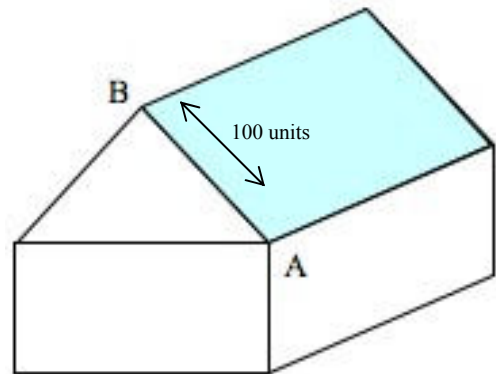


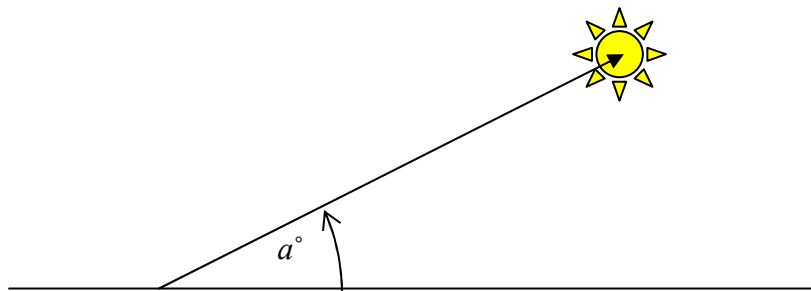
On the Pitch

On the south-facing slope of a roof, a solar panel is set up to capture the sun's rays and generate energy.

For the sake of the investigation we will make the following assumptions:



- The length of the sloping edge, AB, is 100 units.
- The rays of the sun reach the roof as parallel lines.
- A solar panel is at its most efficient when the rays hit it at right angles.
- The altitude of the sun (a°) is the angle of elevation of the sun at local noon.

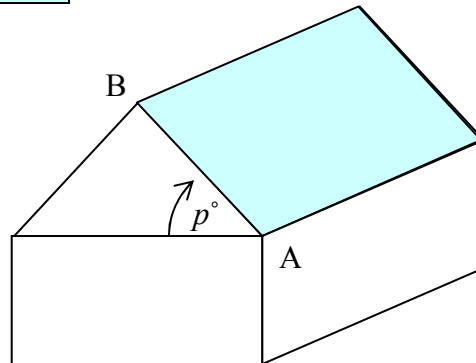


- The altitude of the sun varies day by day according to the table below. These are the altitudes at noon in Glasgow.

Date	altitude °
1-Jan-11	90
15-Jan-11	91.4
1-Feb-11	94
15-Feb-11	96.3
1-Mar-11	98.3
15-Mar-11	99.6
1-Apr-11	99.9
15-Apr-11	99.2
1-May-11	97.7
15-May-11	96.1
1-Jun-11	94.4
15-Jun-11	93.7
1-Jul-11	93.7
15-Jul-11	94.7
1-Aug-11	96.5
15-Aug-11	98

1-Sep-11	99.5
15-Sep-11	99.9
1-Oct-11	99.4
15-Oct-11	98
1-Nov-11	95.5
15-Nov-11	93.1
1-Dec-11	90.9
15-Dec-11	89.8
31-Dec-11	89.9

- the pitch of a roof is the angle, p° , it makes with the horizontal. Once set, this will be a constant.



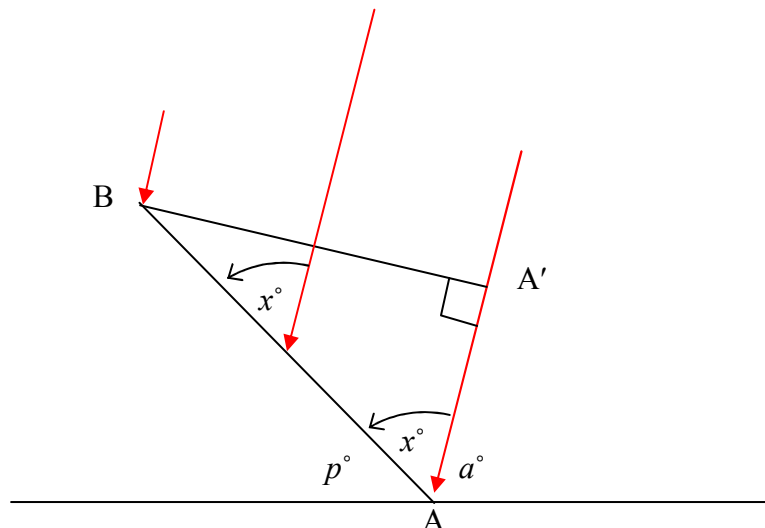
Query 1:

At what angle would you recommend the pitch of the roof be set to get the best out of the roof over the year?

- Draw a graph of *sun's altitude* against *time of year*.
- Calculate the mean value of a° over the year.
- Make a case for a particular value of p° as being the most efficient in the context.

Query 2:

When a solar panel is in position AB and the rays of the sun strike it at x° , the effective size of the panel is actually A'B.



- (i) Explore how the length of A'B varies as x varies. [Take $AB = 100$ units]
- (ii) Explore how this relates to the context.

Query 3:

The table below gives the amount of daylight in each day in the year in Glasgow.

- (i) Use it to explore the relationship between amount of daylight versus altitude.

Date	daylight (m)
1-Jan-11	426.2
15-Jan-11	457.3
1-Feb-11	517.8
15-Feb-11	577.6
1-Mar-11	641.2
15-Mar-11	706.3
1-Apr-11	785.4
15-Apr-11	849.8
1-May-11	920.5
15-May-11	976.6
1-Jun-11	1029.7
15-Jun-11	1052.7
1-Jul-11	1049.1
15-Jul-11	1020.6
1-Aug-11	963.8
15-Aug-11	906.6
1-Sep-11	831.5
15-Sep-11	767.8
1-Oct-11	694.3
15-Oct-11	630.4
1-Nov-11	555.0
15-Nov-11	498.3
1-Dec-11	446.7
15-Dec-11	421.8
31-Dec-11	424.6

- (ii) Why might you want the pitch to relate more to altitudes at times when the altitude takes bigger values?
How might this lead you to reassessing the value of pitch you recommended in Query 1?

Query 4

Suppose we use the product, **daylight** times **effective size** as a measure of the energy produced.

- (i) Use a spreadsheet to help you explore the pattern of energy output over the year for different pitches.
[A formula for computing this will be supplied by your teacher.]
Comment on the pros and cons of each value of pitch.
- (ii) Find the value of the pitch which maximises the annual output of energy.
- (iii) Write a short report, with charts and tables, which concludes with a recommendation for the best pitch angle of pitch in Glasgow.