# The Reasons for the Seasons

**Learning Outcomes in Focus**

**Contextual strand: E&S 4**

Students should be able to develop and use a model of the Earth-sun-moon system to **describe** predictable phenomena observable on Earth, including seasons, lunar phases, and eclipses of the sun and moon.

**DESCRIBE: Develop a detailed picture or image of, for example, a structure or process; using words or diagrams where appropriate; produce a plan, simulation or model.**

**Nature of science: NoS 1 & 5**

1. Students should be able to **appreciate** how scientists work and how scientific ideas are modified over time.

5. Students should be able to **review** and **reflect** on the skills and thinking used in carrying out investigations, and **apply** their learning and skills to solving problems in unfamiliar contexts.

**Learning Intentions**

Students will learn to:

1. Explain the reason for the seasons using data and conclusions gathered through a variety of small investigations.
2. Act like scientists by developing and modifying explanations.

**Prior Learning**

Students should have some familiarity with the concepts of solar energy, angles and area. Students would also need to have learned about temperature, time and their units.

**Equipment needed for each activity.**

**Activity 1**

| | |
|---|---|
| An assortment of thermometers e.g. Datalogger with temp probe, Digital thermometers, mercury thermometers | |
| Blu-tac | 2 metre sticks |
| Graph paper | 2 table lamps |

**Activity 2**

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|---|
| 2 small torches, ends covered but with a square shape cut into the cover |
| 2 retort stands with clamps |
| White board or paper |

**Activity 3**

| |
|---|
| Sunshine ray tube (any material cut into a cylindrical shape as shown on page 7 |
| Season simulator (requires Flash player): http://astro.unl.edu/classaction/animations/coordsmotion/eclipticsimulator.html |
| Graph paper |
| Small laminated squares (1 cm x 1 cm) |

**Activity 4**

| |
|---|
| Polystyrene model (Polystyrene ball on a skewer) x 2 |
| Light sources for 'sun' e.g. standing torches or bulbs (x2) |
| Blu-tac and thumbtacks |
| Protractor (x2) |

# Earth and Space Activity

**Your group number (1-4) determines BOTH your role in the home team AND your expert group number. Assign your roles now and then Reader please read the rest of the instructions to the group.**

1. **Reader**. 2. **Timekeeper**. 3. **Recorder**. 4. **Manager**.

**Timekeeper** set the clock at 10 minutes, **Recorder** have pens and sheet ready and **Manager** ensure that we are all on task!

**Start the clock**

A weather station at Punta Arenas, Chile, and a weather station in Kildare, Ireland recorded the following average temperatures for June and December 2013. Discuss possible reasons for the variance in temperatures shown. On the sheet develop an initial scientific explanation for this variance. Include a diagram as part of this explanation. Remember we have **10 minutes.**

| Place | Location | Average temps for June 2013 | Average temps for December 2013 |
|---|---|---|---|
| Kildare, Ireland | Latitude – 53$^{o}$N<br>Longitude - 8$^{o}$W | 19$^{o}$C | 5$^{o}$C |
| Punta Arenas, Chile | Latitude – 53$^{o}$S<br>Longitude 70$^{o}$W | 2$^{o}$C | 24$^{o}$C |

**After 10 minutes:**

**Reader:** We must now break into our expert teams, and go to our designated workstations. Each expert group will carry out a different activity, and will bring back evidence from their activity which should help us to develop our explanation further. Time allowed is **25 minutes**. We should bring our white boards with us to record our conclusions from our activities to bring back to our home team. We have 25 minutes so let's go!

**After 25 minutes return to Home team**

**Reader:** Each expert now gets 3 minutes to communicate their expert knowledge to the team, timed by the **Timekeeper**. We should then add to, or change our initial explanation, to include evidence / conclusions from all 4 stations. However, our initial explanation should remain visible i.e. do not start over on the other side of the page! Total time, including explanations from experts is **20 minutes**. **Timekeeper** start timing!

When finished check have you:

1. Clearly stated your question for investigation?
2. Clearly explained what you did?
3. Presented data collected?
4. Drawn a conclusion from your data?
5. Explained clearly what you have found out on your white board for your home team?

**Activity 1**

Using the materials provided plan, design and carry out an investigation to **determine whether there is a relationship between the length of time that light is falling on a surface, and its temperature**. Use the paper provided to record your work.

1. Write down everything you know about this topic.
2. What do you think might happen when you carry out this investigation? Give reasons for your answers.
3. Can you think of a hypothesis for this investigation? Write it down.
4. How are you going to set up the investigation to test this hypothesis? Write about what you are going to do. It might be helpful to draw a diagram.
5. Write down what are you going to measure and how are you going to measure it.
6. State how you are going to make this a fair test.
7. What type of data will you collect? How much data? Explain your reasons.
8. Collect and present your data in a clear way.
9. Does your data tell you anything about the relationship you are investigating? How can you show what your data is telling you?
10. Is your hypothesis confirmed? If not, what will you do next?
11. Write down any questions you may have about this topic having completed your investigation.
12. Discuss as an expert group what you have found out. What conclusions can you draw from your investigation?
13. Each individual should now write their conclusion, as well as some evidence for this conclusion, on their white board to bring back to their home team.

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At the end of this activity check have you:

1. Answered all the questions
2. Written a summary of your findings on your white board, including the following words/ideas: ***Area; Tilt; Energy; Spread; Angle.***

**Activity 2**

1. Shine the torch directly on your whiteboard. Concentrate on the square shape of light. How can you change the **size** of the square of light forming on the whiteboard? From your observation of the square decide with the group, and tick, which of the following statements is correct:
   (a) The square appears brightest when it is at its biggest. ☐
   (b) The square appears brightest when it is at its smallest. ☐

2. Clamp the torch in the retort stand so that it is shining down on the graph side of your whiteboard and draw around the shape made. Label this drawing A.

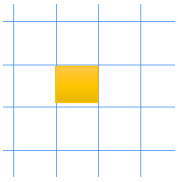
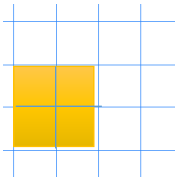
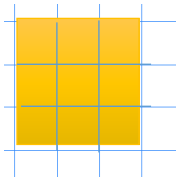
3. Now move the torch to form a larger square of light. Draw around the new shape. Label this drawing B.

4. Now move the torch to make the square of light bigger still. Draw around this shape. Label this drawing C.

5. If 100 packets of light energy leave the torch every second and all land on the paper, then how many packets of light energy land every second

   On square A? _____ On square B? _____ On square C? _____

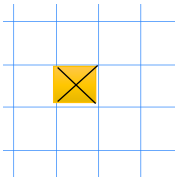
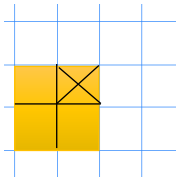
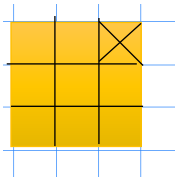
6. Imagine a squared grid was now placed over each your three drawings as shown with the shape made by the light shown as the yellow square here.


A

B

C

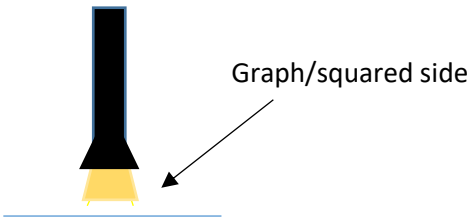
   Look at your answer to Q5 and state how many imaginary packets of light energy land every second on the yellow shape in each case?

   A _____ B _____ C _____

7. Now consider the drawings A, B and C again. If the energy is spread equally over the yellow shape then how many imaginary packets of energy lands every second on each of the smaller squares in the grid (shown marked with an X) for diagram A, B and C?

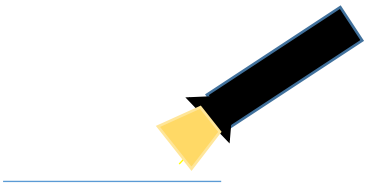

A
Ans =_____

B
Ans =_____

C
Ans = _____

8. Set up the torch in the retort stand so that it shines **directly** on the graph/ squared side of the white board.




Draw around the shape the light makes on the graph paper.
Label this drawing X.

9. Move to a new space on the whiteboard and **without changing the distance from the** torch to the board, tilt the torch so that the light hits the whiteboard at an angle as shown.



Again, draw around the shape made.
Label this shape Y.

10. Use what you know about area to decide which of the two shapes has the greater area.

11. Colour in one grid square on your whiteboard, inside each of the two shapes X and Y.

12. If the torch shines for the same length of time in position X and Y discuss and decide with your group which of the following answers is correct:

(a) Each of the coloured squares will receive the same amount of light energy. ☐

(b) The coloured square in X will receive more energy. ☐

(c) The coloured square in Y will receive more energy. ☐

With your expert group discuss what you have learned from this activity. Write your ideas in the space below. Use the following words and ideas in your discussion: **Tilt; Area**; **Energy; Angle; Spread.**

Discuss how what you have seen relates to the larger group problem. Write your conclusions on your white board to bring back to the home team.

At the end of this activity you should:

1. Have answered all questions.
2. Know how to measure the area of an irregular shape.

**Activity 3(1)**

**Keywords:** area, irregular, estimate

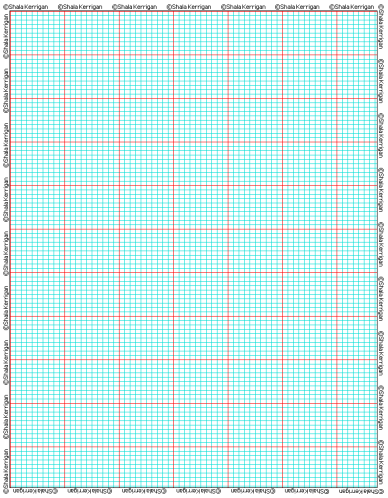
1. Explain why you cannot find the area of this shape by multiplying length and width.

2. In the envelope provided you will find a number of laminated squares which are 1 cm x 1 cm.

1 cm

1 cm

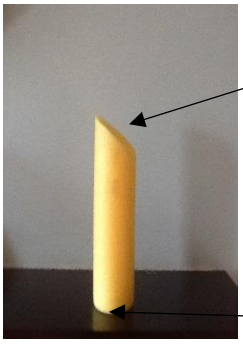
Use them to estimate the area of the shape **above**. Write your answer (think about what units you will use) and explain what you did in the space below:



3. How could you use graph paper to get a good estimate of the area of an irregular shape? Explain carefully what you would do.

PTO.

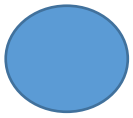
4. Use graph paper to estimate the area of **each end** of the tube you have been given.

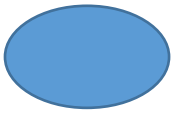


Area of A = _____

Area of B = _____

5. Put an X on which of these two shapes you think has the greater area.





6. Discuss what you have learned about the area of circles and ellipses with the rest of your expert group. Think about how this might relate to the overall question.

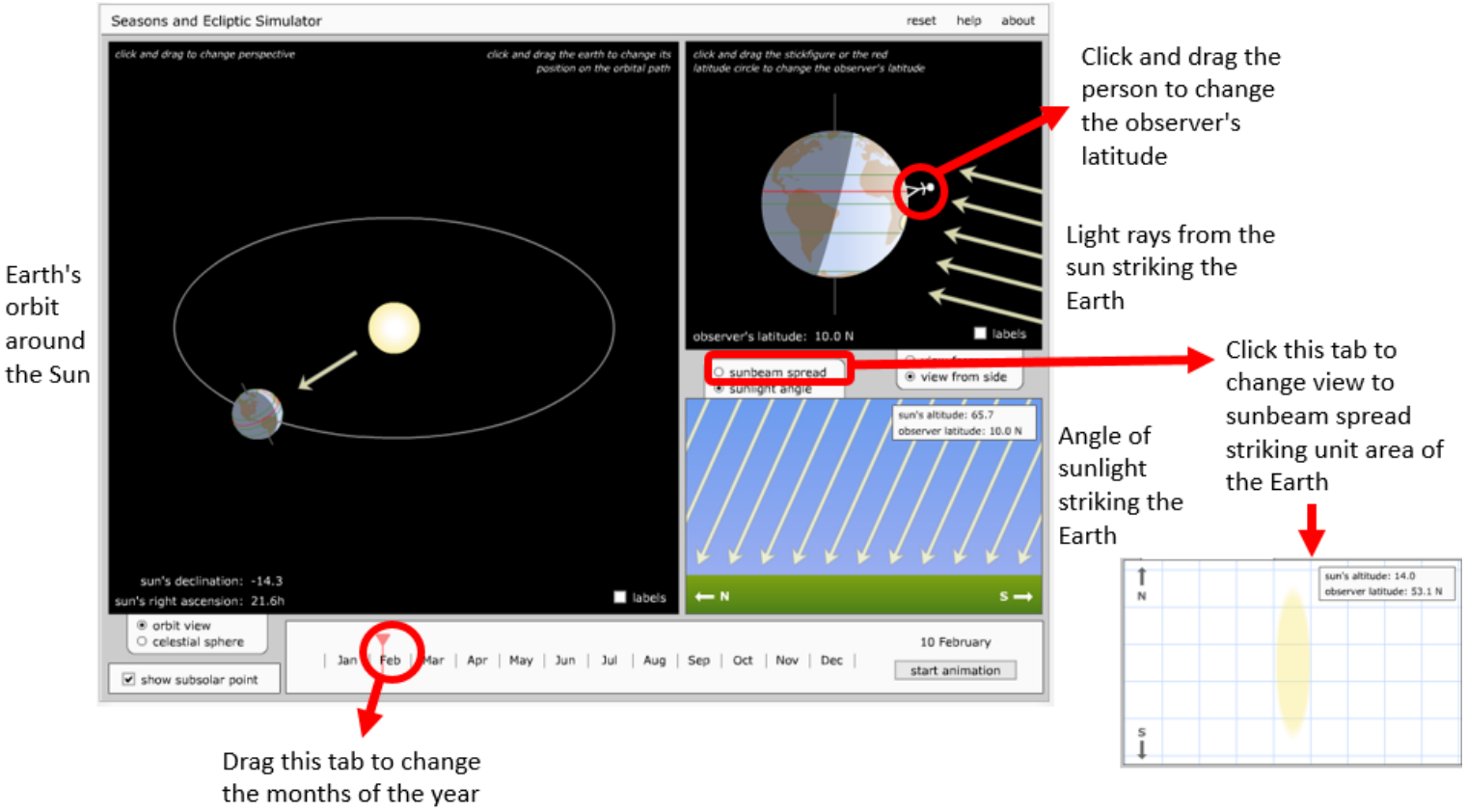
7. When everyone in your expert group has done both activity 3 (1) and activity 3 (2) gather the whole group together to discuss what you have discovered, and how this relates to the overall question. Each individual should then write a conclusion about their findings on a white board to bring back to their home team. You may also want to make note of evidence which validates your conclusion.

At the end of this activity you should be able to explain how the angle at which the sun's rays hits the Earth relates to Latitude.

## Session 2 - Activity 3(2)-Computer Simulation

**Activity 3(2)**

You have been provided with a computer simulation that models the Earth's rotation around the Sun. Guidelines on how to use the simulation are provided on the labelled screens




Work the simulation by manually clicking and dragging, i.e. do not click 'start animation'. (PTO)

Record any observations you have made in each of the following situations. It might be helpful to draw a diagram.

| **Observer : 53$^{o}$ North**<br>**Date : June 21$^{st}$**<br>Angle of sunlight hitting the Earth | **Observer : 53$^{o}$ North**<br>**Date : Dec 21$^{st}$**<br>Angle of sunlight hitting the Earth | **Observer : 53$^{o}$ South**<br>**Date : June 21$^{st}$**<br>Angle of sunlight hitting the Earth | **Observer : 53$^{o}$ South**<br>**Date : Dec 21$^{st}$**<br>Angle of sunlight hitting the Earth |
|---|---|---|---|
| Sunbeam spread | Sunbeam spread | Sunbeam spread | Sunbeam spread |

When you have completed both activity 3 (1) and activity 3 (2) gather the whole group together to discuss what you have discovered, and how this relates to the overall question. Each individual should then write a conclusion about their findings on a white board to bring back to their home team. You should also make note of evidence which validates your conclusion.

At the end of this activity you will write a summary of your findings on your white board for your home team. Your explanation should include some or all of the following words or ideas:

*Day; Tilt; Northern Hemisphere; Southern Hemisphere; Night; Longer; Shorter.*

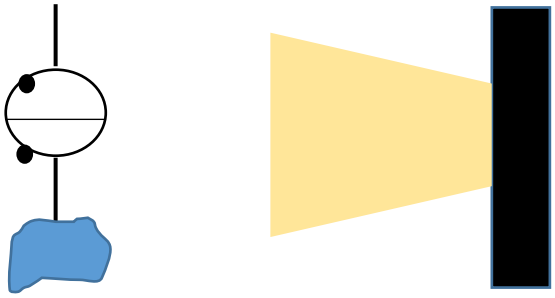
**Activity 4**

Some **Keywords** for this activity are written in **bold.** As a group you must ensure that everyone in the group understands them. You can explain them to your home team.

1. You have been given a polystyrene model of the Earth on its axis. What do you think the black line represents?

2. At the back of the model place one thumbtack a little more than half way up the **Northern Hemisphere** and the other thumb tack the same distance below the equator in the **Southern Hemisphere.** Try to make sure they are more or less in a straight line as shown below and push them fully in.

3. Stand your model of the earth in a clump of blu-tack so that it is nice and straight (you could use the protractor to help you). Put it facing your torch which represents the sun.

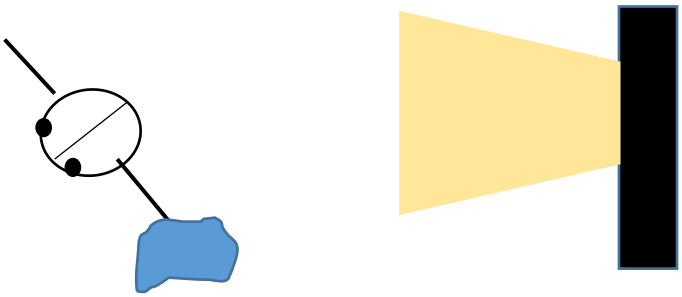


4. Are the thumb tacks lit up by the sun in this arrangement? _____

5. Write T (true) or F (false) after the following statements for what you observe when you twist the skewer so that the Earth rotates in an **anti-clockwise** direction, at a fairly steady speed, on its **axis**.
   a) The tack in the Northern hemisphere gets lit up first.
   b) Both tacks move into the light at the same time.
   c) The tack in the Southern hemisphere is in the light for longer.
   d) Both tacks are in the light for the same amount of time.
   e) The **North Pole** receives light.
   f) The **South Pole** does not receive light

For any FALSE statement write the corrected statement in the space below.

6. Now use the protractor to tilt the Earth to an angle of 45$^{o}$ from the vertical ***away*** from the torch.

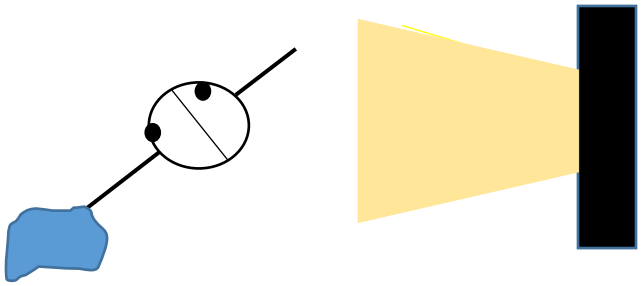


Again, rotate the Earth slowly anticlockwise on its axis. Decide, through observation, which of the following statements are true and write the letter "T" beside them.

a) The tack in the Northern hemisphere gets lit up first.
b) Both tacks move into the light at the same time.
c) The tack in the Southern hemisphere is in the light for longer.
d) Both tacks are in the light for the same amount of time.
e) The North Pole receives light.
f) The South Pole does not receive light.

For any statement that is FALSE write a corrected statement in the space below.

Now tilt the earth ***towards*** the torch so that it is 45$^{o}$ away from vertical.



PTO

Again, rotate the Earth on its axis, in an anticlockwise direction, and through observation decide which of the following statements are true. Write a "T" beside those that are true.

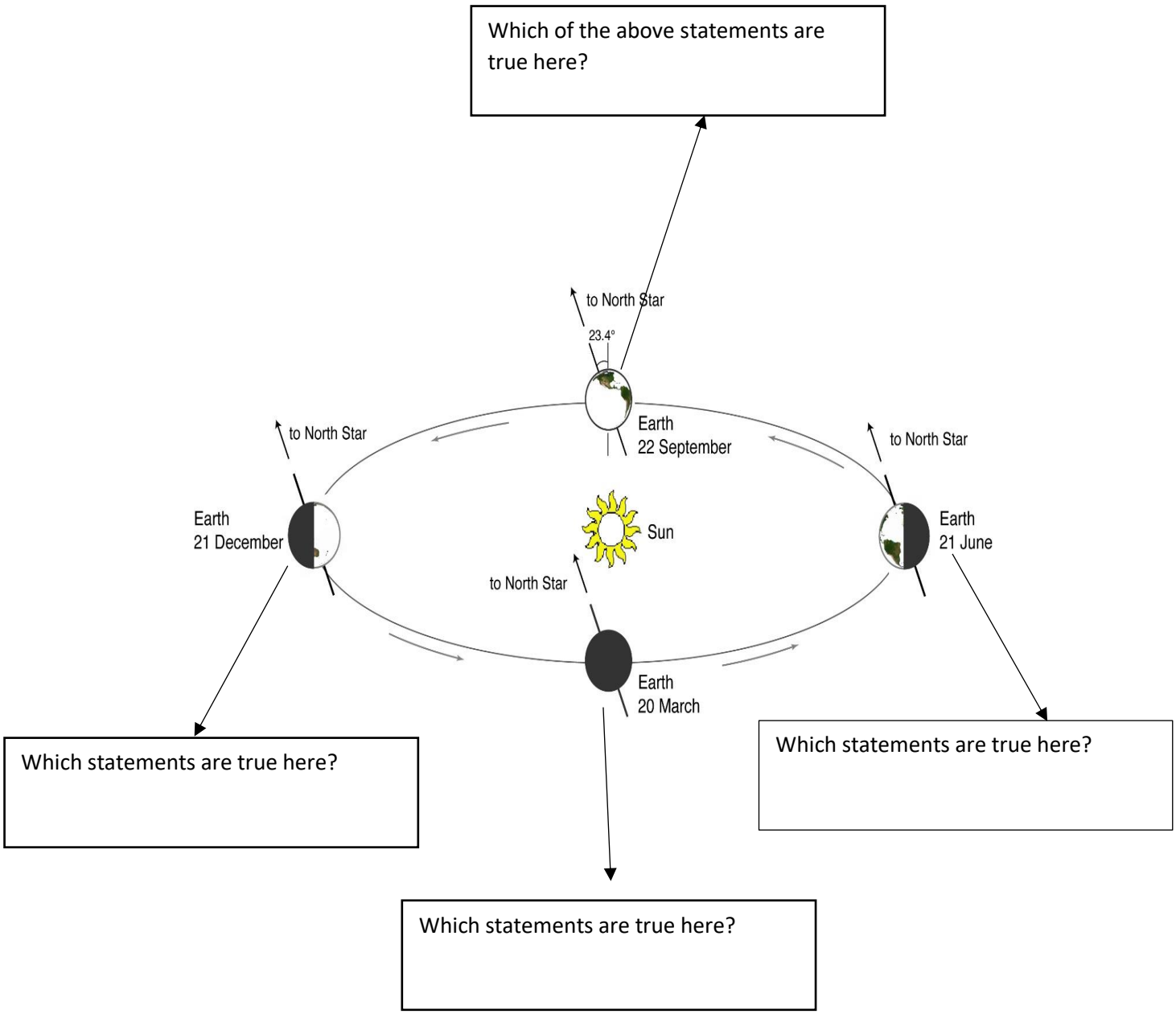
a) The tack in the Northern hemisphere gets lit up first.
b) Both tacks move into the light at the same time.
c) The tack in the Southern hemisphere is in the light for longer.
d) Both tacks are in the light for the same amount of time.
e) The North Pole receives light.
f) The South Pole does not receive light.

For any statements that are FALSE write a corrected statement in the space below.

7. The Earth's position relative to the sun at various times of the year is represented in the diagram shown overleaf. The Earth is tilted at an angle of just over $23^{o}$ from the vertical. Consider each of the statements below, which represent statements for two points at the same longitude, one of which is in the Northern hemisphere and one which is in the Southern hemisphere, as the earth rotates in anti- clockwise direction on its own axis.

   In the box, at each of the 4 positions of the Earth represented in the diagram, write the letters (a – f) which represent the statements that are *true for that location*.

   a) The point in the Northern hemisphere gets lit up first.
   b) Both points move into the light at the same time.
   c) The point in the Southern hemisphere is in the light for longer.
   d) Both points are in the light for the same amount of time.
   e) The North Pole receives light.
   f) The South Pole does not receive light.




8. Discuss with your expert group what you have learned through this activity and how it might relate to the overall question.

9. Using the KEYWORDS given at the start of this activity sheet each person should now write a summary of what they have learned on the white board to bring back to your home team.