

OCR

Oxford Cambridge and RSA

Wednesday 07 October 2020 – Afternoon

A Level Mathematics A

H240/01 Pure Mathematics

Time allowed: 2 hours

You must have:

- the Printed Answer Booklet
- a scientific or graphical calculator



1 (a) For a small angle θ , where θ is in radians, show that $2\cos\theta + (1 - \tan\theta)^2 \approx 3 - 2\theta$. [3]

(b) Hence determine an approximate solution to $2\cos\theta + (1 - \tan\theta)^2 = 28\sin\theta$. [2]

$$\cos\theta = 1 - \frac{1}{2}\theta^2$$

$$\tan\theta = \theta$$

$$\sin\theta = \theta$$

$$\begin{aligned}
 a) \quad & 2\cos\theta + (1 - \tan\theta)^2 \\
 & \approx 2\left(1 - \frac{1}{2}\theta^2\right) + (1 + \theta)^2 \\
 & \approx 2 - \theta^2 + 1 + 2\theta + \theta^2 \\
 & \approx 3 - 2\theta \quad \text{as required}
 \end{aligned}$$

$$b) \quad 2\cos\theta + (1 - \tan\theta)^2 = 28\sin\theta$$

$$3 - 2\theta = 28\theta$$

$$3 = 30\theta$$

$$\theta = \frac{1}{10}$$

2 Simplify fully.

(a) $\sqrt{12a} \times \sqrt{3a^5}$

[2]

(b) $(64b^3)^{\frac{1}{3}} \times (4b^4)^{-\frac{1}{2}}$

[2]

(c) $7 \times 9^{3c} - 4 \times 27^{2c}$

[4]

$$\begin{aligned}
 a) & \quad \sqrt{12a} \times \sqrt{3a^5} \\
 &= \sqrt{12} \times a^{\frac{1}{2}} \times \sqrt{3} \times a^{\frac{5}{2}} \\
 &= \sqrt{36} a^{\frac{5}{2}} \\
 &= 6 a^3
 \end{aligned}$$

$$\begin{aligned}
 b) & \quad (8+5^3)^{\frac{1}{2}} \times (4b^4)^{-\frac{1}{2}} \\
 &= 4b \times 4^{-\frac{1}{2}} \times b^{-2} \\
 &= 4b^{-1} \times \frac{1}{\sqrt{4}} = \frac{4}{\sqrt{4}} \times \frac{1}{b} = \frac{2}{b}
 \end{aligned}$$

(e) $7 \times 9^{3c} - 4 \times 27^{2c}$

[4]

$$\begin{aligned}
 & c) \quad 7 \times (3^2)^{3c} - 4 \times (3^3)^{2c} \\
 & = 7 \times 3^{6c} - 4 \times 3^{6c} \\
 & = 3 \times 3^{6c} \\
 & = 3^{6c+1}
 \end{aligned}$$

3 A cylindrical metal tin of radius r cm is closed at both ends. It has a volume of 16000π cm³.

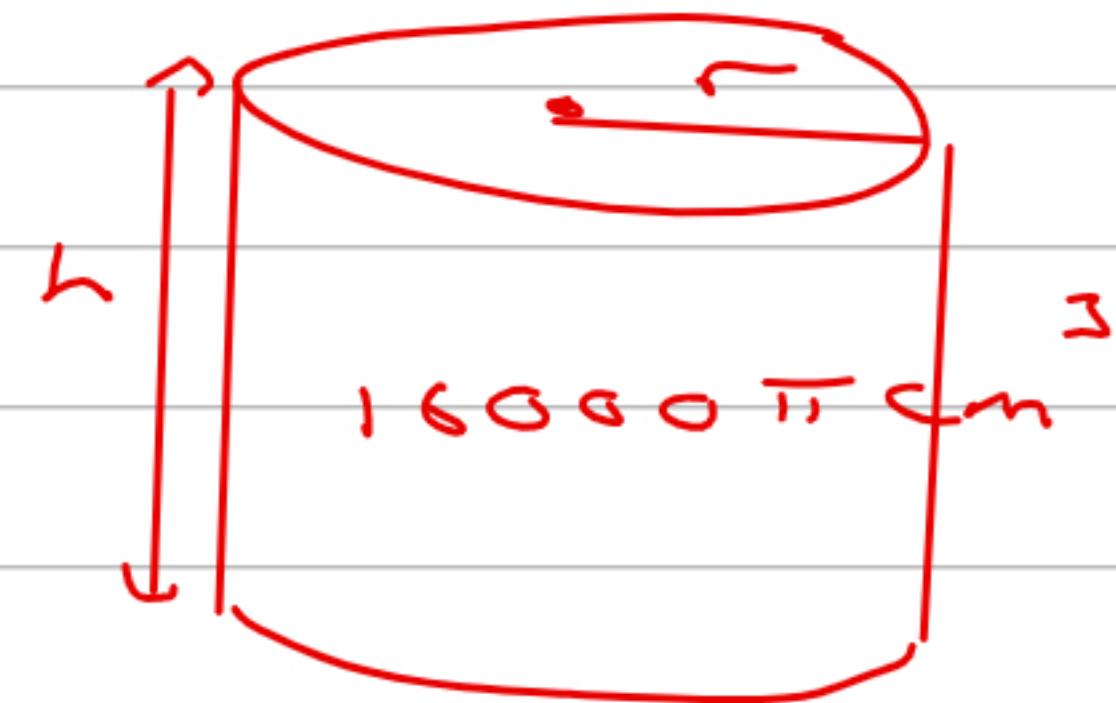
(a) Show that its total surface area, A cm², is given by $A = 2\pi r^2 + 32000\pi r^{-1}$. [4]

(b) Use calculus to determine the minimum total surface area of the tin. You should justify that it is a minimum. [6]

$$a) V = \pi r^2 h$$

$$16000\pi = \cancel{\pi} \times r^2 \times h$$

$$h = \frac{16000}{r^2}$$



Surface area, $A = 2\pi r^2 + 2\pi rh$
 $= 2\pi r^2 + 2\pi r \left(\frac{16000}{r^2} \right)$

$$= 2\pi r^2 + 32000\pi r^{-1}$$

as required

b) $A = 2\pi r^2 + 32000 \pi r^{-1}$

$$\frac{dA}{dr} = 4\pi r - 32000 \pi r^{-2}$$

minimum when $\frac{dA}{dr} = 0$

$$4\cancel{\pi}r = \frac{32000 \cancel{\pi}}{r^2}$$

$$r^3 = \sqrt{8000}$$

$$r = 20$$

$$A = 2\pi r^2 + \frac{32000}{r} = 2\pi r^2 + \frac{32000}{20} = 2400\pi \text{ cm}^2$$

$$\frac{dA}{dr} = 4\pi r - 32000 \pi r^{-2}$$

$$\frac{d^2A}{dr^2} = 4\pi + 64000 \pi r^{-3}$$

when $r = 20$

$$\frac{d^2A}{dr^2} = 12\pi$$

as $\frac{d^2A}{dr^2} > 0$ this is a minimum

4 Prove by contradiction that there is no greatest multiple of 5.

[3]

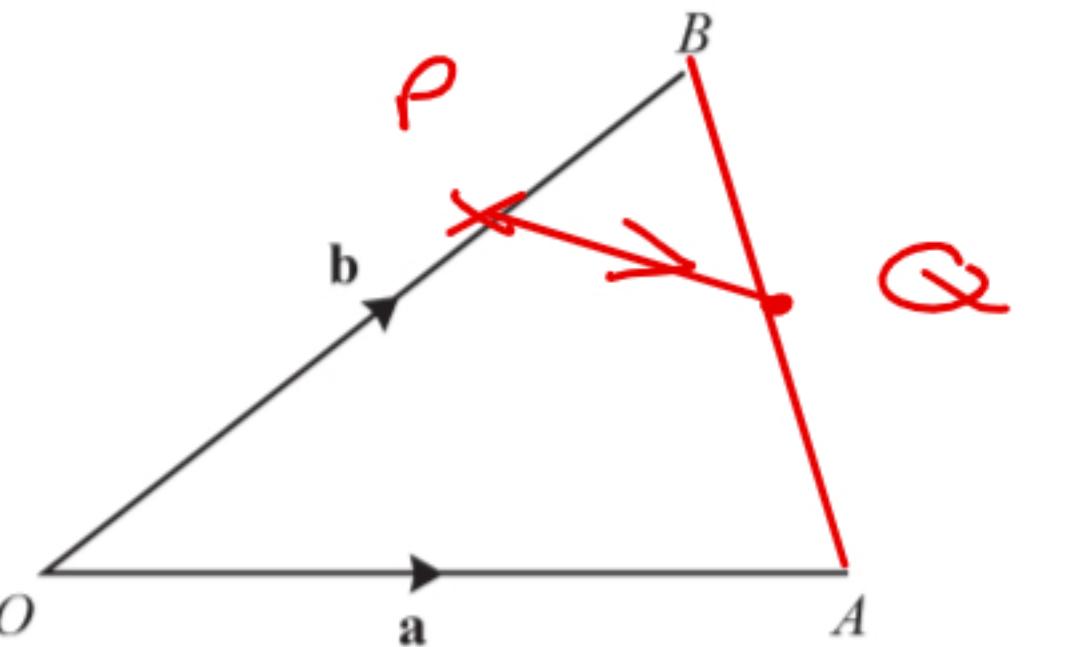
Assumption - there is a greatest multiple of 5 that exists, $5n$, with n an integer

Next multiple of 5 is $5n + 5$

As $5n + 5 > 5n$ there does exist a multiple of 5 greater than $5n$

This contradicts the assumption
Therefore there is no greatest multiple of 5

5



The diagram shows points A and B , which have position vectors \mathbf{a} and \mathbf{b} with respect to an origin O .
 P is the point on OB such that $OP : PB = 3:1$ and Q is the midpoint of AB .

(a) Find \overrightarrow{PQ} in terms of \mathbf{a} and \mathbf{b} .

[2]

$$\begin{aligned}\overrightarrow{OP} &= \frac{3}{4} \underline{\mathbf{b}} & \overrightarrow{PB} &= \frac{1}{4} \underline{\mathbf{b}} \\ \overrightarrow{BA} &= \overrightarrow{BO} + \overrightarrow{OA} = -\underline{\mathbf{b}} + \underline{\mathbf{a}}\end{aligned}$$

$$\begin{aligned}\overrightarrow{PQ} &= \overrightarrow{PB} + \overrightarrow{BQ} = \frac{1}{4} \underline{\mathbf{b}} + \frac{1}{2} (-\underline{\mathbf{b}} + \underline{\mathbf{a}}) \\ &= \frac{1}{4} \underline{\mathbf{b}} - \frac{1}{2} \underline{\mathbf{b}} + \frac{1}{2} \underline{\mathbf{a}} \\ &= -\frac{1}{4} \underline{\mathbf{b}} + \frac{1}{2} \underline{\mathbf{a}}\end{aligned}$$

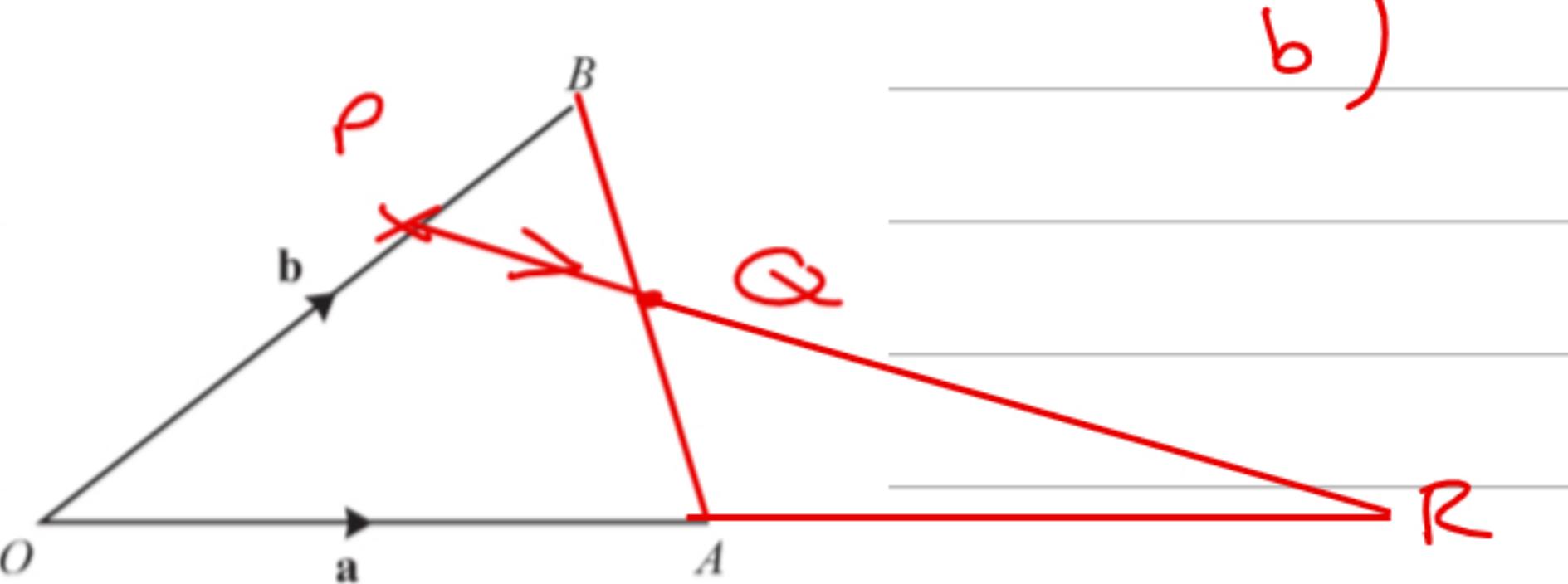
The line OA is extended to a point R , so that PQR is a straight line.

- (b) Explain why $\overrightarrow{PR} = k(2\mathbf{a} - \mathbf{b})$, where k is a constant.

[2]

- (c) Hence determine the ratio $OA : AR$.

[4]

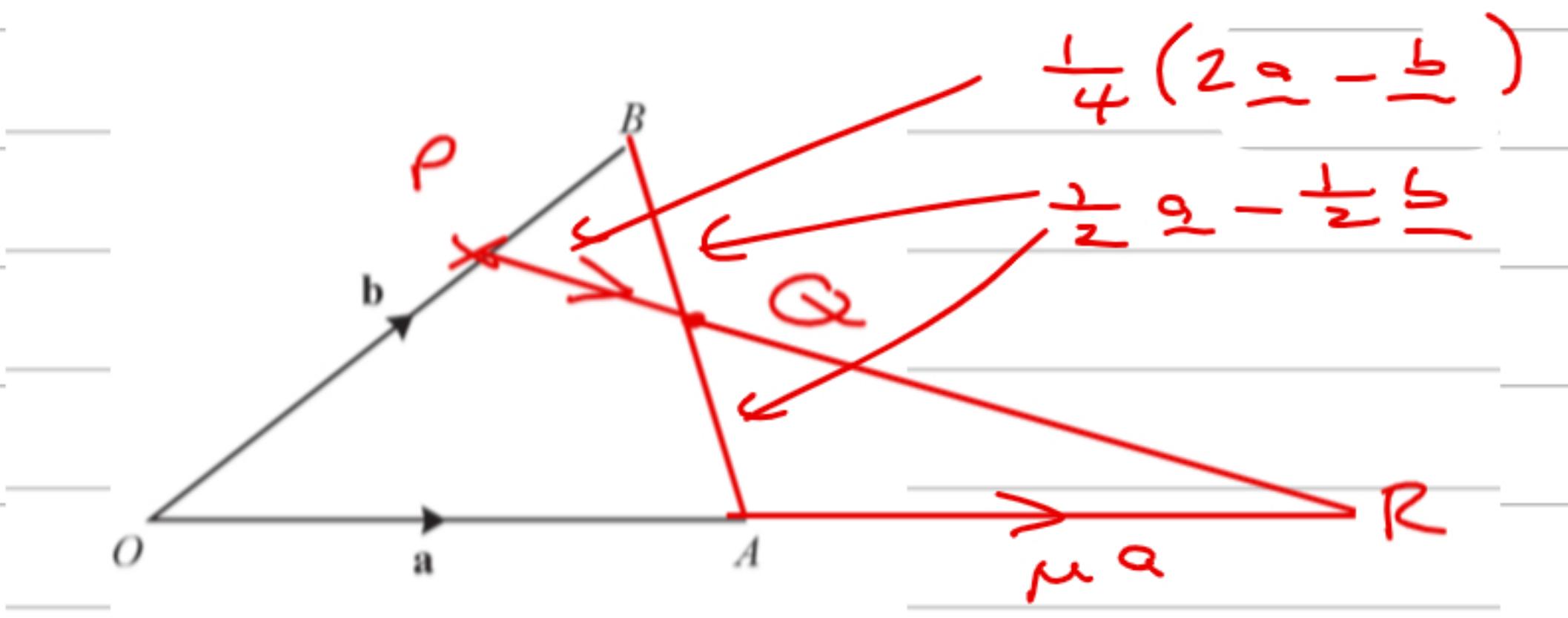


b)

From part a)

$$\begin{aligned}\overrightarrow{PQ} &= -\frac{1}{4}\underline{b} + \frac{1}{2}\underline{a} \\ \overrightarrow{PR} &= \frac{1}{4}(2\underline{a} - \underline{b})\end{aligned}$$

as PR is a straight line,
it must be a multiple of
 $2\underline{a} - \underline{b}$, $\therefore k(2\underline{a} - \underline{b})$



$$\vec{PR} = k(2\vec{a} - \vec{b})$$

$$\vec{PR} = \vec{PO} + \vec{OR}$$

$$k(2\vec{a} - \vec{b}) = -\frac{3}{4}\vec{b} + \vec{a} + \mu\vec{a}$$

$$2k\vec{a} - \vec{a} - \mu\vec{a} = -\frac{3}{4}\vec{b} + k\vec{b} \quad \textcircled{1}$$

$$\vec{a}(2k - 1 - \mu) = \vec{b}(k - \frac{3}{4})$$

in PR

\vec{a} component is double \vec{b}

$\therefore \vec{a} \downarrow$

$$2k - 1 - \mu = 2(k - \frac{3}{4})$$

~~$$2k - 1 - \mu = 2k - \frac{3}{2}$$~~

$$\frac{3}{2} - 1 = \mu$$

$$\mu = \frac{1}{2}$$

OA : AR

$$1 : \frac{1}{2}$$

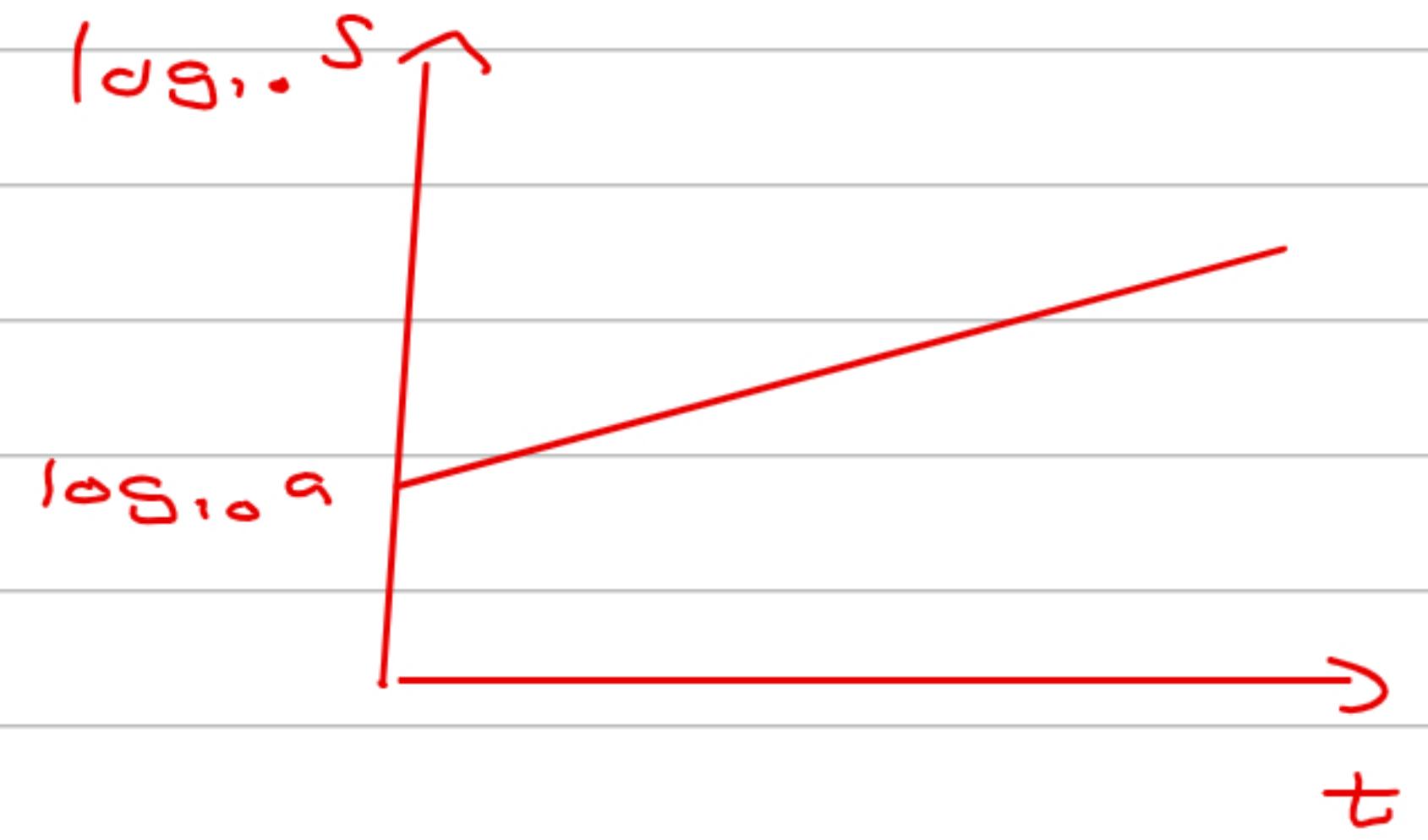
$$2 : 1$$

- 6 A mobile phone company records their annual sales on 31st December every year.

Paul thinks that the annual sales, S million, can be modelled by the equation $S = ab^t$, where a and b are both positive constants and t is the number of years since 31st December 2015.

Paul tests his theory by using the annual sales figures from 31st December 2015 to 31st December 2019. He plots these results on a graph, with t on the horizontal axis and $\log_{10}S$ on the vertical axis.

- (a) Explain why, if Paul's model is correct, the results should lie on a straight line of best fit on his graph. [3]



a) If $S = a b^t$

then the graph of $\log_{10}S$ against t
will be a straight line with gradient
 $\log_{10}b$ and vertical intercept $\log_{10}a$

$S = a \times b^t$ then taking logs

$$\log_{10}S = \log_{10}a + t \log_{10}b$$

↑ ↑
 intercept gradient

The results lie on a straight line of best fit which has a gradient of 0.146 and an intercept on the vertical axis of 0.583.

- (b) Use these values to obtain estimates for a and b , correct to 2 significant figures. [2]

- (c) Use this model to predict the year in which, on the 31st December, the annual sales would first be recorded as greater than 200 million. [3]

- (d) Give a reason why this prediction may not be reliable. [1]

b) $\log_{10} S = \log_{10} a + t \log_{10} b$

\uparrow
gradient

$$\log_{10} b = 0.146$$

$$b = 10^{0.146} = 1.4 \quad (2 \text{ sf})$$

$$\log_{10} a = 0.583$$

$$a = 10^{0.583} = 3.8 \quad (2 \text{ sf})$$

c) $\log_{10}(200) = 2.301029996$

$$2.301029996 = 0.583 + t \times 0.146$$

$$t = \frac{2.301029996 - 0.583}{0.146}$$

$$t = 11.767 \text{ years since } 31-12-15$$

In year 2027 sales would exceed
200 million

d) 11.67 years is a long time to assume the
model will still be valid

- 7 Two students, Anna and Ben, are starting a revision programme. They will both revise for 30 minutes on Day 1. Anna will increase her revision time by 15 minutes for every subsequent day. Ben will increase his revision time by 10% for every subsequent day.

- (a) Verify that on Day 10 Anna does 94 minutes more revision than Ben, correct to the nearest minute. [3]

Let Day X be the first day on which Ben does more revision than Anna.

a) Anna Day 1 2

30	45
$\curvearrowright +15$	

arithmetic progression $a = 30, d = 15$

$$\text{day } 10 = a + 9d = 30 + 9 \times 15 = 165 \text{ minutes}$$

Ben Day 1 2

30	$\times 1.1 \rightarrow 33$
----	-----------------------------

geometric progression $a = 30, r = 1.1$ day $10 = a r^9 = 30 \times 1.1^9$
 $= 70.738$

$$165 - 70.738 \dots = 94.26 \dots = 94 \text{ minutes}$$

Let Day X be the first day on which Ben does more revision than Anna.

- (b) Show that X satisfies the inequality $X > \log_{1.1}(0.5X+0.5) + 1$.

[3]

- (c) Use the iterative formula $x_{n+1} = \log_{1.1}(0.5x_n + 0.5) + 1$ with $x_1 = 10$ to find the value of X .

You should show the result of each iteration.

[3]

- (d) (i) Give a reason why Anna's revision programme may not be realistic.

[1]

- (ii) Give a **different** reason why Ben's revision programme may not be realistic.

[1]

$$\text{Anna} \quad a + (x-1)d \\ 30 + 15(x-1)$$

$$\text{Ben} \quad a - \frac{x-1}{1.1^{x-1}} \\ 30 \times 1.1^{-x+1}$$

b) $\therefore 30 \times 1.1^{-x+1} > 30 + 15(x-1)$

divide through by 30

$$1.1^{-x+1} > 1 + 0.5(x-1)$$

$$1.1^{-x+1} > 0.5x + 0.5$$

taking $\log_{1.1}$ to both sides

$$\log_{1.1} 1.1^{x-1} > \log_{1.1} (0.5x + 0.5)$$

$$(x-1) \log_{1.1}(1.1) > \log_{1.1} (0.5x + 0.5)$$

$$x-1 > \log_{1.1} (0.5x + 0.5)$$

$$x > \log_{1.1} (0.5x + 0.5) + 1$$

as required

- (c) Use the iterative formula $x_{n+1} = \log_{1.1}(0.5x_n + 0.5) + 1$ with $x_1 = 10$ to find the value of X .

You should show the result of each iteration.

[3]

$\downarrow 0$

$$x_2 = \log_{1.1}(0.5 \times 10 + 0.5) + 1 = 18.8863$$

$$x_3 = 25.09904937$$

$$x_4 = 27.9514937$$

$$x_5 = 29.03976053$$

$$x_6 = 29.42691809$$

$$x_7 = 29.56127756$$

$$x_8 = 29.6075065$$

$$x_9 = 29.62336546$$

$$x_{10} = 29.6288004$$

as $x >$

$x = 30$

(d) (i) Give a reason why Anna's revision programme may not be realistic. [1]

(ii) Give a **different** reason why Ben's revision programme may not be realistic. [1]

8 (a) Differentiate $(2+3x^2)e^{2x}$ with respect to x .

[3]

(b) Hence show that $(2+3x^2)e^{2x}$ is increasing for all values of x .

[4]

a) $u = 2 + 3x^2$ $v = e^{2x}$
 $u' = 6x$ ~~$v' = 2e^{2x}$~~

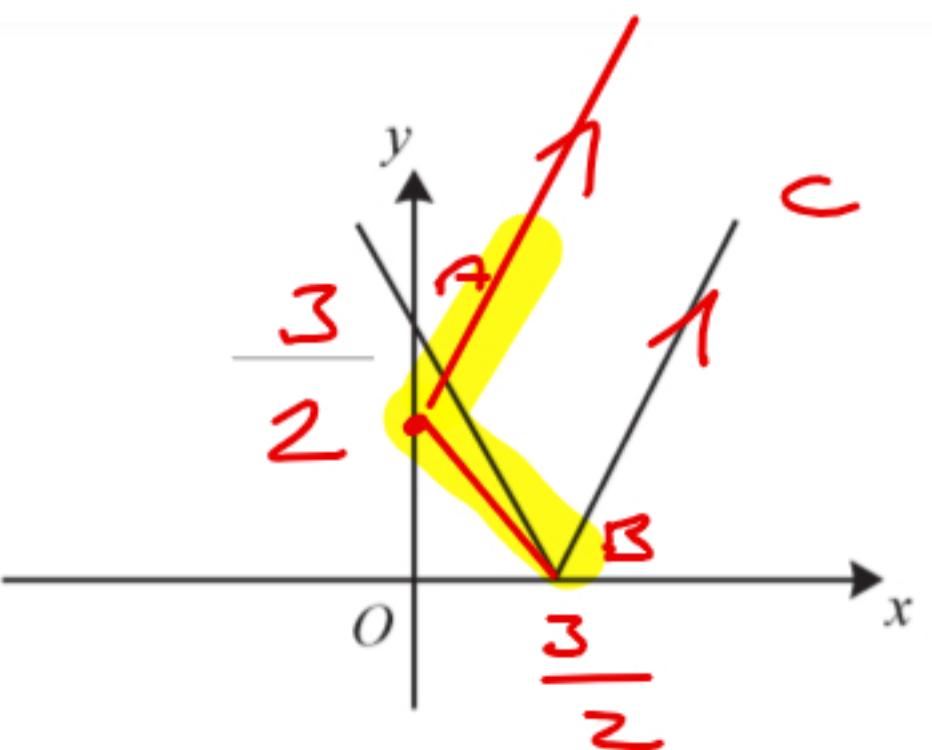
$$\begin{aligned}\frac{d}{dx} (2+3x^2)e^{2x} &= 2e^{2x}(2+3x^2) + 6x e^{2x} \\&= 2e^{2x} \underbrace{(2+3x^2+3x)}_{\uparrow 3x^2+3x+2} \\&= 3(x^2+x+\frac{2}{3}) \\&= 3((x+\frac{1}{2})^2 - (\frac{1}{2})^2 + \frac{5}{12}) \\&= 3((x+\frac{1}{2})^2 + \frac{5}{12}) \\&= 3((x+\frac{1}{2})^2 + \frac{5}{4})\end{aligned}$$

e^{2x} is +ve
for all x

b) as e^{2x} and $(2+3x^2+3x)$
are both +ve for all x ,
 $(2+3x^2)e^{2x}$ is increasing
for all values of x

minimum pt is $y = \frac{5}{4}$
so function
always +ve

9



The diagram shows the graph of $y = |2x - 3|$.

- (a) State the coordinates of the points of intersection with the axes.

[2]

$$(0, 3) \text{ and } \left(\frac{3}{2}, 0\right)$$

- (b) Given that the graphs of $y = |2x - 3|$ and $y = ax + 2$ have two distinct points of intersection, determine

- (i) the set of possible values of a ,

[4]

- (ii) the x -coordinates of the points of intersection of these graphs, giving your answers in terms of a .

[3]

$$\text{b(i) gradient } AB = -\frac{3}{\frac{3}{2}} = -2$$

$$\text{gradient } BC = 2$$

$$\text{gradient from } (0, 2) \text{ to } B = -\frac{2}{\frac{3}{2}} = -\frac{4}{3}$$

would have 1 solution

For 2 crossings $a < 2$ and $a > -\frac{4}{3}$

$$\therefore -\frac{4}{3} < a < 2$$

(ii)

$$|2x - 3| = ax + 2$$

$$2x - 3 = ax + 2$$

$$2x - ax = 5$$

$$x(2-a) = 5$$

$$x = \frac{5}{2-a}$$

f : $y = |2x - 3|$
g : $y = x + 2$
+ Input...

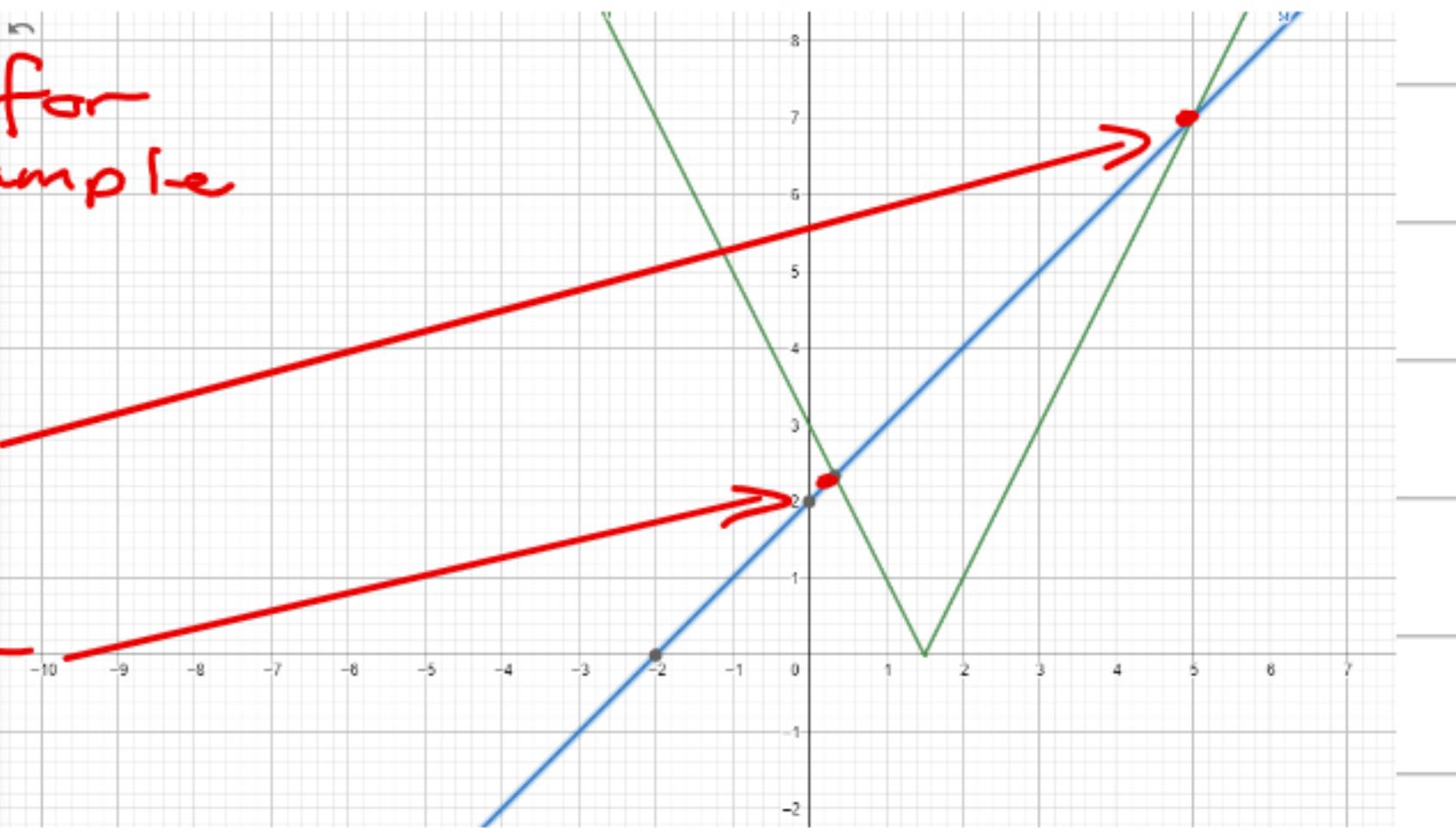
for example

if $a=1$

$$x = 5$$

or

$$x = \frac{1}{3}$$



$$-(2x - 3) = ax + 2$$

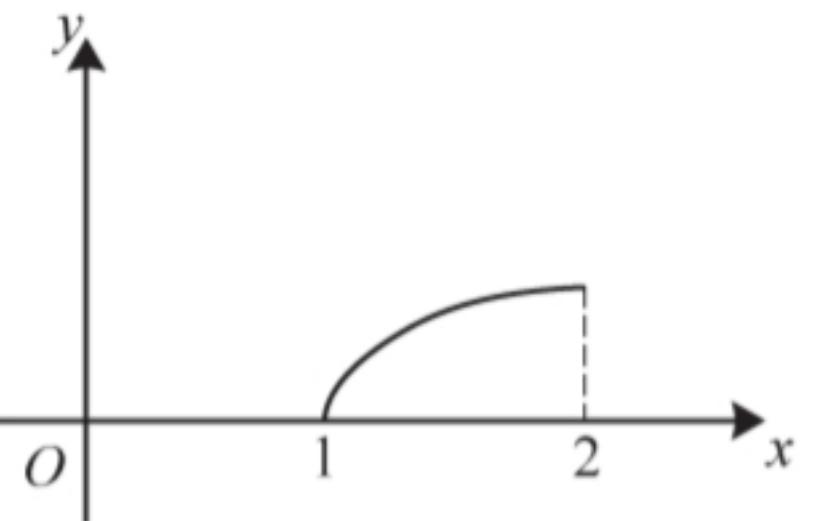
$$-2x + 3 = ax + 2$$

$$1 = 2x + ax$$

$$1 = x(2+a)$$

$$x = \frac{1}{2+a}$$

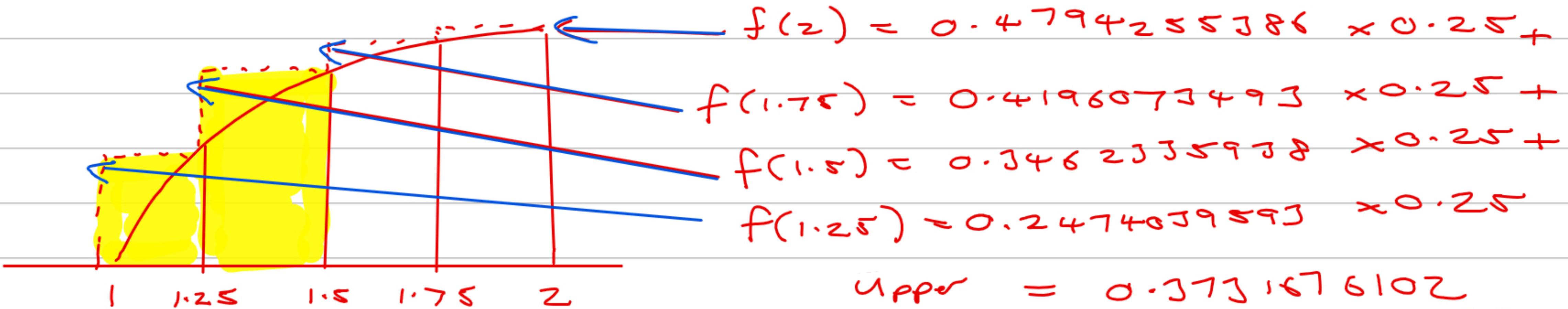
10



The diagram shows the curve $y = \sin\left(\frac{1}{2}\sqrt{x-1}\right)$, for $1 \leq x \leq 2$.

- (a) Use rectangles of width 0.25 to find upper and lower bounds for $\int_1^2 \sin\left(\frac{1}{2}\sqrt{x-1}\right) dx$. Give your answers correct to 3 significant figures. [4]

upper bounds
(above curve)



$$\begin{aligned} \text{Upper} &= 0.3731676102 \\ &= 0.373 \quad (3 \text{ s.f.}) \end{aligned}$$

Lower Bounds



$$f(1.75) = 0.4196073493 \times 0.25 +$$

$$f(1.5) = 0.3462335938 \times 0.25 +$$

$$f(1.25) = 0.2474039593 \times 0.25 +$$

$$\text{Lower} = 0.2533112256$$

$$= 0.253 \text{ (3sf)}$$

(b) (i) Use the substitution $t = \sqrt{x-1}$ to show that $\int \sin\left(\frac{1}{2}\sqrt{x-1}\right)dx = \int 2t \sin\left(\frac{1}{2}t\right)dt$. [3]

(ii) Hence show that $\int_1^2 \sin\left(\frac{1}{2}\sqrt{x-1}\right)dx = 8 \sin\frac{1}{2} - 4 \cos\frac{1}{2}$. [4]

$$t = (\alpha - 1)^{\frac{1}{2}}$$

$$\frac{dt}{dx} = \frac{1}{2}(\alpha - 1)^{-\frac{1}{2}}$$

$$\frac{dx}{dt} = \frac{1}{2\sqrt{\alpha-1}}$$

$$\therefore dx = 2\sqrt{\alpha-1} dt$$

$$dx = 2t dt$$

$$\left. \begin{aligned} & \int \sin\left(\frac{1}{2}\sqrt{x-1}\right)dx \\ &= \int \sin\left(\frac{1}{2}t\right) \times 2t dt \\ &= \int 2t \sin\left(\frac{1}{2}t\right) dt \end{aligned} \right\}$$

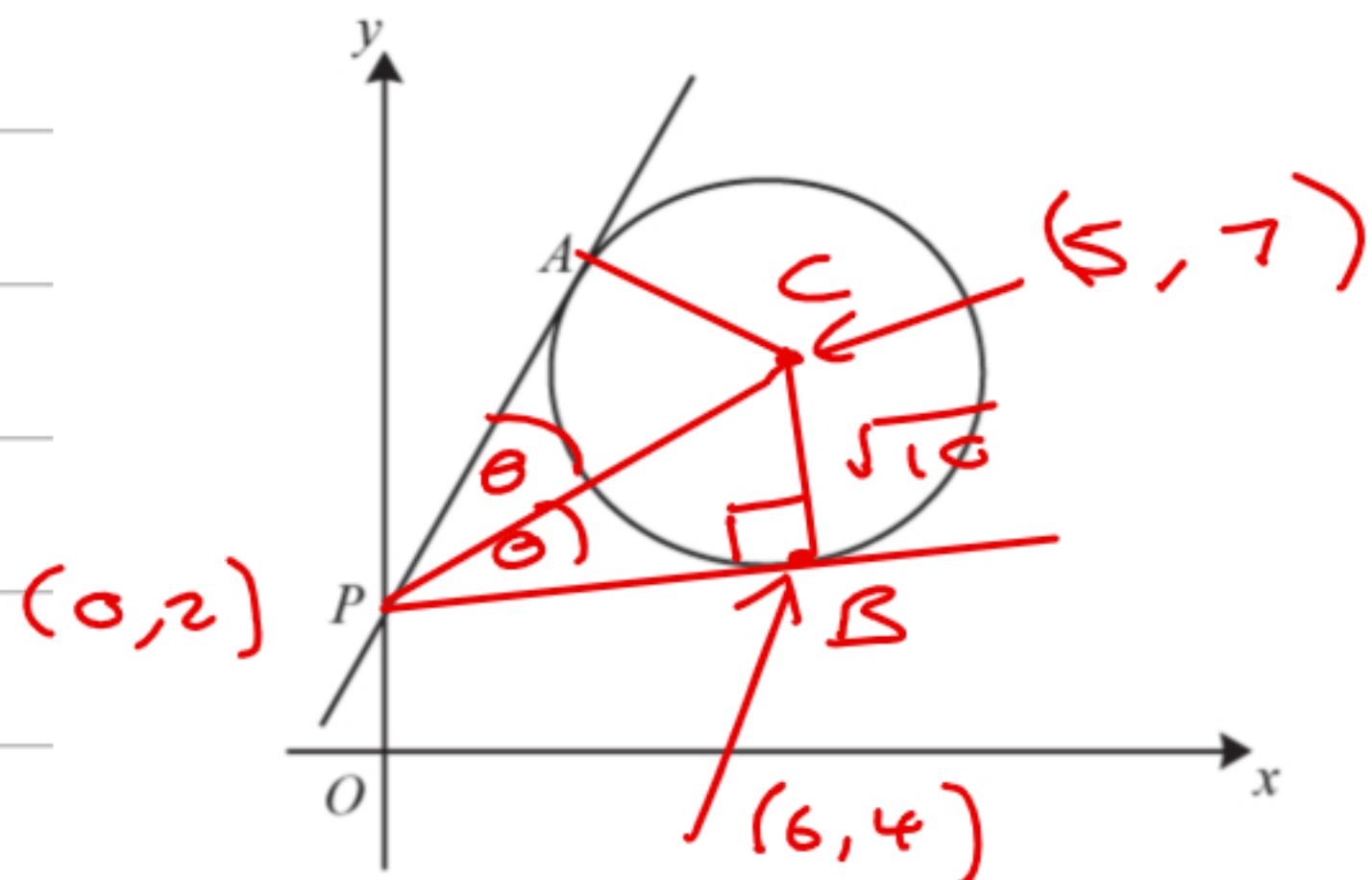
(ii) Hence show that $\int_1^2 \sin\left(\frac{1}{2}\sqrt{x-1}\right)dx = 8\sin\frac{1}{2} - 4\cos\frac{1}{2}$.

[4]

$$\begin{aligned}
 &= \int_{\underset{u}{\substack{\uparrow \\ t=1}}}^{u=2t} 2t \sin\left(\frac{1}{2}t\right) dt \quad \begin{array}{l} u=2t \\ u'=2 \end{array} \quad \begin{array}{l} v=-2\cos\left(\frac{1}{2}t\right) \\ v'=\sin\left(\frac{1}{2}t\right) \end{array} \\
 &\text{limits } t = \sqrt{x-1} \\
 &x=2, t=1 \\
 &x=1, t=0 \\
 &\text{integrating by parts gives} \\
 &= \left[-4t \cos\left(\frac{1}{2}t\right) - \int 2x - 2 \cos\left(\frac{1}{2}t\right) dt \right]_0^1 \\
 &= \left[-4t \cos\left(\frac{1}{2}t\right) + 4 \int \cos\left(\frac{1}{2}t\right) dt \right]_0^1 \\
 &= \left[-4t \cos\left(\frac{1}{2}t\right) + 4 \times 2 \sin\left(\frac{1}{2}t\right) \right]_0^1 \\
 &= \left[-4t \cos\left(\frac{1}{2}t\right) + 8 \sin\left(\frac{1}{2}t\right) \right]_0^1 \\
 &= (-4 \cos\left(\frac{1}{2}\right) + 8 \sin\left(\frac{1}{2}\right)) - (0 + 8 \sin(0)) \\
 &= 8 \sin\left(\frac{1}{2}\right) - 4 \cos\left(\frac{1}{2}\right)
 \end{aligned}$$

as required

11 In this question you must show detailed reasoning.



The diagram shows a circle with equation $x^2 + y^2 - 10x - 14y + 64 = 0$. A tangent is drawn from the point $P(0, 2)$ to meet the circle at the point A . The equation of this tangent is of the form $y = mx + 2$, where m is a constant **greater than 1**.

- (a) (i) Show that the x -coordinate of A satisfies the equation $(m^2 + 1)x^2 - 10(m+1)x + 40 = 0$. [2]
- (ii) Hence determine the equation of the tangent to the circle at A which passes through P . [4]

a) i) $x^2 + y^2 - 10x - 14y + 64 = 0$

let $y = mx + 2$ for intersection

$$x^2 + (mx + 2)^2 - 10x - 14(mx + 2) + 64 = 0$$

$$x^2 + m^2x^2 + 4mx^2 + 4 - 10x - 14mx - 28 + 64 = 0$$

$$x^2(1 + m^2) - 10mx - 10x + 40 = 0$$

$$(m^2 + 1)x^2 - 10(m+1)x + 40 = 0$$

(ii) $b^2 - 4ac = 0$

$$(-10m - 10)^2 - 4(m^2 + 1) \times 40 = 0$$

$$100m^2 + 200m + 100 - 160m^2 - 160 = 0$$

$$-60m^2 + 200m - 60 = 0$$

$$m = 3, \quad m = \frac{1}{3}$$

Tangent is $y = 3x + 2$

A second tangent is drawn from P to meet the circle at a second point B . The equation of this tangent is of the form $y = nx + 2$, where n is a constant **less than 1**.

(b) Determine the exact value of $\tan APB$.

[4]

$$n = \frac{1}{3} \quad \text{for } 2^{\text{nd}} \text{ tangent}$$

$$y = \frac{1}{3}x + 2$$

$$x^2 + y^2 - 10x - 14y + 64 = 0$$

$$(x-5)^2 - 5^2 + (y-7)^2 - 7^2 + 64 = 0$$

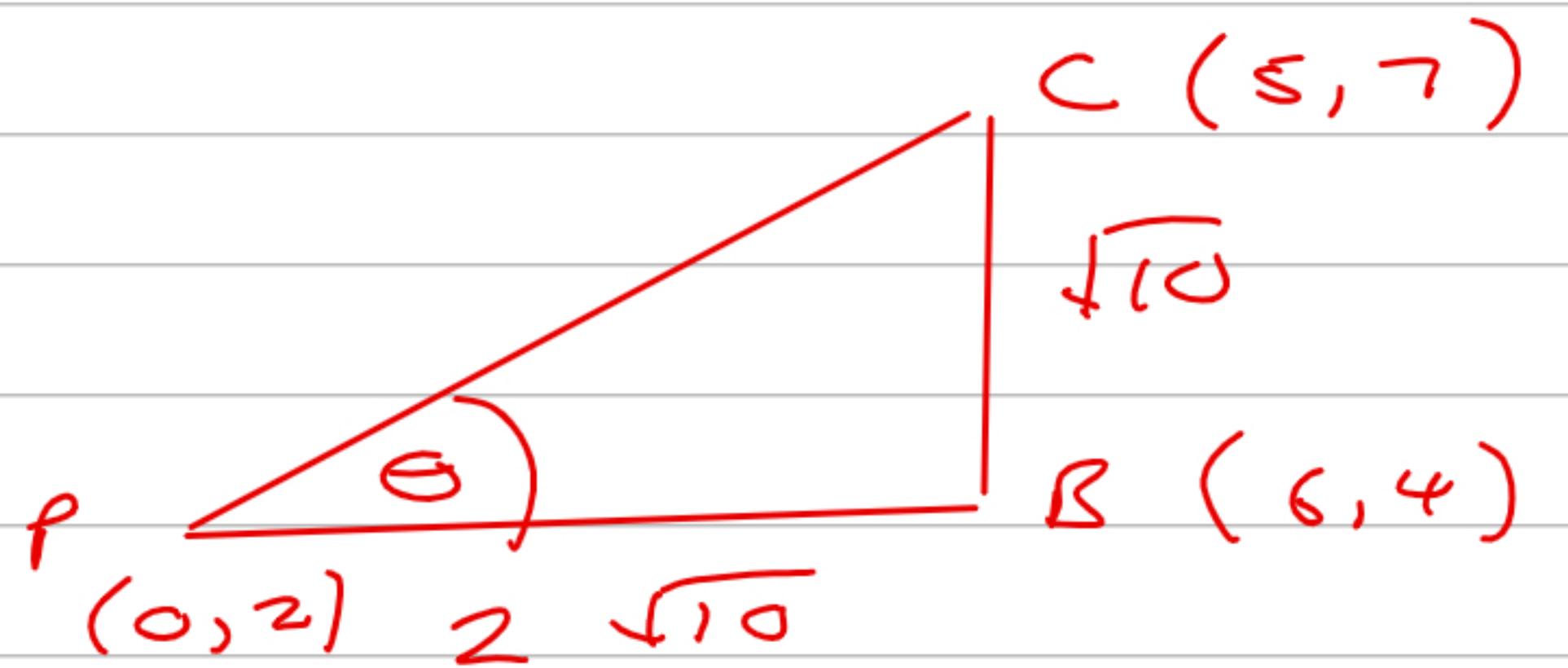
$$(x-5)^2 + (y-7)^2 = 10$$

Circle centre $(5, 7)$ radius $= \sqrt{10}$

$$\text{When } n = \frac{1}{3} \quad \left(\left(\frac{1}{3}\right)^2 + 1\right)x^2 - 10\left(\frac{1}{3} + 1\right)x + 40 = 0$$

$$\frac{10}{9}x^2 - \frac{40}{3}x + 40 = 0$$

$$x = 6 \quad > \quad y = \frac{1}{3} \times 6 + 2 = 4$$



$$\begin{aligned} PB &= \sqrt{(6-0)^2 + (4-2)^2} \\ &= 2\sqrt{10} \end{aligned}$$

$$\tan \theta = \frac{\sqrt{10}}{2\sqrt{10}} = \frac{1}{2}$$

$$\begin{aligned} \tan APB &= \tan 2\theta = \frac{2\tan \theta}{1 - \tan^2 \theta} \\ &= \frac{2 \times \frac{1}{2}}{1 - \frac{1}{4}} = \frac{1}{\frac{3}{4}} = \frac{4}{3} \end{aligned}$$

12 Find the general solution of the differential equation

$$(2x^3 - 3x^2 - 11x + 6) \frac{dy}{dx} = y(20x - 35).$$

Give your answer in the form $y = f(x)$.

[9]

$$\int \frac{1}{y} dy = \int \frac{20x - 35}{2x^3 - 3x^2 - 11x + 6} dx$$

$$f(-2) = 2(-2)^3 - 3(-2)^2 - 11(-2) + 6 = 0 \quad \therefore x+2 \text{ factor.}$$

of $2x^3 - 3x^2 - 11x + 6$

$$\begin{array}{r}
 2x^2 - 7x + 3 \\
 \hline
 x + 2 \left| \begin{array}{r} 2x^3 - 3x^2 - 11x + 6 \\ - (2x^3 + 4x^2) \end{array} \right. \\
 \hline
 \begin{array}{r} -7x^2 - 11x \\ - (-7x^2 - 14x) \end{array} \\
 \hline
 \begin{array}{r} 3x + 6 \\ - (3x + 6) \end{array} \\
 \hline
 0
 \end{array}$$

$$\begin{array}{l}
 (2x - 1)(x - 3) \\
 (x + 2)(2x - 1)(x - 3)
 \end{array}$$

$$\int \frac{1}{5} dy = \int \frac{20x - 35}{2x^3 - 3x^2 - 11x + 6} dx$$

Ctrl

Partial fractions

$$\frac{20x - 35}{(x+2)(2x-1)(x-3)} = \frac{A}{x+2} + \frac{B}{2x-1} + \frac{C}{x-3}$$

$$20x - 35 = A(2x-1)(x-3) + B(x+2)(x-3) + C(x+2)(2x-1)$$

$$\text{let } x = 3 \quad 2 \leq = C \times 5 \times 3 \quad C = 1$$

$$x = -2 \quad -75 = A(-2) - 5 \times -5 \quad A = -3$$

$$x = \frac{1}{2} \quad -25 = B \times \frac{5}{2} \times -\frac{5}{2} \quad B = 4$$

$$\int \frac{1}{y} dy = \int -\frac{3}{x+2} + \frac{4}{2x-1} + \frac{1}{x-3} dx$$

$$\ln y = -3 \ln |x+2| + \frac{4}{2} \ln |2x-1| + \ln |x-3| + \ln k$$

$$\ln y = \ln |2x-1|^2 + \ln |x-3| - \ln |x+2|^3 + \ln k$$

$$\ln y = \ln k \frac{(2x-1)^2 (x-3)}{(x+2)^3}$$

$$y = \frac{k (2x-1)^2 (x-3)}{(x+2)^3}$$