



## Instructions

There are **two** sections in this examination paper.

Section A	Concepts and Skills	150 marks	6 questions
Section B	Contexts and Applications	150 marks	2 questions

Answer **all eight** questions, as follows:

In Section A, answer:

Questions 1 to 5 and

**either** Question 6A **or** Question 6B.

In Section B, answer Question 7 and Question 8.

Write your answers in the spaces provided in this booklet. You will lose marks if you do not do so. There is space for extra work at the back of the booklet. You may also ask the superintendent for more paper. Label any extra work clearly with the question number and part.

The superintendent will give you a copy of the *Formulae and Tables* booklet. You must return it at the end of the examination. You are not allowed to bring your own copy into the examination.

Marks will be lost if all necessary work is not clearly shown.

Answers should include the appropriate units of measurement, where relevant.

Answers should be given in simplest form, where relevant.

Write the make and model of your calculator(s) here:

Answer **all six** questions from this section.

**Question 1****(25 marks)**

- (a) Given the co-ordinates of the vertices of a quadrilateral  $ABCD$ , describe **three** different ways to determine, using co-ordinate geometry techniques, whether the quadrilateral is a parallelogram.

method 1:

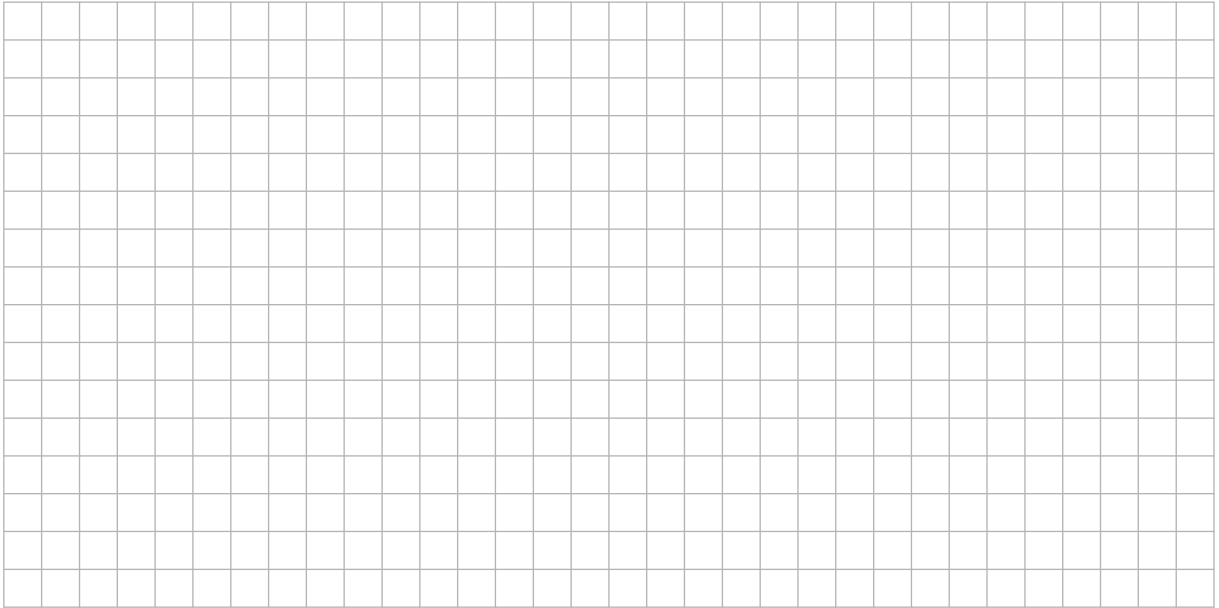
method 2:

method 3:

- (b) Using **one** of the methods you described, determine whether the quadrilateral with vertices  $(-4, -2)$ ,  $(21, -5)$ ,  $(8, 7)$  and  $(-17, 10)$  is a parallelogram.



(c) Verify that  $(4, 7)$  is the point that they have in common.



(d) Find the equation of the common tangent.



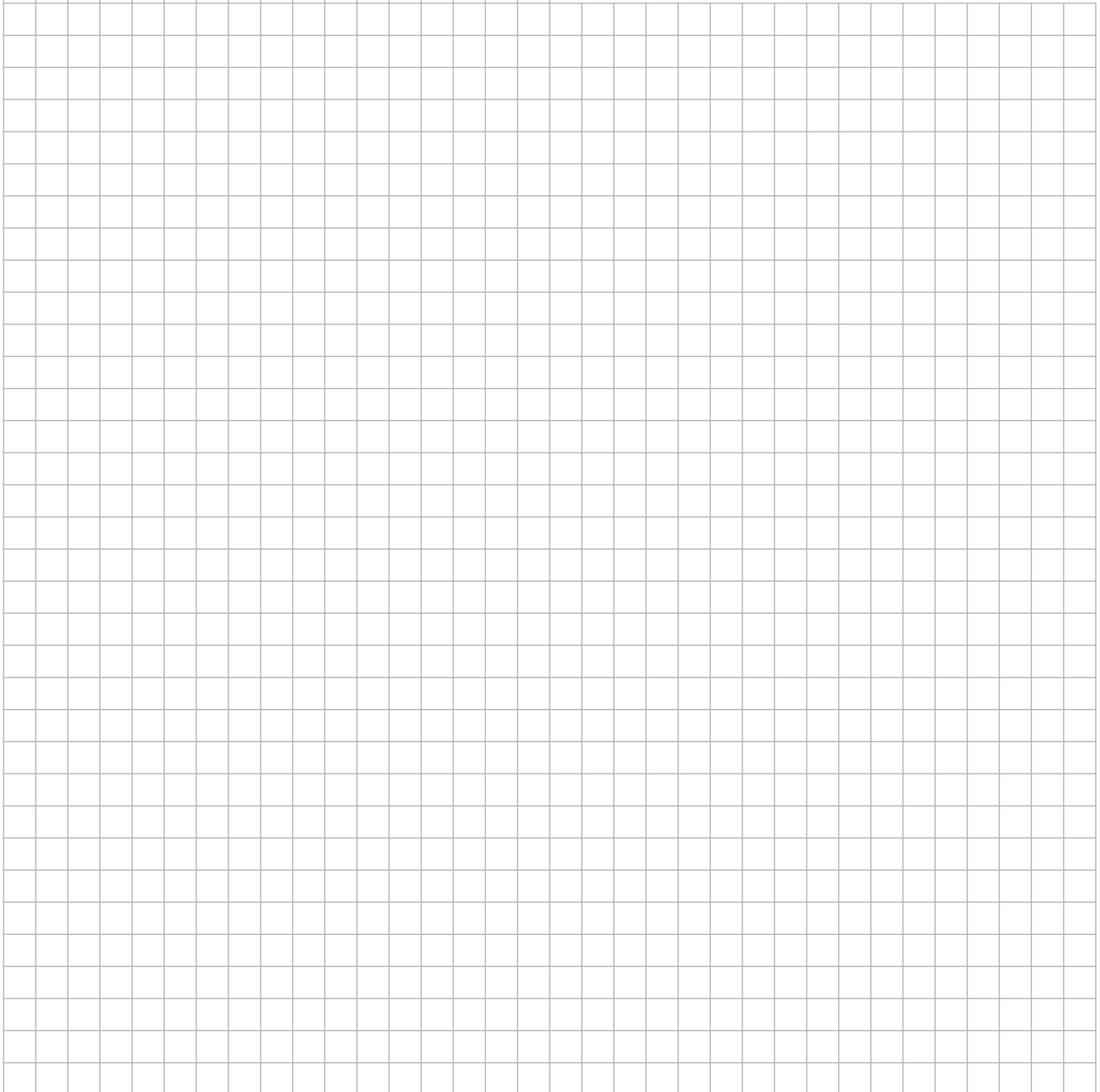
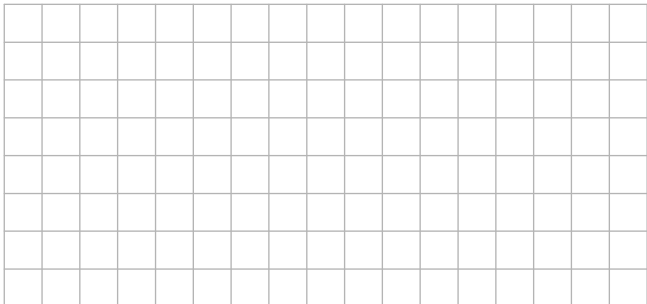
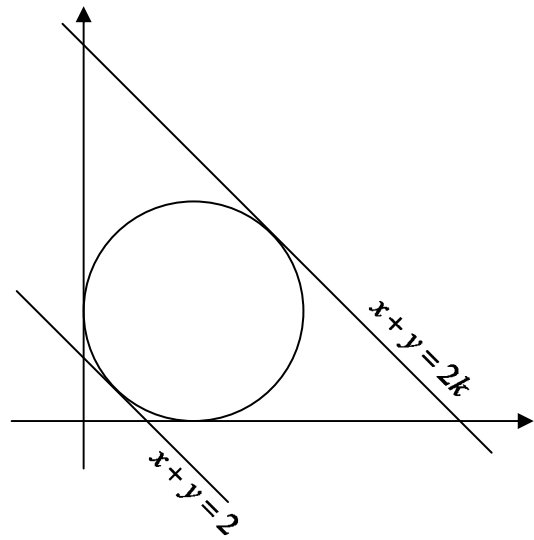
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**Question 3**

**(25 marks)**

The circle shown in the diagram has, as tangents, the  $x$ -axis, the  $y$ -axis, the line  $x + y = 2$  and the line  $x + y = 2k$ , where  $k > 1$ .

Find the value of  $k$ .









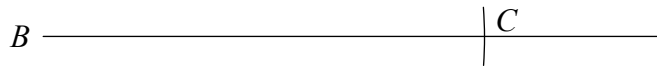
**Question 6**

**(25 marks)**

Answer **either** 6A **or** 6B.

**Question 6A**

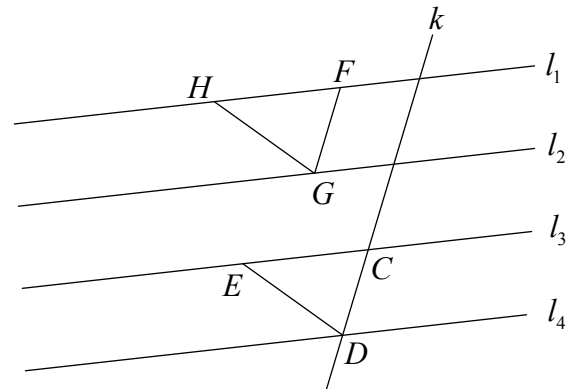
- (a) (i) Given the points  $B$  and  $C$  below, construct, without using a protractor or setsquare, a point  $A$  such that  $|\angle ABC| = 60^\circ$ .



- (ii) Hence construct, on the same diagram above, and using a compass and straight edge only, an angle of  $15^\circ$ .

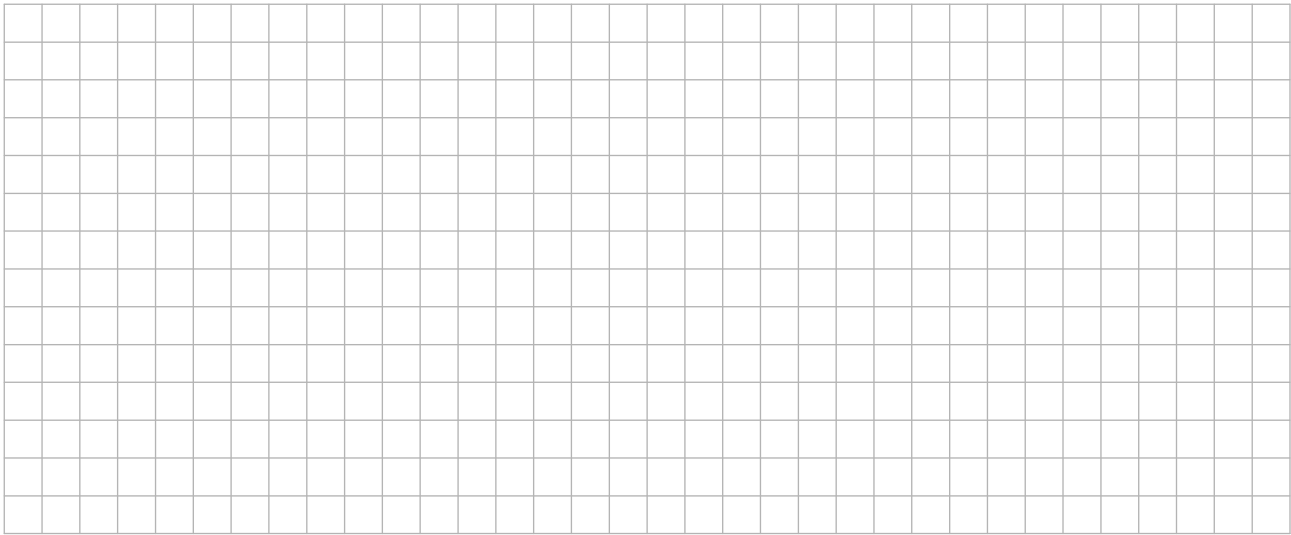
- (b) In the diagram,  $l_1, l_2, l_3,$  and  $l_4$  are parallel lines that make intercepts of equal length on the transversal  $k$ .  $FG$  is parallel to  $k$ , and  $HG$  is parallel to  $ED$ .

Prove that the triangles  $\triangle CDE$  and  $\triangle FGH$  are congruent.



*There is space to continue your work on the next page.*

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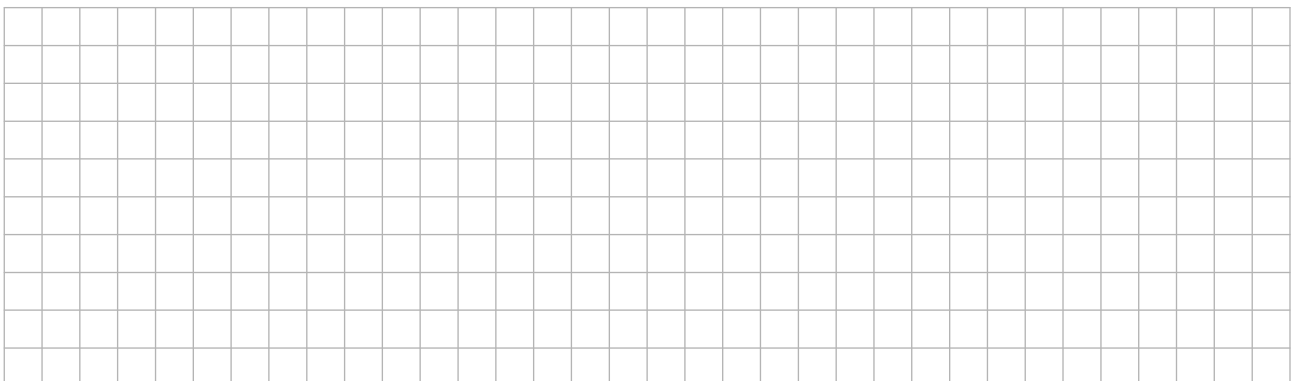
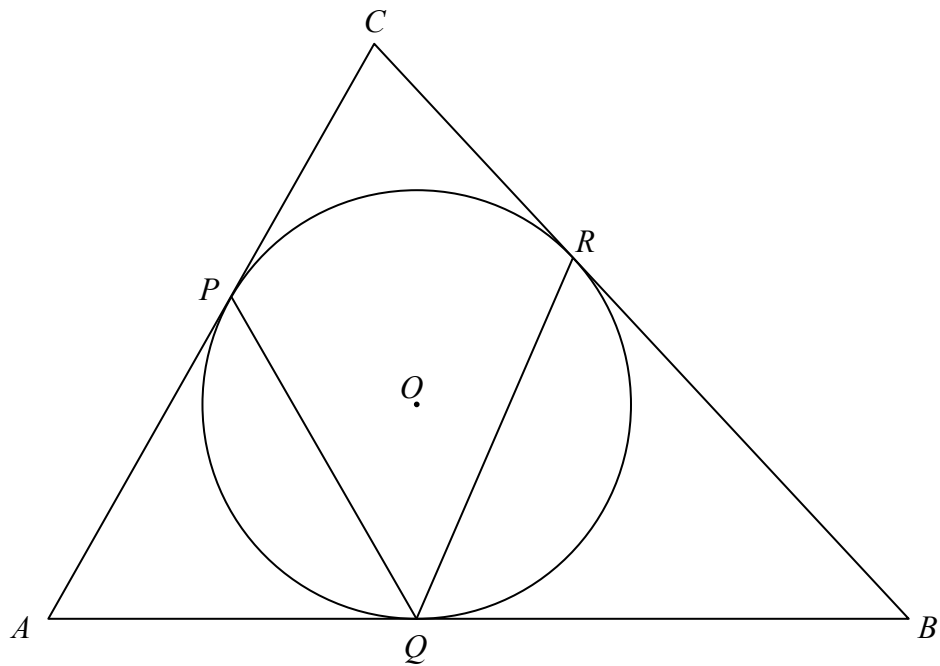


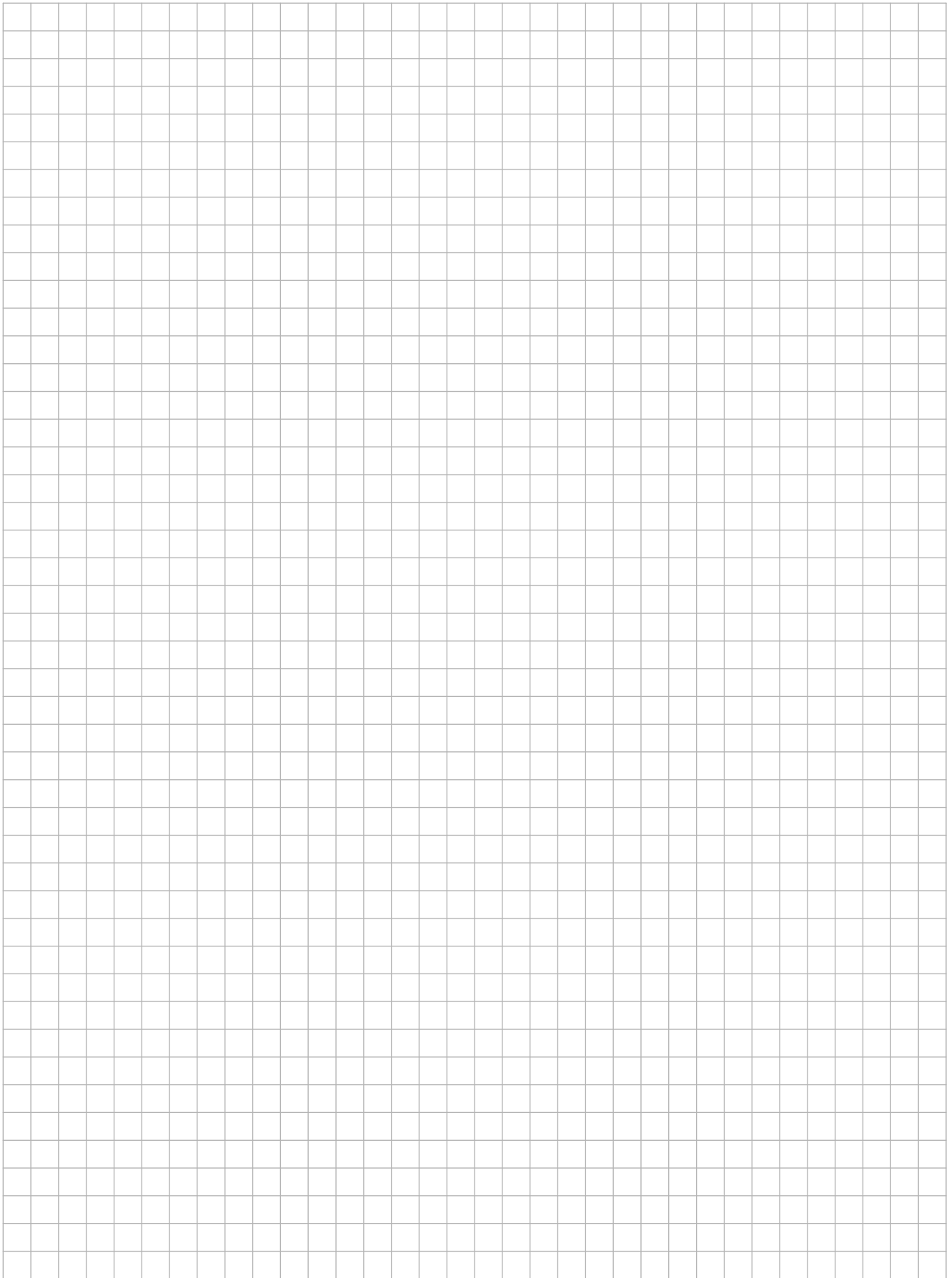
**OR**

**Question 6B**

The incircle of the triangle  $ABC$  has centre  $O$  and touches the sides at  $P$ ,  $Q$  and  $R$ , as shown.

Prove that  $|\angle PQR| = \frac{1}{2}(|\angle CAB| + |\angle CBA|)$ .





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- (e) The study described in part (d) was so large that it can be assumed to represent the population. Suppose that, in early 2012, researchers want to know whether the proportion of properties in negative equity has changed. They analyse 2000 randomly selected properties with mortgages. They discover that 552 of them are in negative equity. Use a hypothesis test at the 5% level of significance to decide whether there is sufficient evidence to conclude that the situation has changed since December 2010.

Be sure to state the null hypothesis clearly, and to state the conclusion clearly.

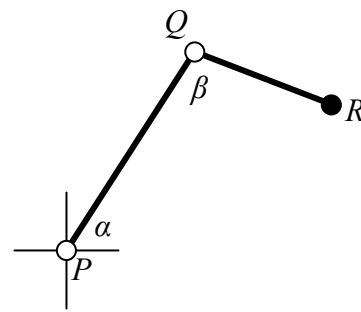


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**Question 8**

**(75 marks)**

The diagram is a representation of a robotic arm that can move in a vertical plane. The point  $P$  is fixed, and so are the lengths of the two segments of the arm. The controller can vary the angles  $\alpha$  and  $\beta$  from  $0^\circ$  to  $180^\circ$ .



- (a) Given that  $|PQ| = 20$  cm and  $|QR| = 12$  cm, determine the values of the angles  $\alpha$  and  $\beta$  so as to locate  $R$ , the tip of the arm, at a point that is 24 cm to the right of  $P$ , and 7 cm higher than  $P$ . Give your answers correct to the nearest degree.





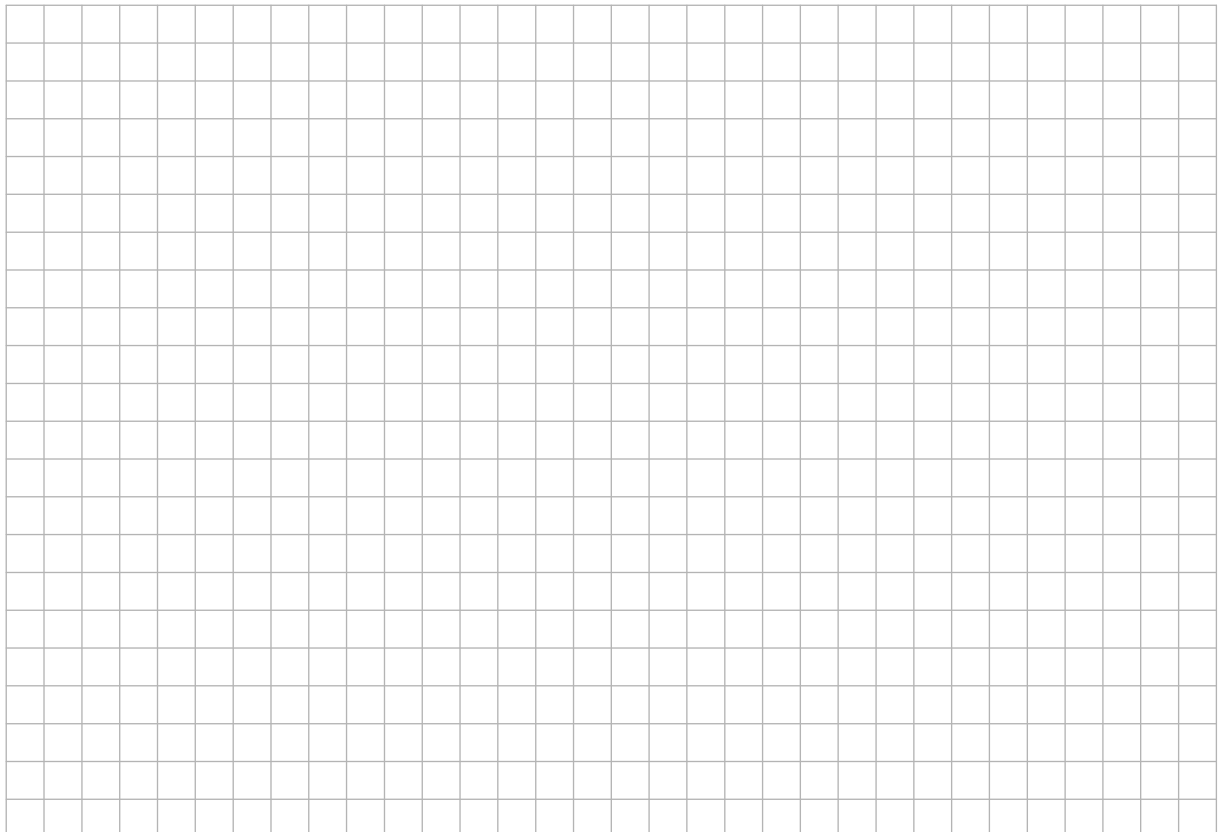
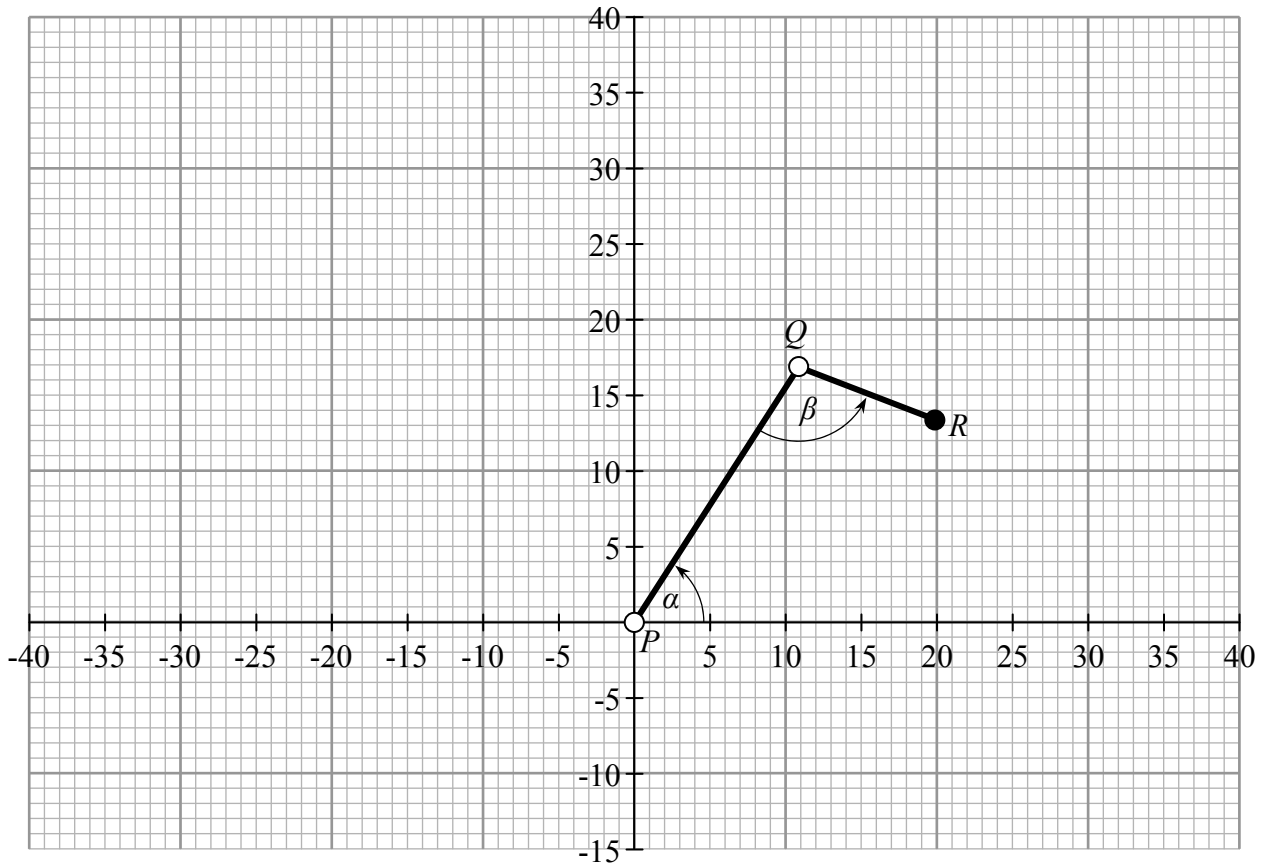
- (b) In setting the arm to the position described in part (a), which will cause the greater error in the location of  $R$ : an error of  $1^\circ$  in the value of  $\alpha$  or an error of  $1^\circ$  in the value of  $\beta$ ?

Justify your answer. You may assume that if a point moves along a circle through a small angle, then its distance from its starting point is equal to the length of the arc travelled.

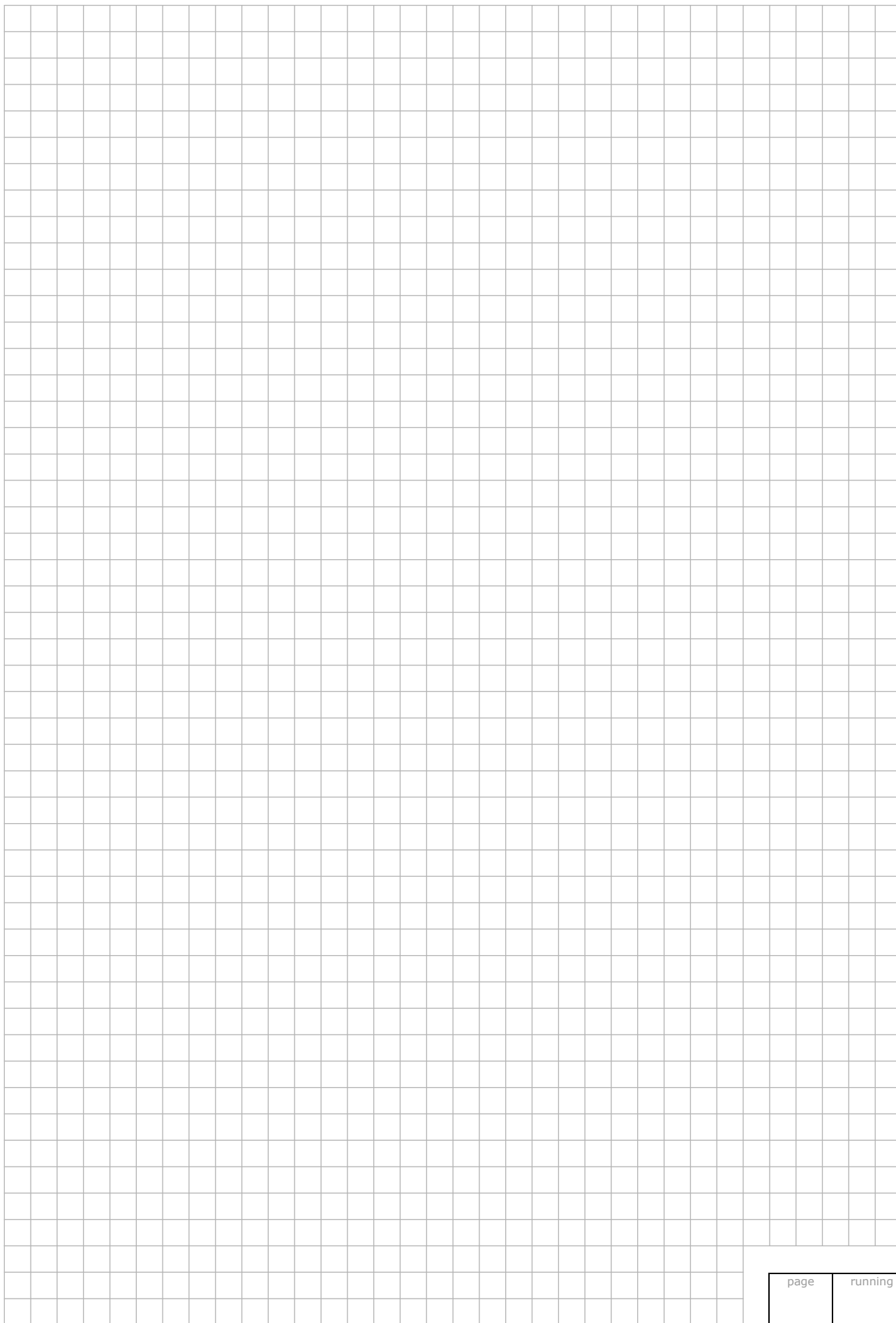
- (c) The answer to part (b) above depends on the particular position of the arm. That is, in certain positions, the location of  $R$  is more sensitive to small errors in  $\alpha$  than to small errors in  $\beta$ , while in other positions, the reverse is true. Describe, with justification, the conditions under which each of these two situations arises.

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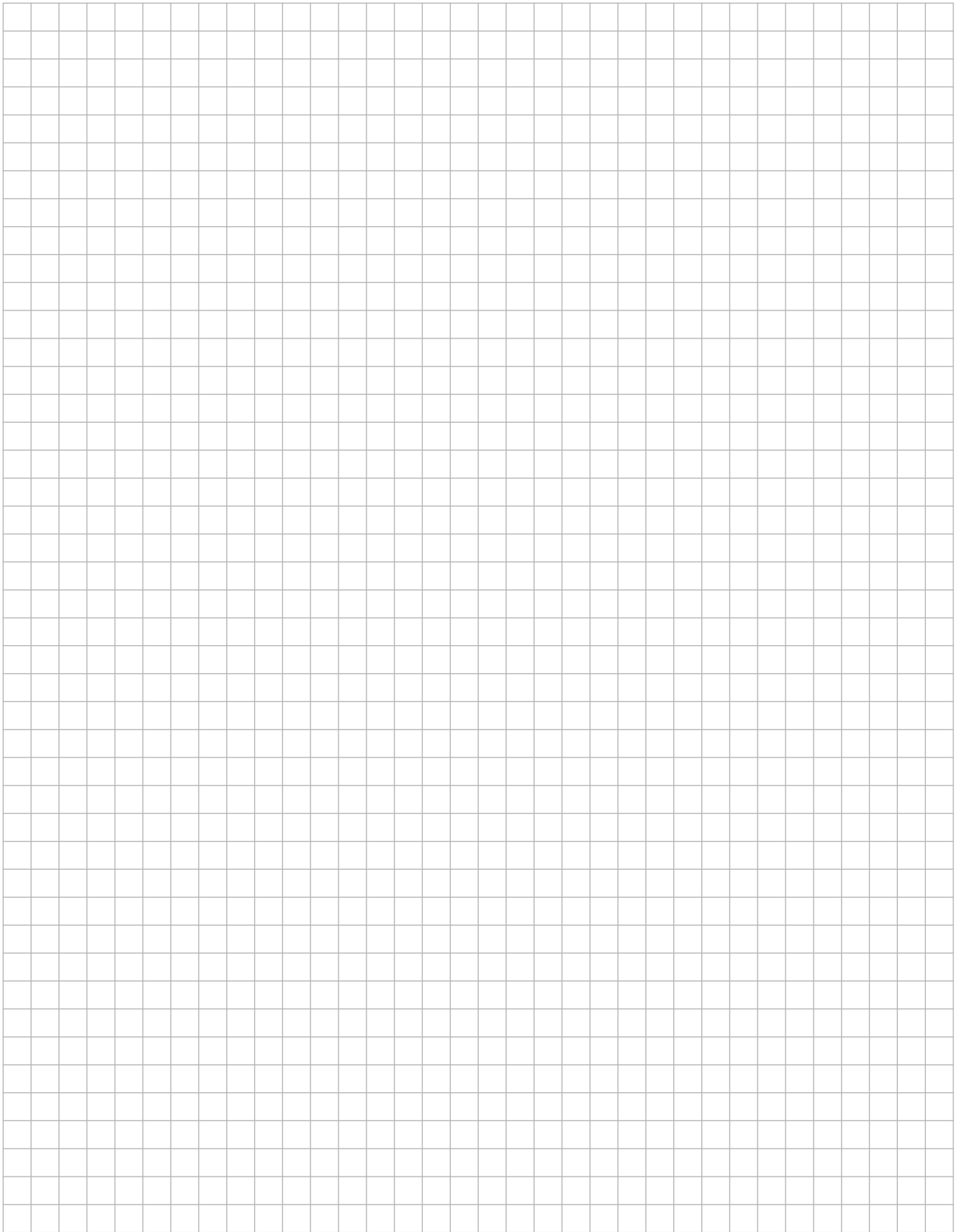
- (d) Illustrate the set of all possible locations of the point  $R$  on the coordinate diagram below. Take  $P$  as the origin and take each unit in the diagram to represent a centimetre in reality. Note that  $\alpha$  and  $\beta$  can vary only from  $0^\circ$  to  $180^\circ$ .



You may use this page for extra work.



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Leaving Certificate 2012 – Higher Level

## Mathematics (Project Maths – Phase 1) – Paper 2

Monday 11 June

Morning 9:30 – 12:00