Name:	Target Grade:	Actual Grade:

BRIGHT CULTURE

LINEAR LAW

READ THESE INSTRUCTIONS FIRST

INSTRUCTIONS TO CANDIDATES

1. Find a quiet, comfortable spot free place from distractions.
2. Spend one minute on each mark.
3. Time yourself for every single question.
4. Every chapter has their own question types. Ensure that you know the different question type for each chapter.
5. Make a conscientious effort to remember your mistakes, especially in terms of answering techniques. E.g Take a picture for the mistakes that you made, keep it in a photo album, and revise it over and over again.
6. Highlight question types that you tend to keep making mistakes and review them nearing exams.
7. Always review the common questions and question type that you tend to make mistakes nearing exams.
8. During exams, classify the question type and recall what you have learnt, how you need to analyse the questions for the different question type, what you need to take note of and answer with the correct answering techniques!

✨ Wishing you all the best for this test!

You've got this!

💡 With lots of love,
Bright Culture 💛

MARKS

If you are struggling in this paper, means you need to work harder!

If you need any professional guidance and further advice on how to advance, feel free to WhatsApp us at 91870820 or find us at www.bright-culture.com/. We are committed to connect you to your future to reach your goals.

CHAPTER 7: LINEAR LAW

1 Variables x and y are related by the equation $y = ab^x$ where a and b are constants.

The table below shows corresponding values of x and y.

x	1	2	3	4	5	6
y	4.8	9.6	19.2	38.4	76.8	153.6

(i) Draw the graph of $\lg y$ plotted against x, using a scale of 2 cm for 1 unit on the x-axis and 1 cm for 0.1 unit on the $\lg y$-axis. [3]

(ii) Use the graph to estimate the value of a and of b. [3]

(iii) By adding a suitable straight line to your graph in **part (i)**, estimate the solution to the equation $ab^x = 10^{2-\frac{x}{3}}$. [2]

(iv) The point $(14, k)$ lies on the graph of $\lg y$ against x, using the values of a and b that were found in part **(ii)**, find the value of k. [1]

2 It is known that x and y are related by an equation $y = ab^x + 4$, where a and b are constants.

x	1	2	3	4
y	10	16	28	52

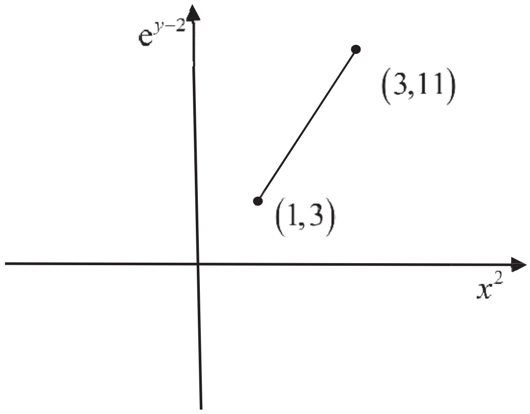
(i) Draw a straight line graph of $\lg(y-4)$ against x, using a scale of 2 cm to 1 unit on the x-axis and 2 cm to 0.2 units on the $\lg(y-4)$ -axis. [2]

(ii) Use your graph to estimate the value of a and of b. [5]

(iii) Use your graph to estimate the value of x when $y = 33$. [2]

(iv) On the same diagram, draw the line representing the equation $y - 4 = 10^{2x}$ and hence find the value of x for which $10^{2x} = ab^x$. [2]

3 ***(a)***



The diagram shows part of a straight line graph obtained by plotting e^{y-2} against x^2.

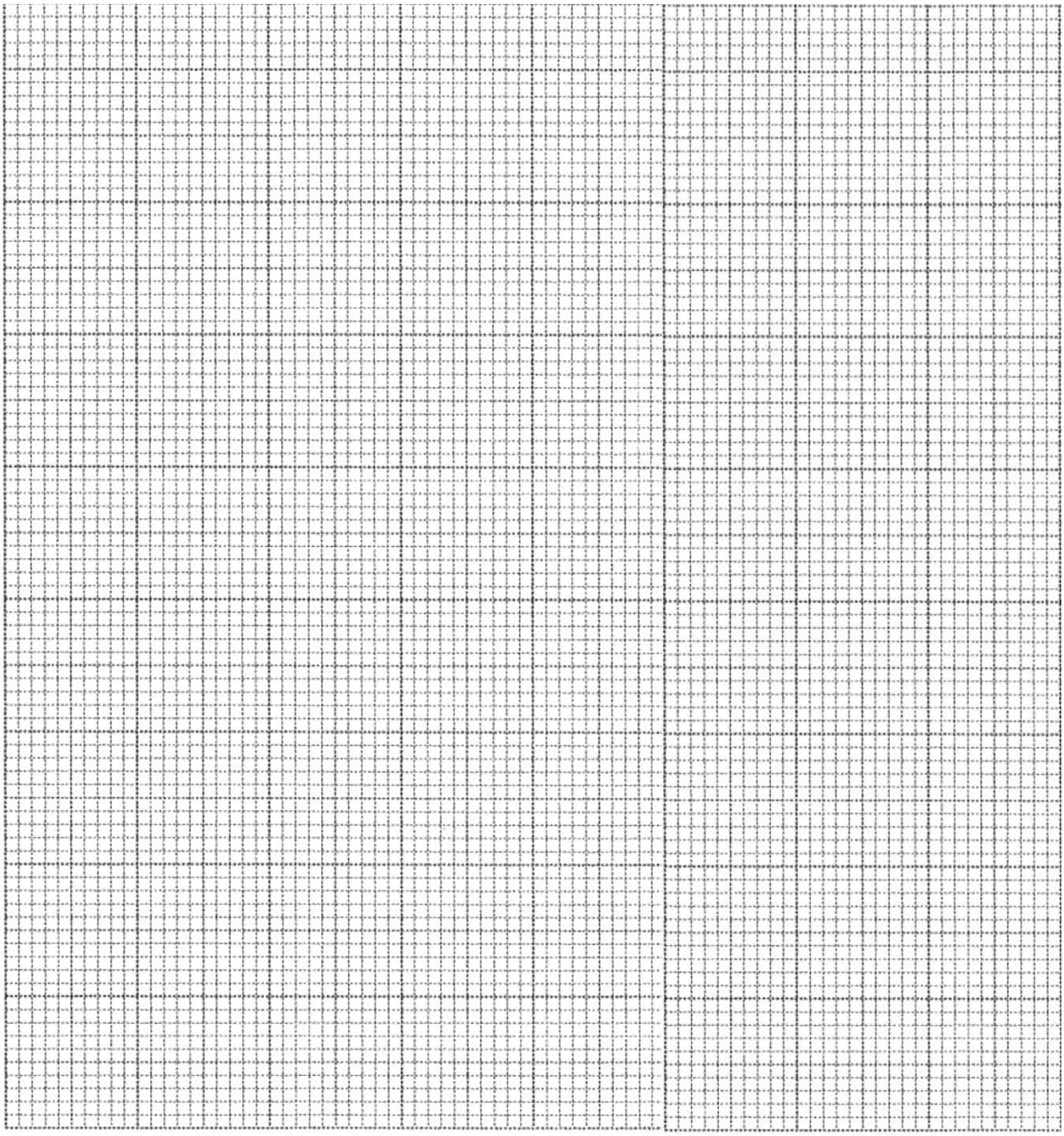
(i) Given that the line passes through the points $(1,3)$ and $(3,11)$, express y in terms of x. [3]

(ii) Explain clearly why the range of values of x for which the equation found in part **(i)** is not defined for $-\frac{1}{2} \le x \le \frac{1}{2}$. [3]

(b) A new machine is used to measure the surface area of a solid, A cm^2 with a length of x cm. It is known that A and x are related by the equation, $A = px + qx^2$, where p and q are constants. The table below shows corresponding values of A and x. One of the values of A is believed to be inaccurate.

x (cm)	2	4	6	8	10
A (cm^2)	42	148	318	552	700

(ii) Draw the graph of $\frac{A}{x}$ plotted against x, using a scale of 1 cm for 1 unit on the x-axis and a scale of 1 cm for 5 units on the $\frac{A}{x}$ axis. [3]



(iii) Use the graph to estimate the value of each of the constants p and q.
[3]

(iv) Identify the inaccurate value of A and suggest a reason why this may be inaccurate.

[2]

4 The table below shows experimental values of two variables, x and y.

x	1	2	3	4	5
y	0.50	2.12	3.18	4.00	4.70

It is known that x and y are related by the equation constants $y = \frac{a}{\sqrt{x}} + b\sqrt{x}$

where a and b are constants

(i) Plot $\frac{y}{\sqrt{x}}$ against $\frac{1}{x}$ and draw a straight line. [3]

(ii) Use your graph to estimate the value of each of the constants a and b. [3]

(iii) By drawing another straight line on the graph in part (i), solve the following simultaneous equations. [5]

$$y = \frac{a}{\sqrt{x}} + b\sqrt{x}$$

$$y\sqrt{x} = 3$$

5 **(a)** The variables x and y are related in such a way that when $\frac{x}{y}$ is plotted against $\frac{1}{x}$, a straight line is obtained. The line passes through (2, 9) and (5, 3). Find an expression for y in terms of x. [4]

(b) The table shows experimental values of two variables, x and y.

x	2	4	6	8
y	8.48	5.99	4.90	4.24

It is known that x and y are related by the equation $x^n y = k$, where n and k are constants. Draw a suitable straight line graph to represent the above data and use it to estimate the values of n and k.

[6]

6 A bowl of liquid is heated to a high temperature. It subsequently cools in such a way that its temperature, T °C , is given by $T = 15 + Ae^{-kt}$, where t minutes is the time of cooling and A and k are constants. The table below shows corresponding values of t and T.

t	5	10	15	20	25
T	58.8	40.3	29.6	23.4	19.9

(i) Draw the graph of $\ln(T-15)$ against t. [3]

(ii) Use the graph to estimate the value of each of the constants A and k. [5]

(iii) State the initial temperature of the liquid. [1]

(iv) Use the graph to estimate the time taken for the temperature of the liquid to drop to half of its original temperature. [2]

ANSWERS

1 Variables x and y are related by the equation $y = ab^x$ where a and b are constants. $\frac{x}{y}$

The table below shows values of x and y.

x	1	2	3	4	5	6
y	4.8	9.6	19.2	38.4	76.8	153.6

(i) Draw the graph of $\lg y$ against x, using a scale of 2 cm for 1 unit on the x-axis and 1 cm for 0.1 unit on the $\lg y$-axis. [3]

x	1	2	3	4	5	6
$\lg y$	0.681	0.982	1.28	1.58	1.89	2.19

(ii) Use the graph to estimate the value of a and of b. [3]

$y = ab^x$

$\lg y = \lg ab^x$

$\lg y = \lg a + \lg b^x$

$\lg y = \lg a + x \lg b$

From the graph,

$\lg b = \text{gradient}$

$= \frac{2.20 - 0.38}{6 - 0}$

$= \frac{9}{300}$

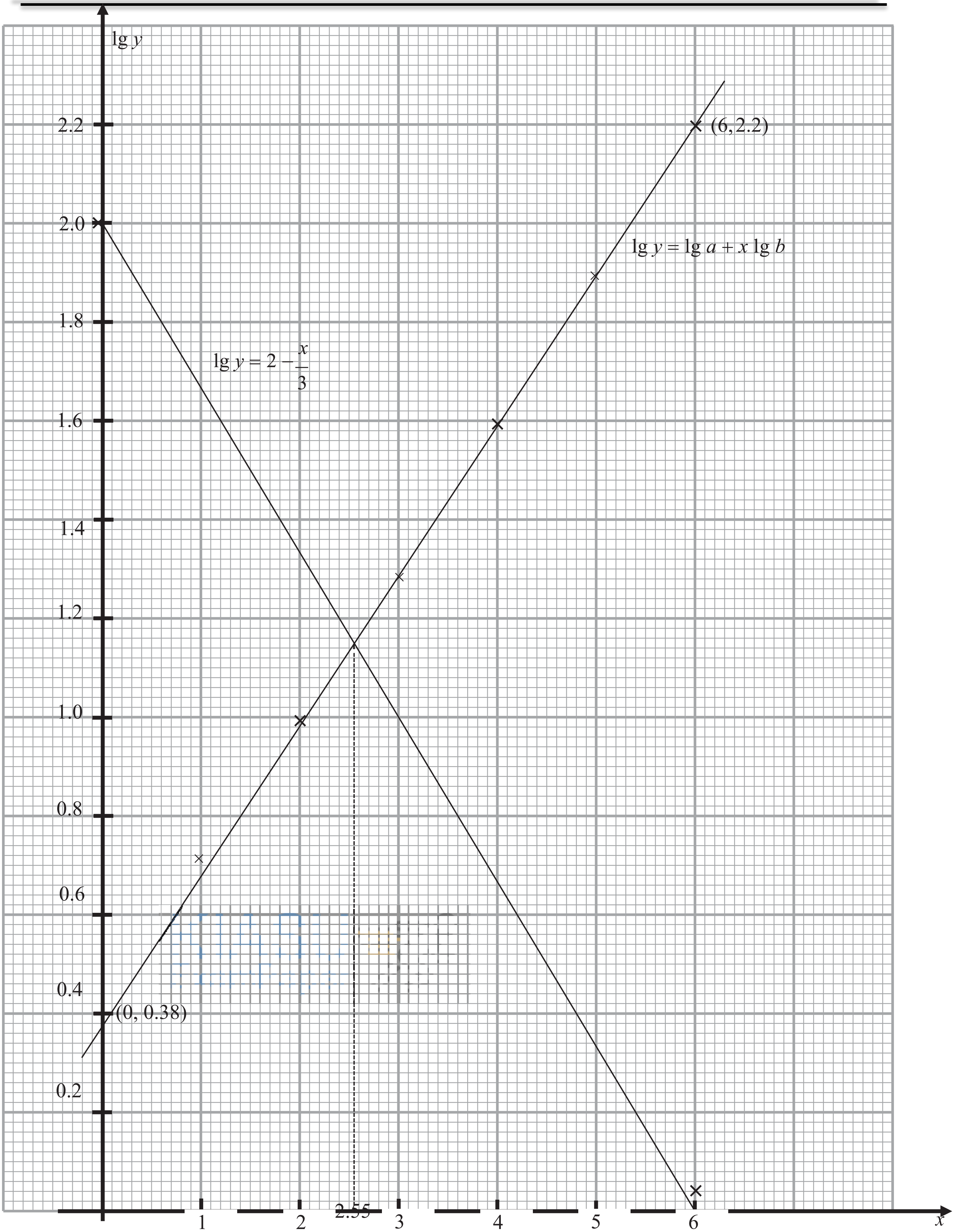
$b = 10^{\frac{91}{300}}$

$= 2.01$ (3 s.f)

$\lg a = 0.38$

$a = 10^{0.38}$

$= 2.40$ (3 s.f)


lg y
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
(6,2.2)
lg y = lg a + x lg b
lg y = 2 − x/3
(0, 0.38)
1
2
2.55
3
4
5
6
x

(iii) By adding a suitable straight line to your graph in **part (i)**, estimate the solution to the equation $ab^x = 10^{2-\frac{x}{3}}$. [2]

$ab^x = 10^{2-\frac{x}{3}}$

$\lg ab^x = \lg 10^{2-\frac{x}{3}}$

$\lg y = \lg 10^{2-\frac{x}{3}}$

$= \left(2-\frac{x}{3}\right)\lg 10$

Draw $\lg y = 2 - \frac{x}{3}$ (Draw $Y = 2 - \frac{X}{3}$ which is a straight line)

From the graph, $x = 2.55$

(iv) The point $(14, k)$ lies on the graph of $\lg y$ against x, using the values of a and b that were found in part (ii), find the value of k. [1]

$\lg y = 0.38 + \frac{91}{300}x$

$k = 0.38 + \frac{91}{300}(14)$

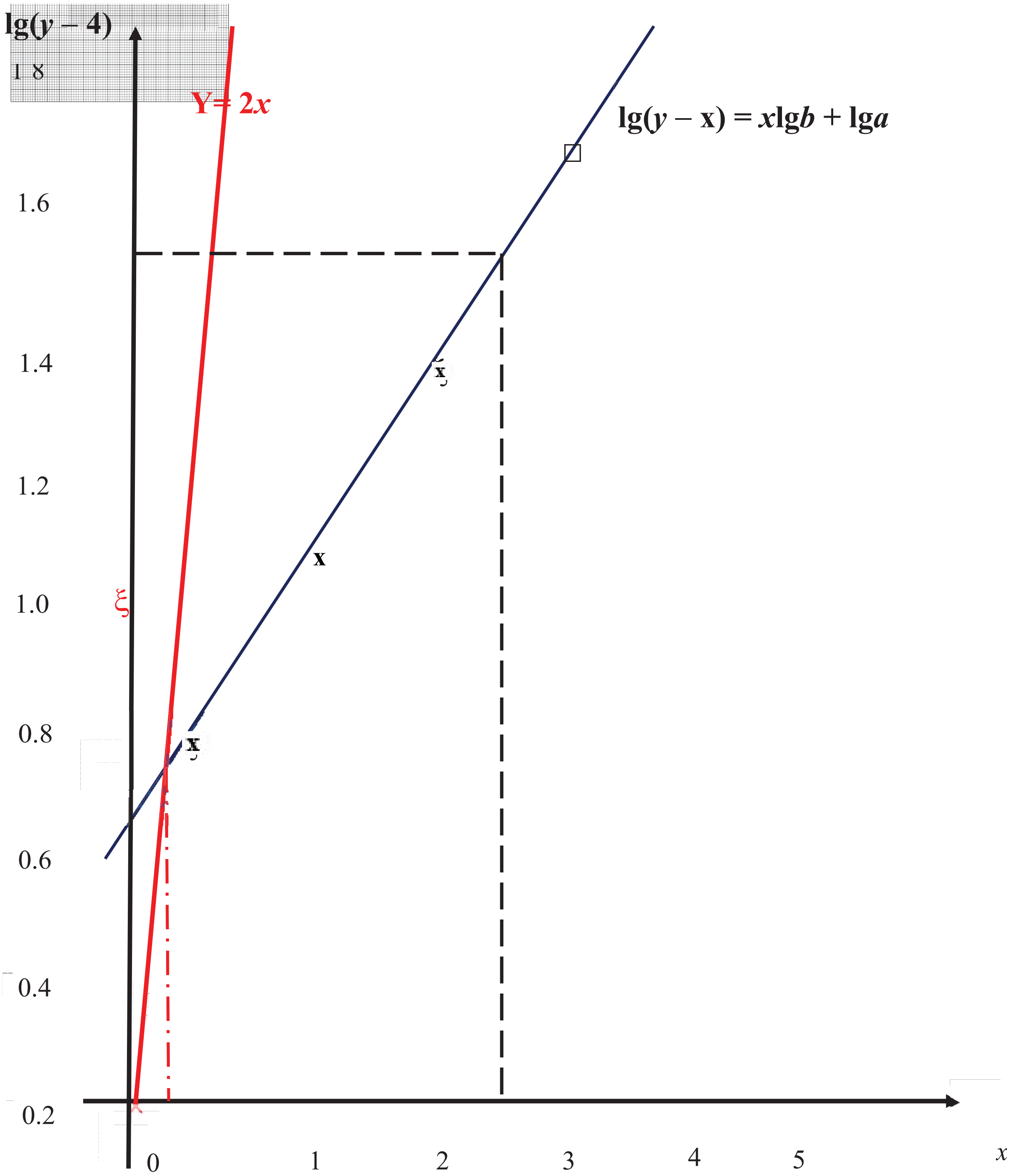
$= 4.63$ (3 s.f)

2 It is known that x and y are related by an equation, $y = ab^x + 4$ where a and b are constants.

x	1	2	3	4
y	10	16	28	52

(i) Draw a straight line graph of $\lg(y-4)$ against x, using a scale of 2 cm to 1 unit on the x-axis and 2 cm to 0.2 units on the $\lg(y-4)$ -axis. [2]

x	1	2	3	4
y	10	16	28	52
$\lg(y-4)$	0.778	1.08	1.38	1.68



(ii) Use your graph to estimate the value of a and of b. [5]

$y = ab^x + 4$

$y - 4 = ab^x$

$\lg(y-4) = \lg(ab^x)$

$\lg(y-4) = x\lg b + \lg a$

Gradient $= \dfrac{1.68 - 1.08}{4 - 2}$

$\lg b = 0.3$

$b = 2.00$ (to 3 s.f.)

vertical intercept $= 0.5$

$\lg a = 0.5$

$a = 3.16$

(iii) Use your graph to estimate the value of x when $y = 33$. [2]

When $y = 33$, $\lg(y-4) = \lg 29$

≈ 1.462 or 1.46

$x = 3.25$

(iv) On the same diagram, draw the line representing the equation $y - 4 = 10^{2x}$ and hence

find the value of x for which $10^{2x} = ab^x$. [2]

$y - 4 = 10^{2x}$

$\therefore \lg(y-4) = 2x$ is the equation of line representing $y - 4 = 10^{2x}$.

Draw the line $Y = 2X$

$10^{2x} = ab^x$

$\lg 10^{2x} = \lg(ab^x)$

$2x = \lg a + x\lg b$

Value of x is the x-coordinate of the point of intersection of $Y = 2X$ and $Y = \lg a + x\lg b$

$x = 0.3$ or 0.25

3 (a) (i) $y = \ln(4x^2 - 1) + 2$

(b) (ii) $p = 5$, $q = 8$ (ii) Inaccurate $A = 700$

<table>
<tr>
<td>4(i)</td>
<td>

$y = \frac{a}{\sqrt{x}} + b\sqrt{x}$

$\frac{y}{\sqrt{x}} = \frac{a}{x} + b$

<table>
<tr><td>$\frac{1}{x}$</td><td>1</td><td>0.5</td><td>0.33</td><td>0.25</td><td>0.20</td></tr>
<tr><td>$\frac{y}{\sqrt{x}}$</td><td>0.5</td><td>1.50</td><td>1.84</td><td>2.0</td><td>2.10</td></tr>
</table>

</td>
<td>A1 (table)

B2 (4 to 5 correct points for line of best fit)</td>
</tr>
<tr>
<td>4(ii)</td>
<td>$a = -2$
$b = 2.5$</td>
<td>M1 , A1
A1</td>
</tr>
<tr>
<td>4(iii)</td>
<td>

$y\sqrt{x} = 3$

$\frac{y}{\sqrt{x}} = \frac{3}{x}$

Draw $\frac{y}{\sqrt{x}}$ against $\frac{1}{x}$.

<table>
<tr><td>$\frac{1}{x}$</td><td>1</td><td>0.5</td><td>0.25</td></tr>
<tr><td>$\frac{y}{\sqrt{x}}$</td><td>3</td><td>1.5</td><td>0.75</td></tr>
</table>

Point of intersection is (0.5 , 1.5)

$\frac{1}{x} = 0.5$

$x = 2$

$\frac{y}{\sqrt{x}} = 1.5$

$y = 1.5 \times \sqrt{2} = 2.12$

</td>
<td>A1

B1 (str line graph)

A1

A1 (correct *x* value)

A1 (correct *y* value)</td>
</tr>
</table>

5	(a) The variables x and y are related in such a way that when $\frac{x}{y}$ is plotted against $\frac{1}{x}$, a straight line is obtained. The line passes through (2, 9) and (5, 3). Find an expression for y in terms of x. [4]	
(i)	Let $Y = \frac{x}{y}, X = \frac{1}{x}$ Gradient $= \frac{9-3}{2-5} = -2$ $\therefore Y - 3 = -2(X-5)$ $Y = -2X + 13$ $\frac{x}{y} = -\frac{2}{x} + 13$ $\frac{x}{y} = \frac{13x-2}{x}$ $y = \frac{x^2}{13x-2}$	M1 M1 M1 A1

(b) The table shows experimental values of two variables, x and y.

x	2	4	6	8
y	8.48	5.99	4.90	4.24

It is known that x and y are related by the equation $x^n y = k$, where n and k are constants. Draw a suitable straight line graph to represent the above data and use it to estimate the values of n and k. [6]

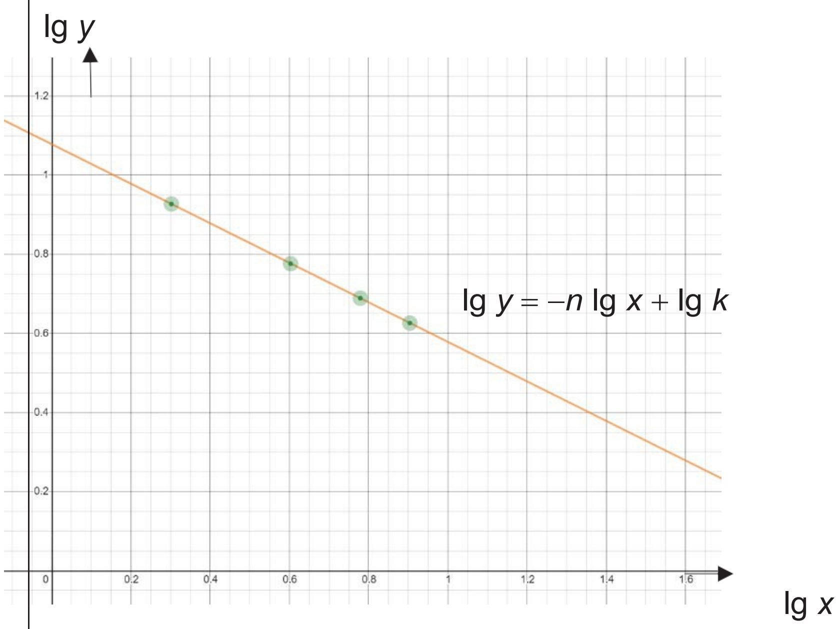
(ii)

$x^n y = k$

$\lg y = -n \lg x + \lg k$ — M1

x	2	4	6	8
y	8.48	5.99	4.90	4.24
$\lg x$	0.301	0.602	0.778	0.903

B1



G1 – correct points

G1 – y-intercept

Deduct 1 mark for labels

$\lg k = 1.08$ (1.06 – 1.10)

$k = 12.0$ **(11.5 – 12.6)** — A1

$$-n = \frac{1.00 - 0.60}{0.15 - 0.95}$$

$= -0.500$

$\therefore n = 0.500$ (0.45 – 0.55) — A1

6 A bowl of liquid is heated to a high temperature. It subsequently cools in such a way that its temperature, T °C, is given by $T = 15 + Ae^{-kt}$, where t minutes is the time of cooling and A and k are constants. The table below shows corresponding values of t and T.

t	5	10	15	20	25
T	58.8	40.3	29.6	23.4	19.9

(i) Draw the graph of $\ln(T-15)$ against t. **[3]**

t	5	10	15	20	25
T	58.8	40.3	29.6	23.4	19.9
$\ln(T-15)$	3.78	3.23	2.68	2.13	1.59

[B1 for table]