The Ogden Trust

making physics matter

Phizzi problem solving

Age 9-11 years

Magnetometer

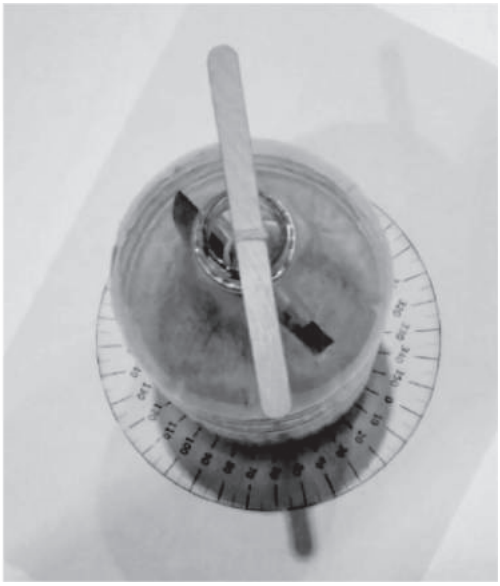
Problems to solve

Mrs Flaherty's Year 5 class has been learning about the Earth and space. They were lucky to have a solar physicist come to talk to them about the Sun and solar storms. They learnt that solar storms can cause slight changes in Earth's magnetic field.

1

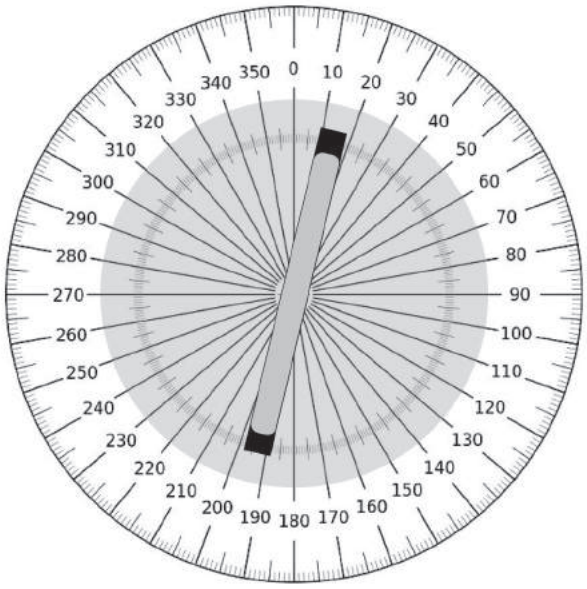
The class worked in teams to build their own magnetometer, a measuring instrument that can measure slight changes in Earth's magnetic field. They decide to see if they can use their magnetometers to predict when solar storms have happened. They set up their magnetometers on a bench, sat on top of a printout of a 360° protractor. Once the hanging magnet had settled in one place, the children lined up the north pole of the magnet with 0° on the paper protractor. Each day, at the same time, they recorded the position that the north pole of the magnet pointed to.

(a) Leah and Cameron read the angle position of the north pole every day over a month and record their data in a table. Use the images to complete their measurements and add this data to the results table.

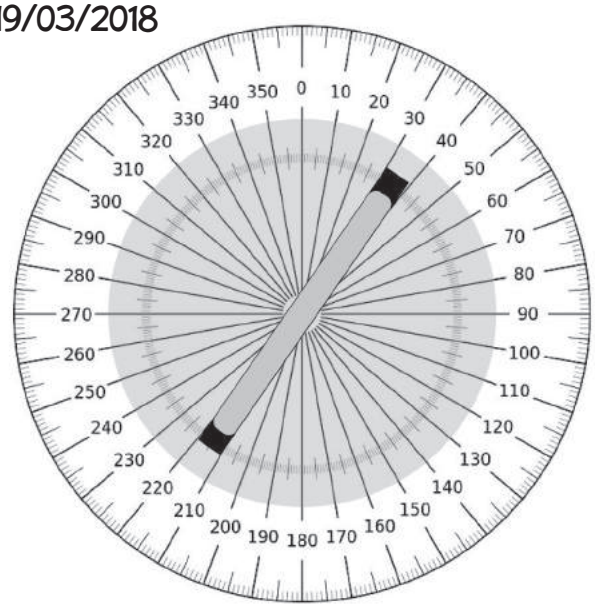


Day	Date	Angle of the north pole (degrees)
1	01/03/2018	15
2	02/03/2018	10
3	03/03/2018	10
4	04/03/2018	15
5	05/03/2018	
6	06/03/2018	10
7	07/03/2018	13
8	08/03/2018	10
9	09/03/2018	13
10	10/03/2018	15
11	11/03/2018	18
12	12/03/2018	15
13	13/03/2018	13
14	14/03/2018	10
15	15/03/2018	10
16	16/03/2018	15
17	17/03/2018	10
18	18/03/2018	20
19	19/03/2018	
20	20/03/2018	
21	21/03/2018	18
22	22/03/2018	14
23	23/03/2018	13
24	24/03/2018	10
25	25/03/2018	15
26	26/03/2018	15
27	27/03/2018	10
28	28/03/2018	13
29	29/03/2018	13
30	30/03/2018	10
31	31/03/2018	13

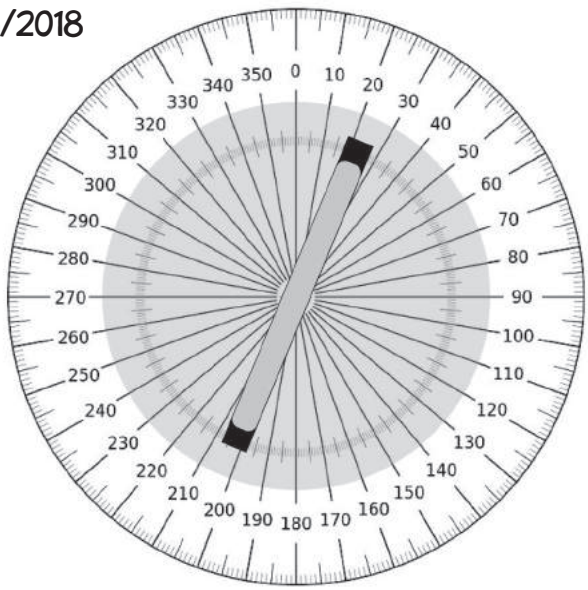
05/03/2018



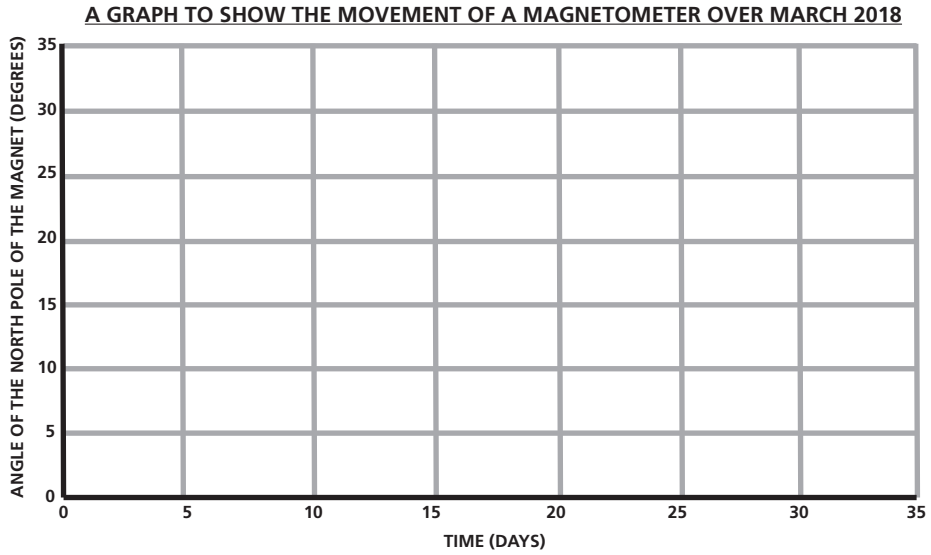
19/03/2018



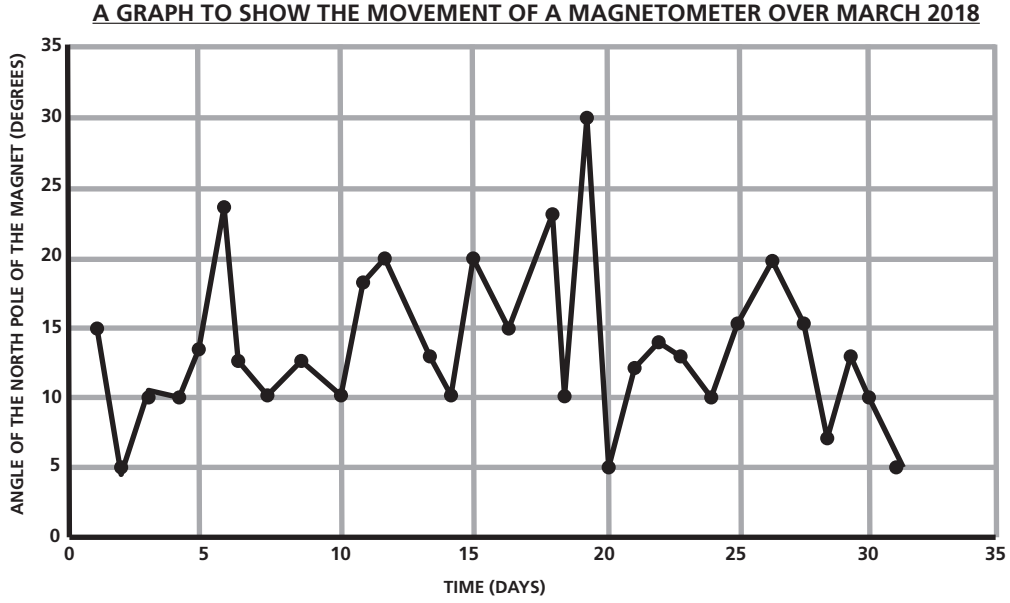
20/03/2018



(b) You now have a complete set of data for observing the Earth's magnetic field over the month of March. Draw a line graph of Leah and Cameron's data.



(c) From your line graph, do you think there was a solar storm in March? Explain your answer.



(d) Brinda and Ali also collected data over the month of March. This is the line graph of their results. Answer the following questions to compare the two graphs.

(i) On what day was Brinda and Ali's north pole positioned at the greatest angle from its start position? What angle did they measure that day?

(ii) On what day was Leah and Cameron's north pole positioned at the greatest angle from its start position? What angle did they measure that day?

(iii) Did the two groups measure their greatest angle on the same day? How did their measurements compare?

(e) Could you use the magnetometer to make accurate measurements? How could you improve the design of the magnetometer to make it easier to measure angles accurately?

2

Solar storms often occur after we observe a solar flare, a giant explosion on the surface of the Sun that sends particles and energy off into space. The table below shows how many large solar flares there were each month in 2018.

(a) What was the total number of large solar flares recorded in 2018?

(b) In which month were there the most large solar flares?

(c) In how many months were there no large solar flares?

(d) What fraction of 2018's large solar flares were recorded in May?

(e) What percentage of 2018's large solar flares were recorded in February?

(f) In which month would you have expected Leah and Cameon's solar flare data magnetometer to move the most?

Month	Number of large solar flares recorded
January	2
February	25
March	5
April	1
May	10
June	5
July	1
August	0
September	0
October	1
November	0
December	0

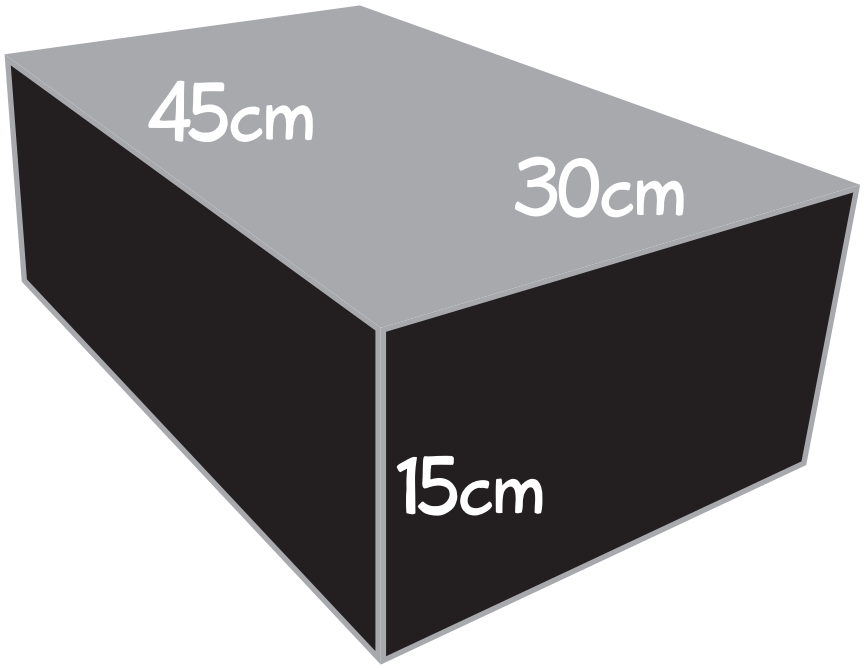
3

Scientists sometimes place magnetometers on space probes and satellites so that they can measure magnetic fields in different places in the solar system. When designing and building satellites, scientists need to think carefully about size and mass.

(a) A magnetometer instrument designed to go on a satellite is a cuboid shape with the dimensions shown in the diagram. Calculate the volume of this instrument?

(b) The total volume of the satellite is 60,750cm³. The satellite also needs to carry a camera to collect images and send them back to Earth. What is the maximum volume that the camera can have?

(c) What fraction of the space on the satellite is taken up by the magnetometer?



4

The Earth's core is made of liquid iron and causes planet Earth to be magnetic, we say it has a magnetic field around it. Not all planets have magnetic fields; the pie chart below compares the planets in our solar system that have and have not got magnetic fields.

(a) What fraction of planets in the solar system do not have a magnetic field?

(b) What fraction of planets in the solar system have a weak magnetic field?

(c) How many planets in the solar system have a strong magnetic field?