $2^{\log_2 125}$, $\log_2 5^3$, $(2^{\log_2 5})^3$

$8^{\log_2 5} = 125$ **A1 N3**

[4 marks]

4a.

[3 marks]

Markscheme

(i) interchanging x and y (seen anywhere) **M1**

e.g. $x = e^{y+3}$

correct manipulation **A1**

e.g. $\ln x = y + 3$, $\ln y = x + 3$

$f^{-1}(x) = \ln x - 3$ **AG N0**

(ii) $x > 0$ **A1 N1**

[3 marks]

4b.

[4 marks]

Markscheme

collecting like terms; using laws of logs **(A1)(A1)**

e.g. $\ln x - \ln\left(\frac{1}{x}\right) = 3$, $\ln x + \ln x = 3$, $\ln\left(\frac{x}{1}\right) = 3$, $\ln x^2 = 3$

simplify **(A1)**

e.g. $\ln x = \frac{3}{2}$, $x^2 = e^3$

$x = e^{\frac{3}{2}}$ ($= \sqrt{e^3}$) **A1 N2**

[4 marks]