

Surname	Centre Number	Candidate Number
First name(s)		0



**GCSE**

3310U60-1



**THURSDAY, 9 NOVEMBER 2023 – MORNING**

**MATHEMATICS – NUMERACY  
UNIT 2: CALCULATOR-ALLOWED  
HIGHER TIER**

1 hour 45 minutes

**ADDITIONAL MATERIALS**

A calculator will be required for this examination.  
A ruler, a protractor and a pair of compasses may be required.

**INSTRUCTIONS TO CANDIDATES**

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

You may use a pencil for graphs and diagrams only.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet. If you run out of space, use the additional page(s) at the back of the booklet, taking care to number the question(s) correctly.

Take  $\pi$  as 3.14 or use the  $\pi$  button on your calculator.

**INFORMATION FOR CANDIDATES**

You should give details of your method of solution when appropriate.

Unless stated, diagrams are not drawn to scale.

Scale drawing solutions will not be acceptable where you are asked to calculate.

The number of marks is given in brackets at the end of each question or part-question.

In question 3(c), the assessment will take into account the quality of your linguistic and mathematical organisation, communication and accuracy in writing.

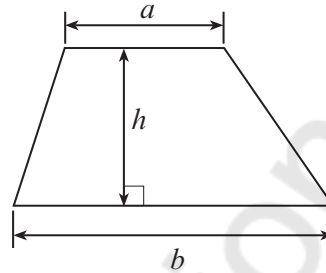
For Examiner's use only		
Question	Maximum Mark	Mark Awarded
1.	4	
2.	8	
3.	12	
4.	15	
5.	4	
6.	7	
7.	6	
8.	12	
9.	8	
10.	4	
<b>Total</b>	<b>80</b>	



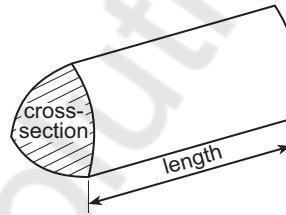
NOV233310U60101

## Formula List – Higher Tier

$$\text{Area of trapezium} = \frac{1}{2}(a + b)h$$

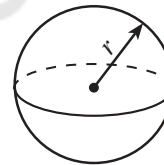


$$\text{Volume of prism} = \text{area of cross-section} \times \text{length}$$



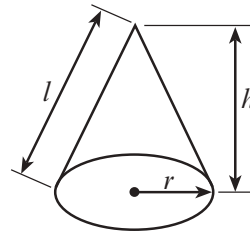
$$\text{Volume of sphere} = \frac{4}{3}\pi r^3$$

$$\text{Surface area of sphere} = 4\pi r^2$$



$$\text{Volume of cone} = \frac{1}{3}\pi r^2 h$$

$$\text{Curved surface area of cone} = \pi r l$$

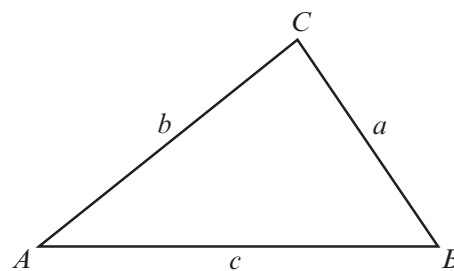


In any triangle  $ABC$

$$\text{Sine rule} \quad \frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$\text{Cosine rule} \quad a^2 = b^2 + c^2 - 2bc \cos A$$

$$\text{Area of triangle} = \frac{1}{2}ab \sin C$$



### The Quadratic Equation

The solutions of  $ax^2 + bx + c = 0$  where  $a \neq 0$  are given by 
$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

### Annual Equivalent Rate (AER)

AER, as a decimal, is calculated using the formula  $\left(1 + \frac{i}{n}\right)^n - 1$ , where  $i$  is the nominal interest rate per annum as a decimal and  $n$  is the number of compounding periods per annum.



1. Treviso is a company that designs and builds bicycles.  
Each wheel on Treviso's new bike has a diameter of 29 inches.

Remember: 1 foot = 12 inches

Ollie tests Treviso's new bike over a distance of 1000 feet.  
How many times will a wheel rotate during the test?

[4]

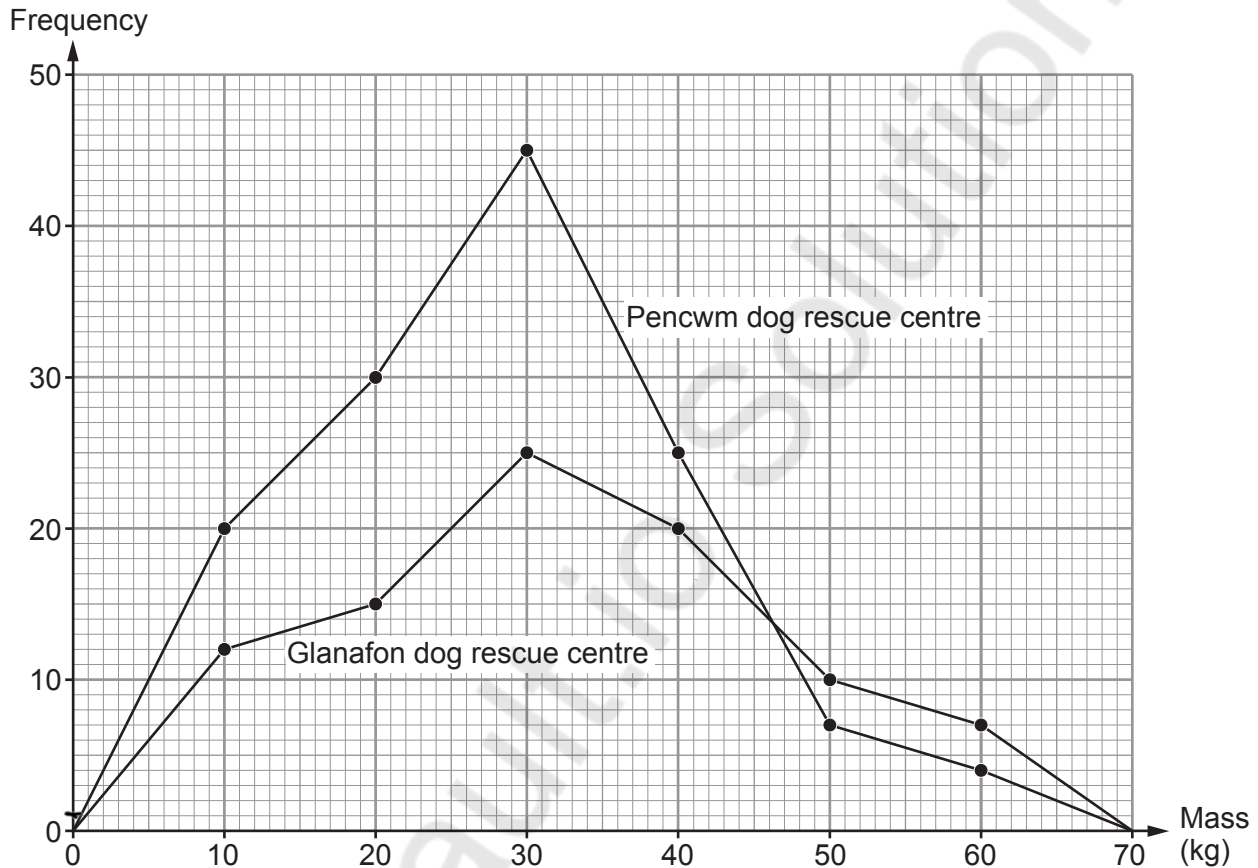
$$\begin{aligned}
 \text{Treviso bike} &= 29 \text{ inch} \\
 \text{if } 1 \text{ foot} &= 12 \text{ inch}; \quad 29 \text{ inch} = \frac{29}{12} \text{ ' } \\
 \text{no of rev} &= \frac{D}{\pi d} = \frac{1000}{\pi \times \frac{29}{12}} = \frac{1000 \times 12}{\pi \times 29} \\
 &= 131.7 \text{ rev} \\
 &\approx 132 \text{ rev}
 \end{aligned}$$



2. Glanafon and Pencwm dog rescue centres take in unwanted dogs.  
The mass of each dog in the two dog rescue centres was recorded.  
Groups of width 10 kg were used:

$$5 \text{ kg} \leq \text{mass} < 15 \text{ kg}, \quad 15 \text{ kg} \leq \text{mass} < 25 \text{ kg}, \quad \dots, \quad 55 \text{ kg} \leq \text{mass} < 65 \text{ kg}$$

The results are shown in the frequency polygons below.



- (a) Doreen, Rory and Muzhir look at these frequency polygons.

- (i) Doreen says,

"The modal group of the masses of dogs in each dog rescue centre is the same."

Is Doreen correct?

Yes  No  Can't tell

You must give a reason for your answer.

[1]

The highest frequency at same mass, i.e. 25kg to 35kg interval



- (ii) Rory says,  
"28 of the dogs in Pencwm each have a mass of 18 kg."

Is Rory correct?

Yes

No

Can't tell

You must give a reason for your answer.

[1]

The data is grouped

- (iii) Muzhir says,  
"There is a higher proportion of dogs that are heavier than 35 kg in Glanafon than in Pencwm."

Without doing any calculations, decide if Muzhir is correct.

Correct

Incorrect

Can't tell

You must give a reason for your answer.

[1]

fewer dogs but more large dogs in Glanafon

- (b) The estimate of the mean mass of the dogs in Glanafon was 32.5 kg.  
How much less was the estimate of the mean mass of the dogs in Pencwm?  
You must show all your working.

[5]

$$\begin{aligned} \text{total no of dogs in pencwm} &= \\ 20 + 30 + 45 + 25 + 7 + 4 &= 131 \quad (\text{FOO}) \\ (10 \times 20) + (20 \times 30) + (30 \times 45) + (40 \times 25) + (50 \times 7) + (60 \times 4) & \\ = \frac{3740}{131} = \frac{\Sigma f_x}{n} &= 28.5 \end{aligned}$$

$$\begin{aligned} 32.5 - 28.5 & \\ = 4 \text{ kg less} & \end{aligned}$$

Estimate of the mean mass of the dogs in Pencwm is 4 kg kg less than in Glanafon.



3. Jac is planning to visit the Empire State Building in New York.

- (a) Planners had an original budget of \$60 million to construct the Empire State Building.  
It actually cost \$41 000 000 to construct.



Complete the following statement.  
Give your answer correct to 2 decimal places. [3]

Constructing the Empire State Building cost ..... % less than the original budget.

$$\begin{aligned} \text{Init budg} &= \$60 \text{ mil}; \text{ actual cost} = \$41 \text{ mil} \\ \text{Diff} &= 19 \text{ mil} \\ \therefore \frac{\$19 \text{ mil}}{60 \text{ mil}} \times 100 &= 31.67\% \end{aligned}$$

- (b) More than 4 million people visit the Empire State Building each year.  
What is 4 million written in standard form?  
Circle your answer. [1]

$$4 \times 10^{-5} \quad 0.4 \times 10^5 \quad 4 \times 10^5 \quad \textcircled{4 \times 10^6} \quad 4 \times 10^7$$

$$4 \times 10^6$$



- (c) In this part of the question, you will be assessed on the quality of your organisation, communication and accuracy in writing.

The conversion rate at the exchange shop is £1 = \$1.25.  
The exchange shop only has \$10 notes and \$50 notes.

Jac has exactly £350.

He wants to exchange as close to £350 as possible for US dollars (\$).

He asks for as **few** notes as possible.

Calculate:

- how many \$10 notes and how many \$50 notes Jac gets ✓
- how much he pays for his currency. . . .

You must show all your working.

[6 + 2 OCW]

$$\begin{aligned} \text{£}1 &= \$1.25; \text{£}350 \approx x \\ x &= 350 \times \$1.25 = \$437.5 \\ \text{approx to next: of } 10 &= \$430 \\ x &= 400 + 30 \\ x &= \frac{400}{50} + \frac{30}{10} \\ &= 8(\$50) + 3(\$10) \end{aligned}$$

$$\begin{aligned} \text{£}1 &= \$1.25 \\ x &= \$430 \\ x &= \frac{430}{1.25} = 344 \end{aligned}$$



4. (a) (i) A single tree can absorb 48 **pounds** of carbon dioxide per year.  
Calculate the carbon dioxide absorbed per year by a forest of 440 of these trees.  
Give your answer in **kilograms**. [2]

$$1 \text{ kg} = 2.2 \text{ pounds}, \quad 48 \text{ pounds} = \frac{48}{2.2} = 21.8 \text{ kg}$$

$$= 440 \times 21.82$$

$$\approx 9600$$

Carbon dioxide absorbed per year is 9600 kg

- (ii) A forest of trees absorbs  $2.3 \times 10^{11}$  grams of carbon dioxide per year.  
Which of the following is  $2.3 \times 10^{11}$ ?  
Circle your answer. [1]

230000000000

230000000000

230000000000

0.0000000000023

0.000000000023

(b)

Remember:  $10000 \text{ m}^2 \approx 2.47 \text{ acres}$

A report states that a fire in a forest has a high risk of spreading when there are more than 60 trees per acre.

There are 615 trees in Grancwm Forest.  
The forest covers an area of  $40000 \text{ m}^2$ .

Would a fire in Grancwm Forest have a high risk of spreading?

Yes

No

You must show all your working to support your answer. [4]

$$10000 \text{ m}^2 = 2.47 \text{ acres}$$

$$40000 = x; \quad x = \frac{40000 \times 2.47}{10000}$$

$$= 9.88 \text{ acres}$$

$$\frac{615 \text{ trees}}{9.88} = 62.24$$

$$9.88$$

$$> 60$$



- (c) A vertical pine tree stands on horizontal ground.  
From a point on the ground 21 metres from its base, the angle of elevation of the top of the pine tree is  $39^\circ$ .

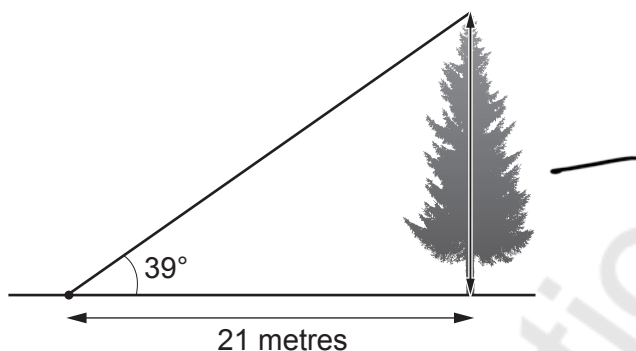


Diagram not drawn to scale

- (i) Show that the pine tree has a vertical height of 17 metres. [3]

$$\tan 39^\circ = \frac{x}{21}$$

$$x = \tan 39^\circ \times 21$$

$$= 17.008 \approx 17$$

- (ii) A cylindrical log is cut from this pine tree.  
The **circumference** of the cross-section of the log is 1.75 m.  
The length of the log is half the height of the tree.

Calculate the volume of the log.

Give your answer in  $\text{m}^3$ .

You must show all your working. [5]

$$L = \frac{1}{2} \times 17$$

$$\text{Volume} = \pi r^2 L$$

$$\text{diameter} = \frac{1.75}{\pi}$$

$$\text{radius} = \frac{1}{2} \text{diameter} = \frac{1.75}{2\pi}$$

$$\text{Volume} = \pi \times \left(\frac{1.75}{2\pi}\right)^2 \times \frac{17}{2}$$

$$= 2.07$$

Volume of the log is  $2.07 \text{ m}^3$



5. A car was bought in 1973 for £2500.

In the first year, this car depreciated by 23% of its value.

In each of the following 39 years, it depreciated by 4% of its value in the previous year.

The car then started to increase in value.

In each of the next 10 years, it increased by 14% of its value in the previous year.

Calculate the value of the car after these 50 years.

You must show all your working.

[4]

$$\begin{aligned}
 & 2500 \times (1 - 0.23) \times (1 - 0.04)^{39} \\
 & \times (1 + 0.14)^{10} \\
 & = 2500 \times 0.77 \times 0.96^{39} \times 1.14^{10} \\
 & \approx \text{£ } 1452.30 \\
 & \approx \text{£ } 1452
 \end{aligned}$$

The value of the car after 50 years is £ 1452



6. A solid statue is made from an alloy of copper and tin.  
It has a volume of  $150 \text{ cm}^3$ .



- (a) In the statue, the volume of copper and the volume of tin are in the ratio 22 : 3.

The density of copper is  $8.96 \text{ g/cm}^3$ .

The density of tin is  $7.31 \text{ g/cm}^3$ .

Calculate the mass of the statue.

You must show all your working.

[4]

$$\text{Vol of Cu} = \frac{22}{25} \times 150$$

$$\therefore \text{mass of Cu} = \frac{22}{25} \times 150 \times 8.96 = 1182.72$$

$$\text{Vol of Tin} = \frac{3}{25} \times 150 ; \text{mass} = \frac{3}{25} \times 150 \times 7.31 = 131.58$$

$$1182.72 + 131.58 = 1314.3 \text{ g}$$

$$= \underline{\underline{1314 \text{ g}}}$$

- (b) The height of the statue is 12 cm.  
A larger statue is mathematically similar to this statue.  
It has a height of 21.6 cm.  
Calculate the volume of this larger statue.

[3]

$$\text{Volume of Bigger Statue} =$$

$$150 \times \left( \frac{21.6}{12} \right)^3$$

$$= 875 \text{ cm}^3$$



7. Carys is buying a new caravan, priced at £20 000. She is going to take out a loan to buy the caravan.



The table below shows her finance options. The monthly payment is missing from Option B.

	Option A	Option B
Deposit	£0	£2000
Loan amount	£20 000	£18 000
Loan period	5 years	4 years
APR of the loan	3.3%	3.3%
Monthly payment	£362.05	

The formula for calculating the monthly payment on a loan is

$$M = \frac{r \times L}{1 - (1 + r)^{-n}}$$

where:

- $M$  is the amount of each monthly payment
- $L$  is the loan needed
- $r$  is the **monthly** interest rate as a decimal
- $n$  is the number of **months** taken to pay back the loan.

- (a) Show that Carys's monthly payment for Option B would be £400.81, correct to the nearest penny. [3]

$$= \frac{0.033 \times 18000}{12}$$

$$1 - \frac{(1 + 0.033)^{4 \times 12}}{12}$$

$$= \frac{0.00275 \times 18000}{1 - (1 + 0.00275)^{-48}} = \underline{\underline{£400.81}}$$

- (b) Carys chooses Option B, rather than Option A. Calculate how much Carys would save on the total amount paid for the caravan. [3]

$$\begin{aligned} & (362.05 \times 5 \times 12) - (400.8 \times 4 \times 12) \\ & - (2000) \\ & = \underline{\underline{£484.12}} \end{aligned}$$

Carys would save £ £484



8. Form-A-Part is a company that makes metal parts for use in engineering.

- (a) A metal part is made from a circular disc with a piece cut out. The part has uniform thickness, a diameter of 60 mm, and centre O. The diagram below shows the cross-section of the metal part.

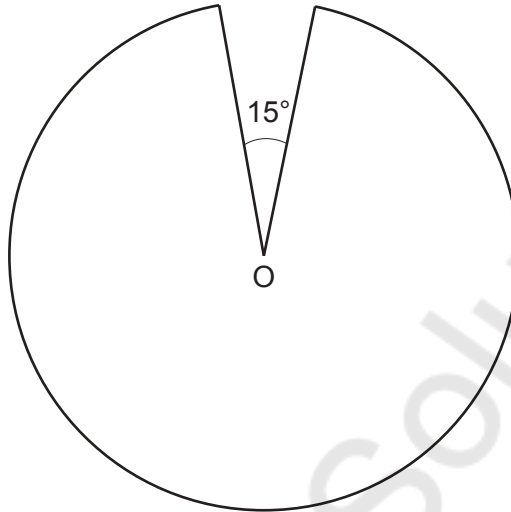


Diagram not drawn to scale

Calculate the perimeter of the cross-section of this metal part.  
Give your answer correct to the nearest millimetre.

[3]

$$\begin{aligned} \text{Perimeter} &= \frac{\theta}{360} \times \pi \times d \quad (360 - 15) \\ &= \frac{345}{360} \times \pi \times 60 \\ &= 291 \text{ mm} \end{aligned}$$

Perimeter of the metal part is 291 mm mm, correct to the nearest millimetre.



- (b) The diagram below shows a metal part made by Form-A-Part. Each part consists of a cone sitting on top of a hemisphere. The diameter of the base of the cone and the diameter of the hemisphere are equal.

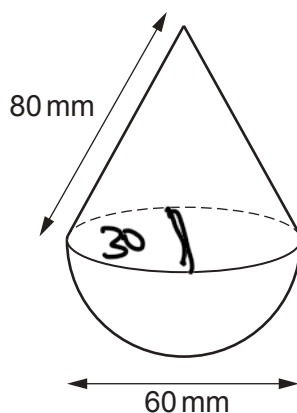


Diagram not drawn to scale

A customer has ordered 20000 of these parts.

Form-A-Part has guaranteed that they will make all of the parts with the measurements shown in the diagram being **correct to the nearest mm**.

All 20000 parts will be given a protective coating that comes in tins.

Each tin covers an area of  $4\,000\,000\text{ mm}^2$ , **correct to the nearest  $100\,000\text{ mm}^2$** .

Form-A-Part must **guarantee** that they have enough tins of protective coating to coat all 20000 parts.

Calculate the minimum number of tins they will need.

You must show all your working.

[6]

$$\begin{aligned}
 &\text{Greatest possible error of part} \\
 &= \text{area of cone} + \text{area of semi circle} \\
 &= \pi Lr + \frac{4\pi r^2}{2} \\
 &= \pi \times 80.5 \times 30.25 + \frac{4 \times \pi \times 30.25^2}{2} \\
 &= 7646.2 + 5746.59 \\
 &= 13392.79 \\
 &\text{Min no tins} = \frac{20000 \times 13399}{3950000} = \approx 68 \text{ tins}
 \end{aligned}$$

Minimum number of tins needed to guarantee having enough coating = 68 tins



- (c) Form-A-Part has decided to randomly sample these 20 000 metal parts to check their quality.

Use the following list of random numbers to select the first 5 parts for the sample. You must start with the first number in the list.

Explain clearly how you are using the numbers to select the sample.

[3]

66923	01325	58552	86923
48925	72712	58033	18266
95775	51056	01325	81036
05929	10429	26883	45630
88925	24800	02891	38441

- \* Number the parts from (0000)1 to 20,000
- \* Consider successive 5-digit numbers
- \* Use numbers in the range (0000) to 20,000
- \* Ignore repeats using rows

The 5 parts selected will be

1st (0)1325      2nd 18266      3rd (0)5929

4th 10429      5th (0)2891



9. A helicopter flies from Swansea to Neath and on from Neath to Port Talbot.

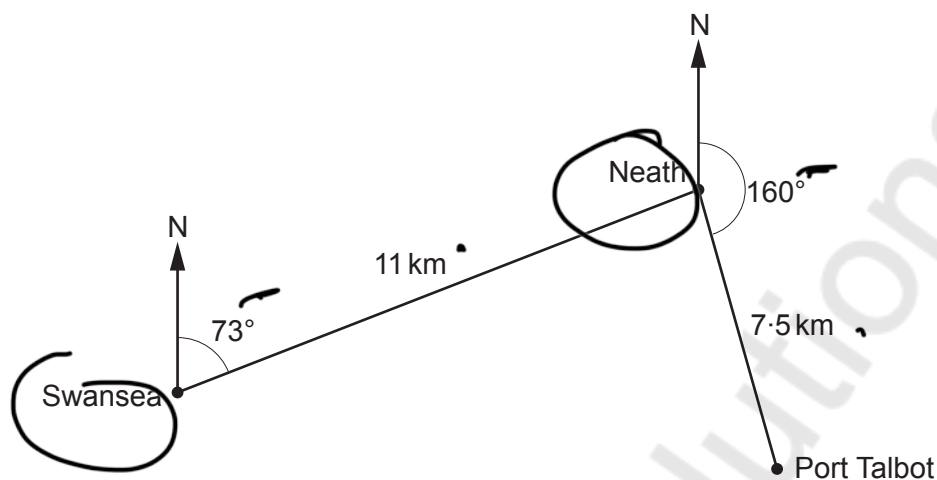


Diagram not drawn to scale

The bearing of Neath from Swansea is  $073^\circ$ .  
The bearing of Port Talbot from Neath is  $160^\circ$ .

- (a) By calculation, show that the bearing of Swansea from Neath is  $253^\circ$ . [1]

$$160 + 73^\circ = \underline{\underline{233^\circ}}$$

- (b) From Port Talbot, the helicopter flies directly back to Swansea.  
Calculate the bearing of this flight from Port Talbot to Swansea. [7]

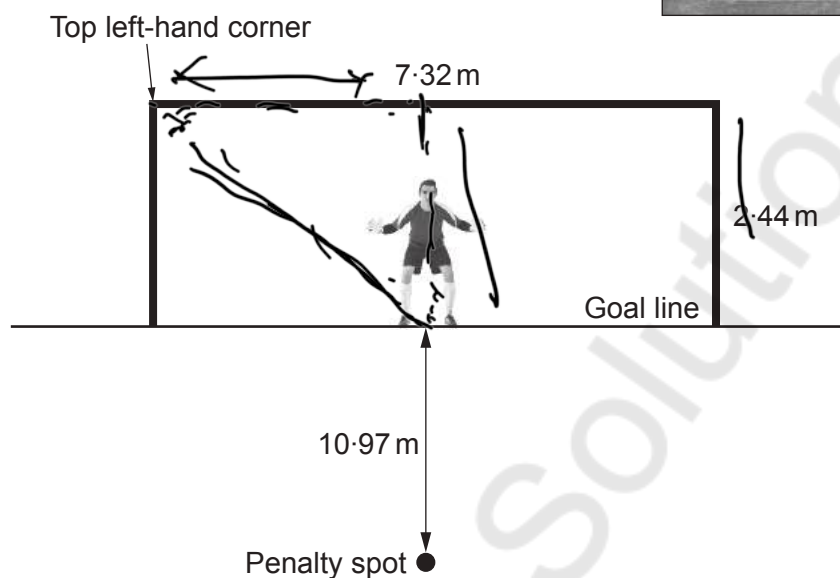
$$\begin{aligned} & \text{Dist Swansea to Port Talbot} \\ & = \sqrt{11^2 + 7.5^2 - (2 \times 11 \times 7.5 \times \cos 93^\circ)} \\ & = 13.6339 \text{ km} \approx 13.63 \text{ km} \\ & = \frac{\sin \theta^\circ}{7.5} = \frac{\sin 93^\circ}{13.63} \\ & \theta = \sin^{-1} \left( \frac{\sin 93^\circ \times 7.5}{13.6} \right) \\ & = 33^\circ \\ & = 233^\circ + 33^\circ \\ & = 286^\circ \end{aligned}$$



The bearing of the flight from Port Talbot to Swansea is  $286^\circ$ .



10. The diagram below shows the dimensions of a goal in football. Players take a penalty kick from the penalty spot. The penalty spot is 10.97 m from the goal line and central to the goal.



*Diagram not drawn to scale*

Mark takes a penalty kick.  
He misses, and the ball hits the top left-hand corner of the goal.

Calculate the straight-line distance from the penalty spot to the top left-hand corner of the goal. [4]

$$\sqrt{10.97^2 + \left(\frac{7.32}{2}\right)^2 + 2.44^2}$$

$$\approx 11.82\text{m}$$



Question number	Additional page, if required. Write the question number(s) in the left-hand margin.
	<p>Mathsvault.io Solutions</p>

Examiner only



**BLANK PAGE**

**PLEASE DO NOT WRITE  
ON THIS PAGE**

Mathvaudio Solutions

