Answer ALL questions.

Write your answers in the spaces provided.

You must write down all the stages in your working.

1 Work out the value of $\dfrac{3^7 \times 3^{-2}}{3^3}$

$= \dfrac{3^5}{3^3}$

$= 3^2$

$= 9$

(Total for Question 1 is 2 marks)

2 $v^2 = u^2 + 2as$

$u = 12 \quad a = -3 \quad s = 18$

(a) Work out a value of v.

$v^2 = 144 + 2 \times (-3) \times 18$

$= 144 - 108$

$= 36$

$v = 6$ or -6

(2)

(b) Make s the subject of $v^2 = u^2 + 2as$

$v^2 - u^2 = 2as$

$s = \dfrac{v^2 - u^2}{2a}$

(2)

(Total for Question 2 is 4 marks)

3 A bonus of £2100 is shared by 10 people who work for a company.
40% of the bonus is shared equally between 3 managers.
The rest of the bonus is shared equally between 7 salesmen.

One of the salesmen says,

"If the bonus is shared equally between all 10 people I will get 25% more money."

Is the salesman correct?
You must show how you get your answer.

10% = 210

40% = 840

$3\overline{)840} = 280$ per manager

60% = 1260

$7\overline{)1260} = 180$ per s/man

equally = 2100 ÷ 10 = £210 each

£180 + 25%

= 180 + 45 = £225 so No

(Total for Question 3 is 5 marks)

4 It would take 120 minutes to fill a swimming pool using water from 5 taps.

(a) How many minutes will it take to fill the pool if only 3 of the taps are used?

120
x 5
600

600 ÷ 3 = 200

..... minutes

(2)

(b) State one assumption you made in working out your answer to part (a).

All taps work at an equal rate

(1)

(Total for Question 4 is 3 marks)

5 A plane travels at a speed of 213 miles per hour.

(a) Work out an estimate for the number of seconds the plane takes to travel 1 mile.

hrs → secs
x3600

200 miles in 3600s

1 mile = 3600/200 s

ms: 16 → 20

18

..... seconds

(3)

(b) Is your answer to part (a) an underestimate or an overestimate?
Give a reason for your answer.

Over as speed was rounded down

(1)

(Total for Question 5 is 4 marks)

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6 Solve the simultaneous equations

$5x + y = 21$ ①
$x - 3y = 9$ ②

① × 3 + $15x + 3y = 63$
$x - 3y = 9$

$16x = 72$

$x = \frac{72}{16} = \frac{9}{2} = 4.5$

① ⇒ $22.5 + y = 21$

$y = -1.5$

$x =$ 4.5

$y =$ -1.5

(Total for Question 6 is 3 marks)

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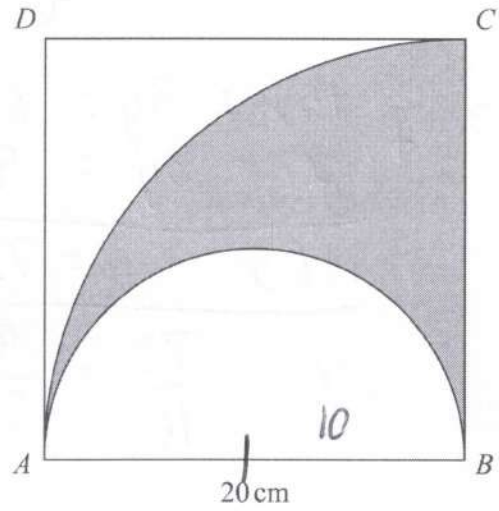
7 The diagram shows a square $ABCD$ with sides of length 20 cm.
It also shows a semicircle and an arc of a circle.



AB is the diameter of the semicircle.
AC is an arc of a circle with centre B.

Show that $\dfrac{\text{area of shaded region}}{\text{area of square}} = \dfrac{\pi}{8}$

$\frac{1}{4}$ = $\frac{\pi r^2}{4}$ = $\frac{\pi \times 20^2}{4}$ = 100π

$\frac{1}{2}$ = $\frac{\pi r^2}{2}$ = $\frac{\pi \times 10^2}{2}$ = 50π

$\frac{\text{Shaded}}{\text{Square}}$ = $\frac{100\pi - 50\pi}{20 \times 20}$ = $\frac{50\pi}{400}$

= $\frac{\pi}{8}$

(Total for Question 7 is 4 marks)

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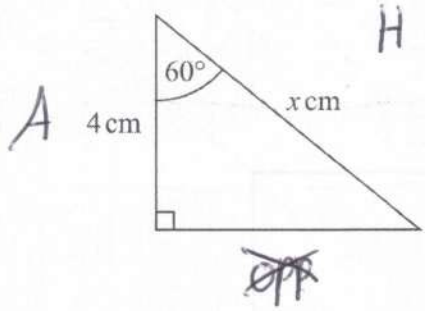
8 (a) Write down the exact value of tan 45°

1

(1)

Here is a right-angled triangle.



cos 60° = 0.5

(b) Work out the value of x.

A
C (H)

$$x = \frac{A}{C} = \frac{4}{\cos 60} = \frac{4}{1/2}$$

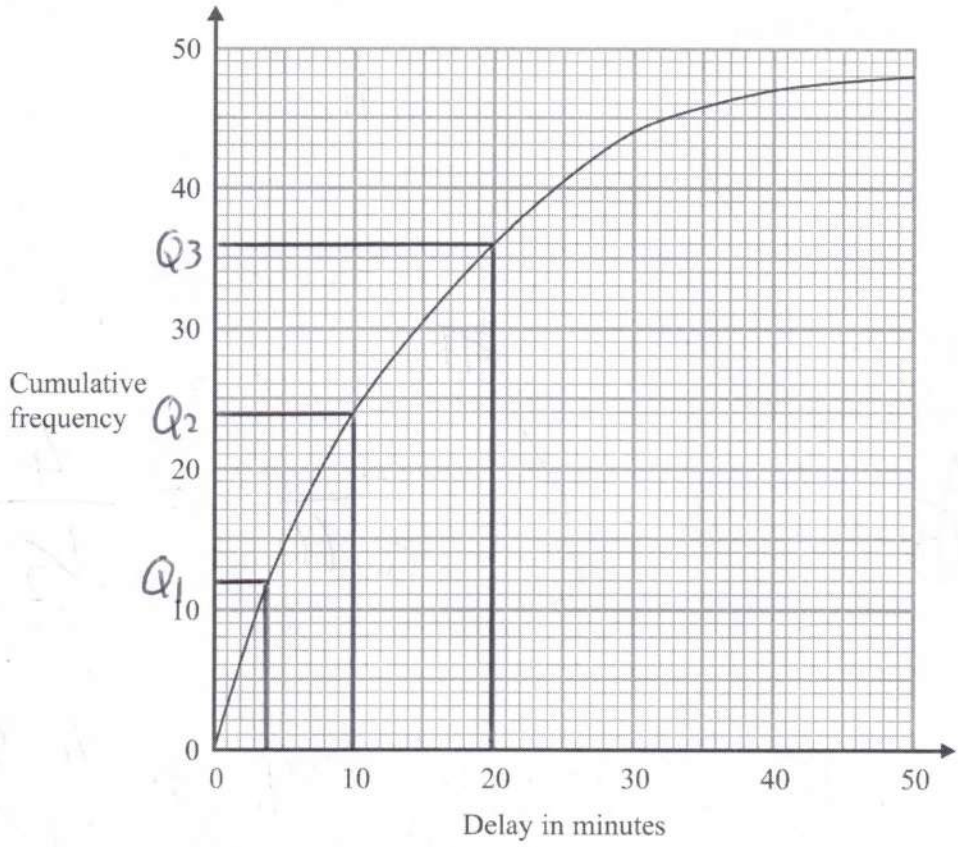
8

(2)

(Total for Question 8 is 3 marks)

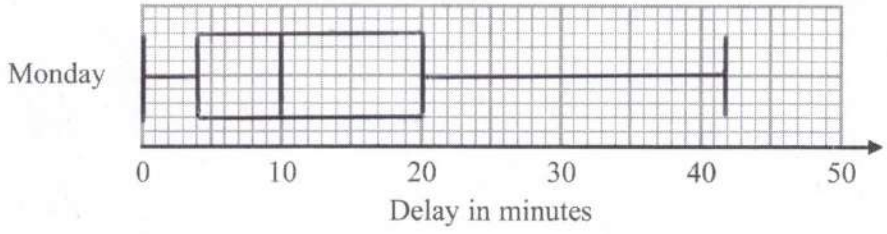
9 The times that 48 trains left a station on Monday were recorded.

The cumulative frequency graph gives information about the numbers of minutes the trains were delayed, correct to the nearest minute.



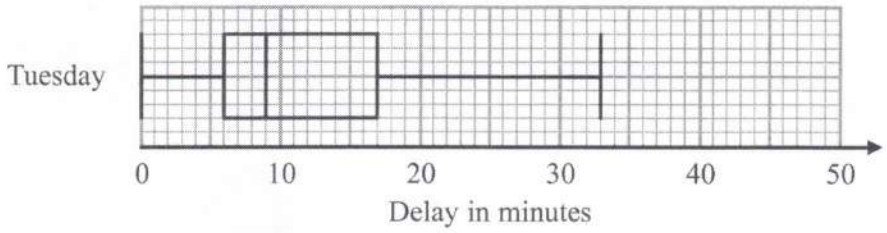
The shortest delay was 0 minutes.
The longest delay was 42 minutes.

(a) On the grid below, draw a box plot for the information about the delays on Monday.



(3)

48 trains left the station on Tuesday.
The box plot below gives information about the delays on Tuesday.



(b) Compare the distribution of the delays on Monday with the distribution of the delays on Tuesday.

On average Monday's delay > Tues

Delays on Monday varied more as range and IQR were greater

(2)

Mary says,

"The longest delay on Tuesday was 33 minutes.
This means that there must be some delays of between 25 minutes and 30 minutes."

(c) Is Mary right?
You must give a reason for your answer.

No, those 12 trains could be any delay from 17 → 33

(1)

(Total for Question 9 is 6 marks)

10 (a) Simplify $\dfrac{(x-1)}{5(x-1)^2}$

$\dfrac{1}{5(x-1)}$

(1)

(b) Factorise fully $50 - 2y^2$

$2(25 - y^2)$

$2(5+y)(5-y)$

(2)

(Total for Question 10 is 3 marks)

11 Jack and Sadia work for a company that sells boxes of breakfast cereal.

The company wants to have a special offer.

Here is Jack's idea for the special offer.

Put 25% more cereal into each box and do **not** change the price.

Here is Sadia's idea.

Reduce the price and do **not** change the amount of cereal in each box.

Sadia wants her idea to give the same value for money as Jack's idea.

By what percentage does she need to reduce the price?

$$\frac{125}{100} = \frac{100}{x}$$

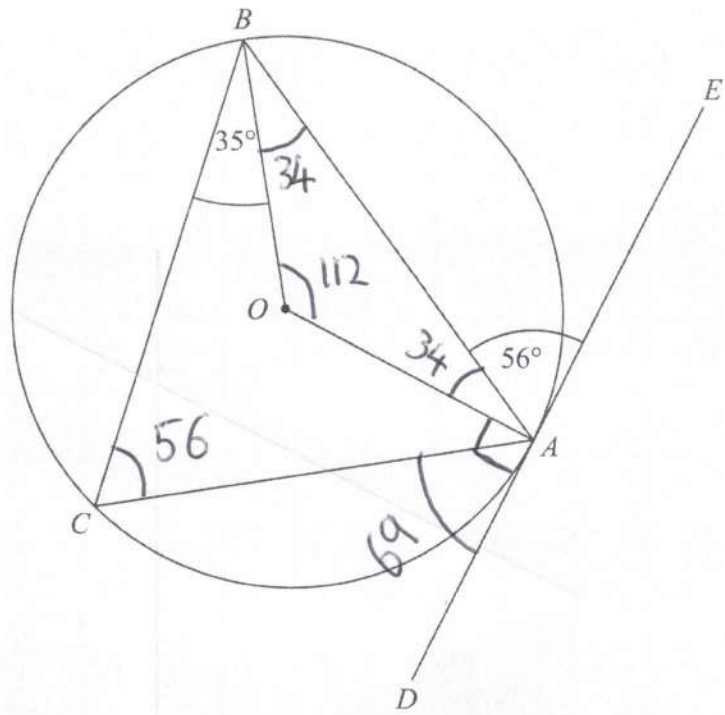
$$\frac{5}{4} = \frac{100}{x}$$

$$x = \frac{400}{5} = 80$$

20 ..... %

(Total for Question 11 is 3 marks)

12



A, *B* and *C* are points on the circumference of a circle, centre *O*.
DAE is the tangent to the circle at *A*.

Angle *BAE* = 56°
Angle *CBO* = 35°

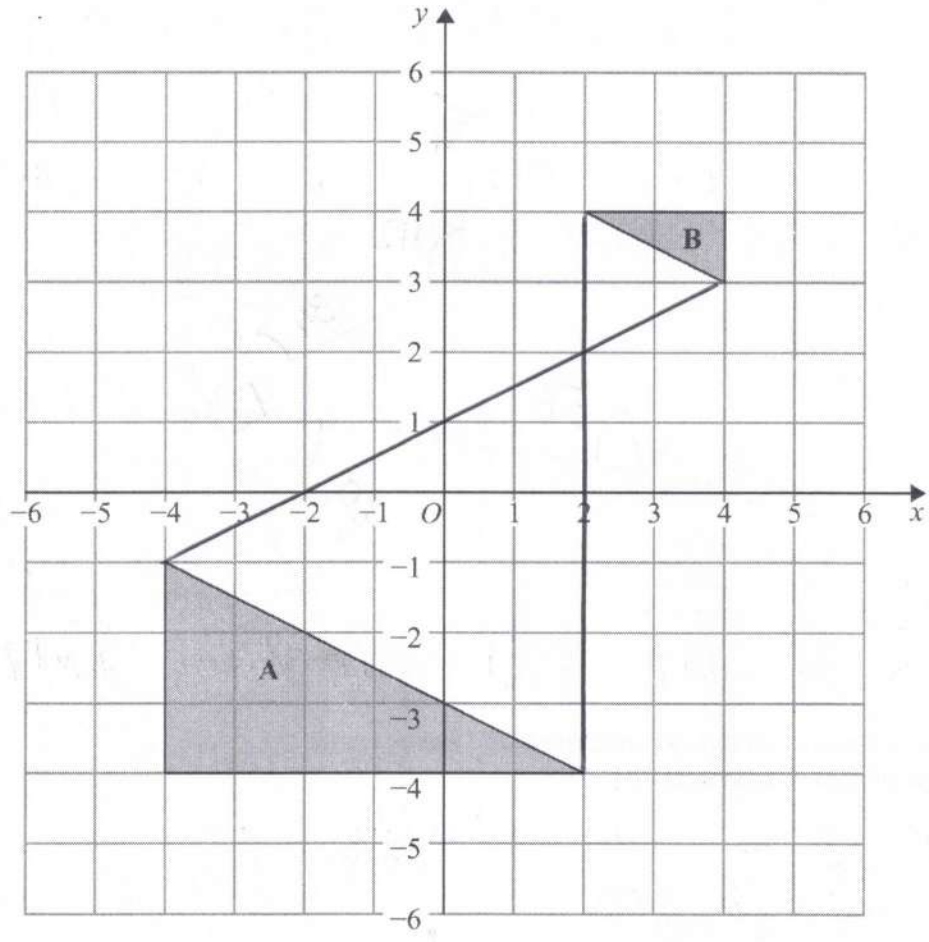
Work out the size of angle *CAO*.
You must show all your working.

90-69

= 31 °

(Total for Question 12 is 3 marks)

13



Describe fully the single transformation that maps triangle **A** onto triangle **B**.

Enlargement, scale factor = $-\frac{1}{3}$, Centre (2, 2)

(Total for Question 13 is 2 marks)

14 (a) Work out the value of $\left(\frac{16}{81}\right)^{\frac{3}{4}}$

$$\frac{\sqrt[4]{16^3}}{\sqrt[4]{81^3}} = \frac{2^3}{3^3}$$

$$= \frac{8}{27}$$

(2)

$3^a = \frac{1}{9}$ $3^b = 9\sqrt{3}$ $3^c = \frac{1}{\sqrt{3}}$

(b) Work out the value of $a + b + c$

$$\frac{1}{9} = 3^{-2} \qquad 9\sqrt{3} = 3^2 \times 3^{\frac{1}{2}} = 3^{2.5}$$

$$\frac{1}{\sqrt{3}} = 3^{-0.5}$$

$$-2 + 2.5 - 0.5 = 0$$

(2)

(Total for Question 14 is 4 marks)

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15 Three solid shapes **A**, **B** and **C** are similar.

The surface area of shape **A** is $4\,cm^2$
The surface area of shape **B** is $25\,cm^2$

The ratio of the volume of shape **B** to the volume of shape **C** is 27 : 64

Work out the ratio of the height of shape **A** to the height of shape **C**.
Give your answer in its simplest form.

Length A:B

$\sqrt{4} : \sqrt{25}$

$2 : 5$

$= 6 : 15$

Length B:C

$\sqrt[3]{27} : \sqrt[3]{64}$

$3 : 4$

$= 15 : 20$

$A:C = 6:20 = 3:10$

(Total for Question 15 is 4 marks)

16 Prove algebraically that $0.2\dot{5}\dot{6}$ can be written as $\frac{127}{495}$

let $x = 0.2\dot{5}\dot{6}$

$10x = 2.\dot{5}\dot{6}$

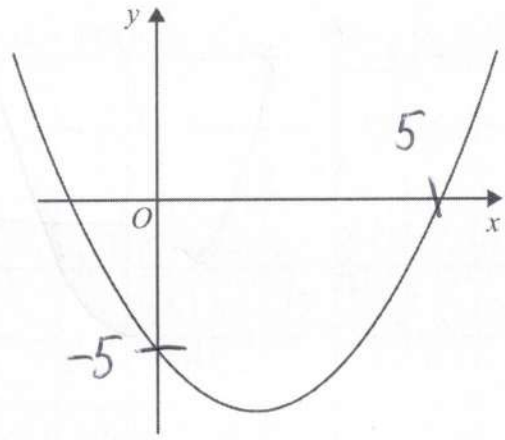
$1000x = 256.\dot{5}\dot{6}$

$990x = 254$

$x = \frac{254}{990} = \frac{127}{495}$

(Total for Question 16 is 3 marks)

17 Here is a sketch of a curve.



The equation of the curve is $y = x^2 + ax + b$ where a and b are integers.

The points $(0, -5)$ and $(5, 0)$ lie on the curve.

Find the coordinates of the turning point of the curve.

$x = 0, y = -5 \Rightarrow \underline{-5 = b}$

$x = 5, y = 0 \Rightarrow 0 = 25 + 5a - 5$

$5a = -20$

$\underline{a = -4}$

$y = x^2 - 4x - 5$

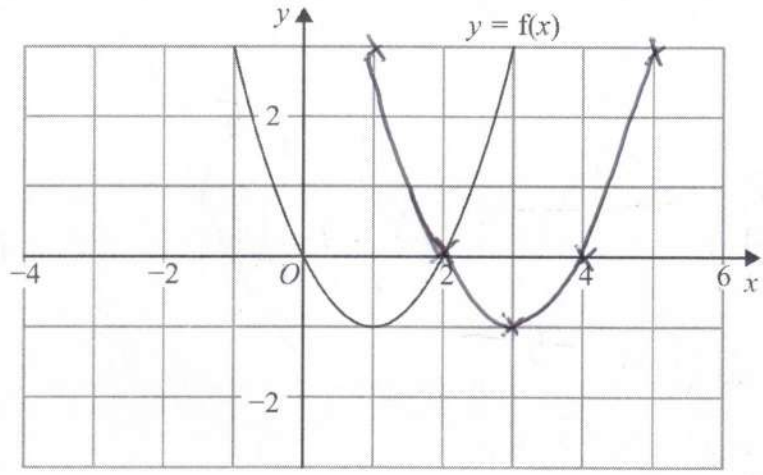
$y = (x-2)^2 - 4 - 5$

$y = (x-2)^2 - 9$

(2 , -9)

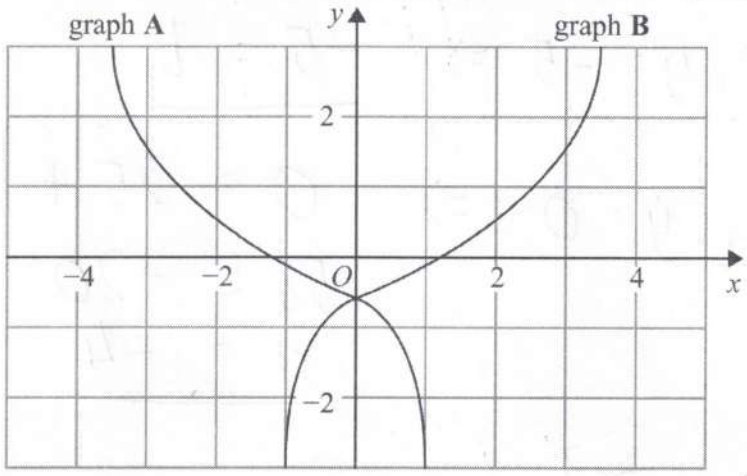
(Total for Question 17 is 4 marks)

18 The graph of $y = f(x)$ is shown on the grid below.



(a) On the grid above, sketch the graph of $y = f(x - 2)$

(1)



On the grid, graph **A** has been reflected to give graph **B**.

The equation of graph **A** is $y = g(x)$

(b) Write down the equation of graph **B**.

ref in y-axis

$x \rightarrow -x$

$y = g(-x)$

(1)

(Total for Question 18 is 2 marks)

19 For all values of x

$$f(x) = (x + 1)^2 \quad \text{and} \quad g(x) = 2(x - 1)$$

(a) Show that $gf(x) = 2x(x + 2)$

$g(x+1)^2 = 2((x+1)^2 - 1)$

$= 2(x^2 + 2x + 1 - 1)$

$= 2(x^2 + 2x)$

$= 2x(x + 2)$

(2)

(b) Find $g^{-1}(7)$

$2(x-1) = 7$

$2x - 2 = 7$

$2x = 9$

$x = \frac{9}{2}$

or $4{\cdot}5$

(2)

(Total for Question 19 is 4 marks)

20 Show that $\dfrac{(\sqrt{18}+\sqrt{2})^2}{\sqrt{8}-2}$ can be written in the form $a(b+\sqrt{2})$ where a and b are integers.

$$(\sqrt{18}+\sqrt{2})^2 = 18+2+\sqrt{36}+\sqrt{36} = 32$$

$$\frac{32}{\sqrt{8}-2} \times \frac{\sqrt{8}+2}{\sqrt{8}+2} = \frac{32\sqrt{8}+64}{8-4}$$

$$[\sqrt{8} = \sqrt{4}\sqrt{2} = 2\sqrt{2}]$$

$$= \frac{64\sqrt{2}+64}{4}$$

$$= 16\sqrt{2}+16 \qquad = 16(1+\sqrt{2})$$

(Total for Question 20 is 3 marks)

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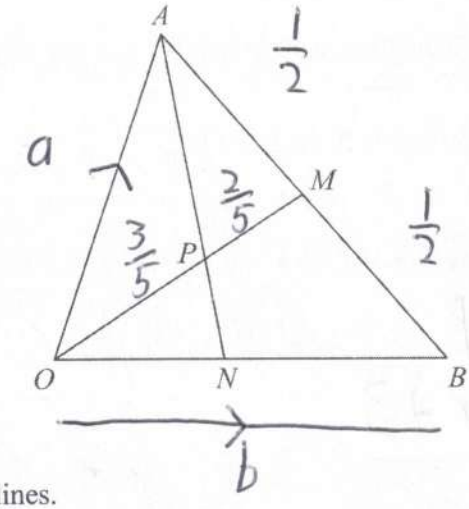
21



OAB is a triangle.
OPM and *APN* are straight lines.
M is the midpoint of *AB*.

$\overrightarrow{OA} = \mathbf{a}$ $\overrightarrow{OB} = \mathbf{b}$

$OP : PM = 3 : 2$

Work out the ratio $ON : NB$

$\overrightarrow{AB} = b - a$

$\overrightarrow{OM} = a + \frac{1}{2}(b-a)$

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

$\overrightarrow{AP} = \overrightarrow{AO} + \overrightarrow{OP}$

$= -a + \frac{3}{5}\left(\frac{1}{2}a + \frac{1}{2}b\right)$

$= -\frac{7}{10}a + \frac{3}{10}b$

$\overrightarrow{ON} = \overrightarrow{OA} + \overrightarrow{AN}$

$= a + K \times \overrightarrow{AP}$

$= a - \frac{7Ka}{10} + \frac{3Kb}{10}$

a must cancel so $1 = 7K/10$

$\Rightarrow K = \frac{10}{7}$, $\frac{3}{10} \times \frac{10}{7} = \frac{3}{7}b = \overrightarrow{ON}$

3:4

(Total for Question 21 is 5 marks)

22 There are only green pens and blue pens in a box.

There are three more blue pens than green pens in the box.
There are more than 12 pens in the box.

Simon is going to take at random two pens from the box.

The probability that Simon will take two pens of the same colour is $\frac{27}{55}$

Work out the number of green pens in the box.

G	B
x	$x+3$

$$GG + BB = \frac{x}{2x+3} \times \frac{x-1}{2x+2} + \frac{x+3}{2x+3} \times \frac{x+2}{2x+2}$$

$$= \frac{x^2-x+x^2+5x+6}{4x^2+10x+6} = \frac{27}{55}$$

$$= \frac{2x^2+4x+6}{4x^2+10x+6} = \frac{27}{55}$$

$$= 55x^2+110x+165 = 54x^2+135x+81$$

$$x^2-25x+84 = 0$$

$$(x-21)(x-4) = 0$$

$x \neq 4$ so $x = 21$

(Total for Question 22 is 6 marks)

TOTAL FOR PAPER IS 80 MARKS