Area of study ENERGY AND CHANGE and WORKING SCIENTIFICALLY
Target **Level 3/6.**

Note that the above images indicate the relative **size** of the Sun to the Earth, **NOT** the distance between the two.

Before we had solar telescopes and satellites people used to believe that the sun was a perfectly smooth sphere. By looking at the photo above you will observe that the surface of the Sun is not smooth and featureless. You would damage your eyes trying to see these surface features without protection. The Sun is too bright to look at directly with your eyes. This module enables you to investigate the sun in terms of its size and some of its features. This can be done via three ways.

YOU CAN USE ANY OF THE THREE METHODS BELOW FOR INVESTIGATING SUN SPOTS

Using the solar telescope from the Southern Cross Cosmos Centre to view and capture images of the sun. To do this you need to Contact Barbara & Donna **at 08 95757577 or 0895757740** to book a day or an evening, that will surely be memorable.

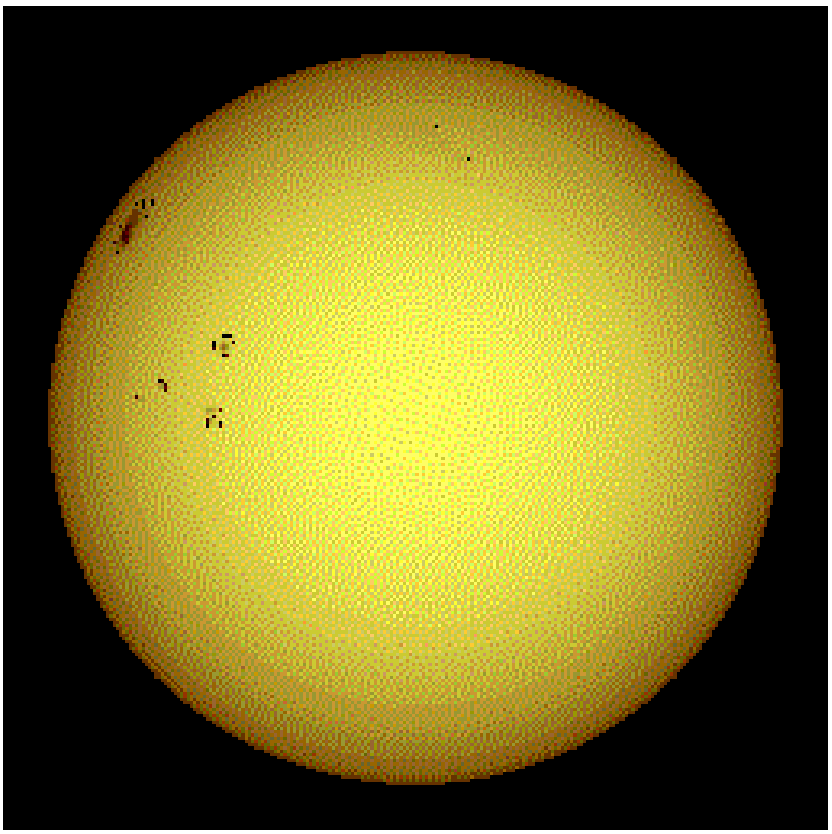
Our 'stars', Barbara & Donna alongside one of the 7 main telescopes at the Southern Cross Cosmos Centre

METHOD 1	METHOD 2	METHOD 3
1 Viewing the Sun through a solar telescope. 2 taking digital photographs of the Sun. 3 storing the digital images onto a computer. 4 scaling and calibrating the images, using software on the computer or projecting the image using the SCCC digital projector on a screen and analysing with measurements and scales. 5 making some measurements, that may surprise you. Use with all students as this is a directed activity	1 Go to http://sohowww.nascom.nasa.gov/data/realtime-images.html 2 Get the latest images of the sun and use the software on the computer called IMAGE to analyse the size of the sun spots you can download the image program from the following site and use it at school hhtp//rsb.info.nih.gov/ij/ http://rsb.info.nih.gov/ij/download.html Use with your better students	1 Use the images provided or one on the wall as your image source. 2. Use ratios and scaling to do the comparisons Use with any students as long as the teacher can help them with ratios.

DECIDE NOW WHICH OF THE THREE METHODS YOU WISH TO USE AND BOOK AHEAD

Sunspot Image Processing

Overview: During this activity you will learn to use computer image processing techniques to measure the size of sunspots. By using a digital camera and a solar telescope you will take some digital photos of the Sun. You will use these techniques to scale and analyse your own images of our Sun.
Astronomers use computers to conduct scientific investigations everyday. One procedure frequently used is called IMAGE PROCESSING. In this activity, you will learn how to process images of our Sun on the computer.



You will be viewing the sun through a telescope that has special filters. These filters enable you to see light from the visible part of the EM (electromagnetic) spectrum without causing you eye damage. When the Sun is viewed through a solar telescope dark spots may be observed on the surface. These spots appear dark to the eye because they are cooler than the surrounding gas. They are in fact quite hot! The photosphere has a temperature of about 5500 ^{0} C and a typical sunspot has a temperature about 3900 ^{0} C.
A sunspot's lifetime can be as short as an hour or two. Sunspots can also last as long as several months. The number of sunspots that can be seen on the surface of the Sun increases and decreases in a regular pattern, known as the solar cycle.
There are a maximum number of sunspots occurring every 11 years. Hopefully, today you will be able to observe some spots on the Sun's surface. (If you can't there are many solar image archives available on the Internet. You could use those images for this activity.) Even if you don't observe sunspots you can still use your images of the Sun, to analyse the size of other surface features.

PREDICT:

HOW BIG ARE SUNSPOTS ANYWAY?

- Are they as big the block that your house is on?
- Are they as big as Perth?
- Are they as big as western Australia?
- Are they as big as earth?

Circle you best guess

These next few pages are intended to describe activities that will enable you to do the work that scientists do when researching the sun. The activity has many parts.

In the **Southern Cross Cosmos Centre (SCCC)** there are telescopes set up with filters that enable you to view the Sun. There are digital cameras connected to them that will allow you to store what you see. Use the solar telescope from the Southern Cross Cosmos Centre to view and capture images of the sun. To do this you need to Contact Barbara & Donna **at 08 95757577 or 0895757740** to book a day or an evening, that will surely be memorable.

Note that if the camera is not available images will be provided either via computers linked to real time images or hard copies of the sun to do your calculations

1. Capture your images from the solar telescope or the real time NASSA images at

http://sohowww.nascom.nasa.gov/data/realtime-images.html or use the images provided

2. The purpose of this activity is to measure sunspots, but while you are viewing the Sun take the opportunity to look out for other surface features. Look at the poster of the Sun's structure and identify these features. Begin filling in the table with your observations now, and complete it once you have a digital image displayed on a computer. (Expand the table if you feel it is necessary.)

Surface Feature	Description

3. Does there appear to be movement on the suns surface?

4. If there is movement, is it random or does it have some kind of pattern that you could describe. Describe the pattern. And try to explain how and why these movements might be happening.

Data analysis

5. Put in the date and time by using the time conversion chart in the **APPENDIX 5**

Date (dd/mm/yy)	**Time (EST/EDT)**

Feature	**Scale Model Size (mm)**	**Actual Size (km) Use app 3 & 4**	**Area (mm) Use app 3 & 4**	**Actual area (km^2) Use app 3 & 4**
Diameter of Sun				
Largest Sunspot				
Sunspot No. 2				
Sunspot No. 3				

6. Use the computer software or rulers and calculators to help you find the length and area of several sunspots. (**See Appendix 3 for help on how to do this if you are uncertain on how to use a proportion (two equivalent ratios) to solve for the actual size of the sunspots)**
Use this space and the next page for working out your answers

Working space continued.

7. Use the data supplied in **APPENDIX 2** to make a detailed statement on the comparative sizes of sunspots and the diameter of the Earth

Approximately how many Earth diameters would fit inside the Sun's diameter? Show your work; circle your answer.

Were you right about the size of sunspots when you made your guestimate at the state of this module?

8. Use the image scale to estimate the size of two other sunspots; record the estimated size of these sunspots in the data table Circle and label the two sunspots (e.g., "No. 2," "No. 3") if you are using the hardcopy sun image.

Do your working here.

9. The hardcopy and computer solar image is really a ***scale model*** of the Sun. Use the Sun's scale model diameter and actual diameter to determine the scale of the image.
(See APPENDIX 4 for help on how to do this if you are uncertain on how to use a proportion (two equivalent ratios) to solve for the actual size of the sunspots)

gravity DISCOVERY CENTRE

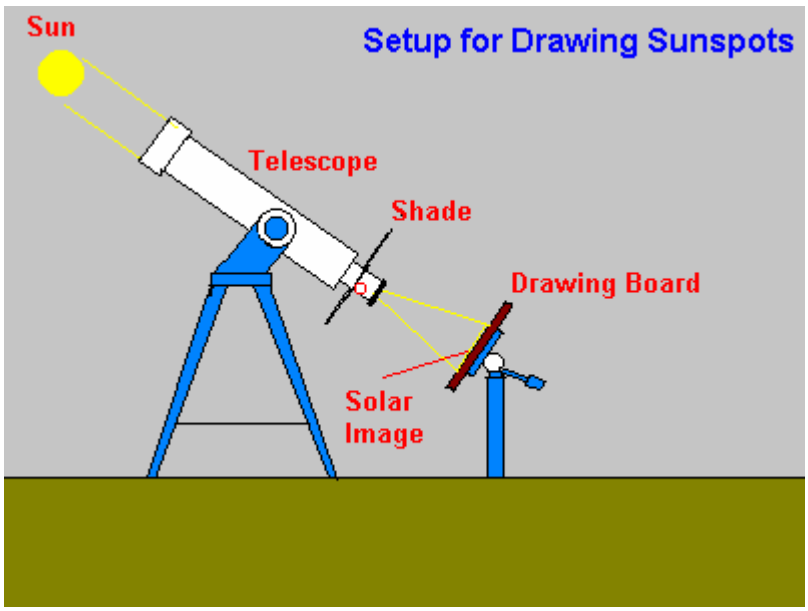
PUBLIC EDUCATION ENDOWMENT TRUST

Application:

When you get back to school divide up into several 'NASA imaging teams'. Each team needs to analyse a different set of sunspots. These could be your images, or images found on the Internet. You will then create a written technical report, a multimedia presentation, and/or an oral presentation that describes:

- which images you analysed
- how the images were analysed
- how many sunspots were present
- how big sunspots are compared to other objects in the solar system
- what, exactly are sunspots

Producing your own images at school



gravity DISCOVERY CENTRE

PUBLIC EDUCATION ENDOWMENT TRUST

APPENDIX 1

For real time sunspot images from NASSA go to:

http://sohowww.nascom.nasa.gov/sindex.html

APPENDIX 2.

Physical Elements of Solar System Bodies

Physical Data	Equatorial Diameter		Mass		Gravity	Rotation Period	Inclination	
Planet	**In Kilometers**	**Oblateness**	**Earth=1**	**Density**	**Earth=1**	**Earth Days**	**to Orbit**	**Albido**
Sun	1,392,000	0	332,946.00	1.41	27.9	25 to 35	-	-
Mercury	4,879	0	0.055274	5.43	0.38	58.646	0	0.11
Venus	12,104	0	0.815005	5.24	0.9	243.019	177.4	0.65
Earth	12,756	1/298	1	5.52	1	0.9973	23.4	0.37
Moon	3,475	0	0.0123	3.34	0.17	27.3217	6.7	0.12
Mars	6,794	1/154	0.107447	3.04	0.38	1.026	25.2	0.15
Jupiter	142,980	1/15.4	317.833	1.33	2.53	0.4101	3.1	0.52
Saturn	1,120,540	1/10.2	95.159	0.7	1.06	0.444	25.3	0.47
Uranus	51,120	1/43.6	14.5	1.3	0.9	0.7183	97.9	0.51
Neptune	49,530	1/58.5	17.204	1.76	1.14	0.6712	28.3	0.041
Pluto	2,300	0	0.0025	1.1	0.08	6.3872	123	0.3

APPENDIX 3

Using a proportion (two equivalent ratios) to solve for the actual size of a sun spot

$$\frac{s}{d} = \frac{S}{D}$$

Where:

s = Scale Model Size of Sunspot

d = Scale Model Diameter of Sun

S = Actual Size of Sunspot

D = Actual Diameter of the Sun (1,400,000 km)

Substitute, cross-multiply, do dimensional analysis, solve for "S":

$$\frac{\text{s (mm)}}{\text{d (mm)}} = \frac{\text{S (km)}}{1{,}400{,}000\ \text{km}}$$

$$\text{S (km)} = \frac{\text{S (km)} \times 1{,}400{,}000\text{km}}{\text{d (mm)}}$$

APPENDIX 4

Determining the Fractional Scale of a Map or Scale Model

The fractional scale of a scale model is the ratio between two sets of dimensions (as between those of a model car and its equivalent actual car). The formula for determining the fractional scale of a map or scale model is:

$$\text{Scale} = \frac{1}{AS / MS}$$

Where:
1 = In a fractional scale, the numerator is always "1"
AS = Actual Size
MS = Equivalent Model Size

"AS" and "MS" should be in the same units, e.g., cm, so that the units will cancel.

Example: If a model car is 20cm long, and the actual car is 3m long, then what is the scale of the model car?

Step 1. Convert meters to centimeters:

3m = 300cm

Step 2. Calculate scale:

$$\frac{1}{300cm / 20cm} = 1/15$$

Therefore, one unit on the model is equivalent to 15 of the same units in the real world. Every feature on the model is 1/15 of actual size; every feature on the actual car is 15 times larger than the same model feature.

APPENDIX 5

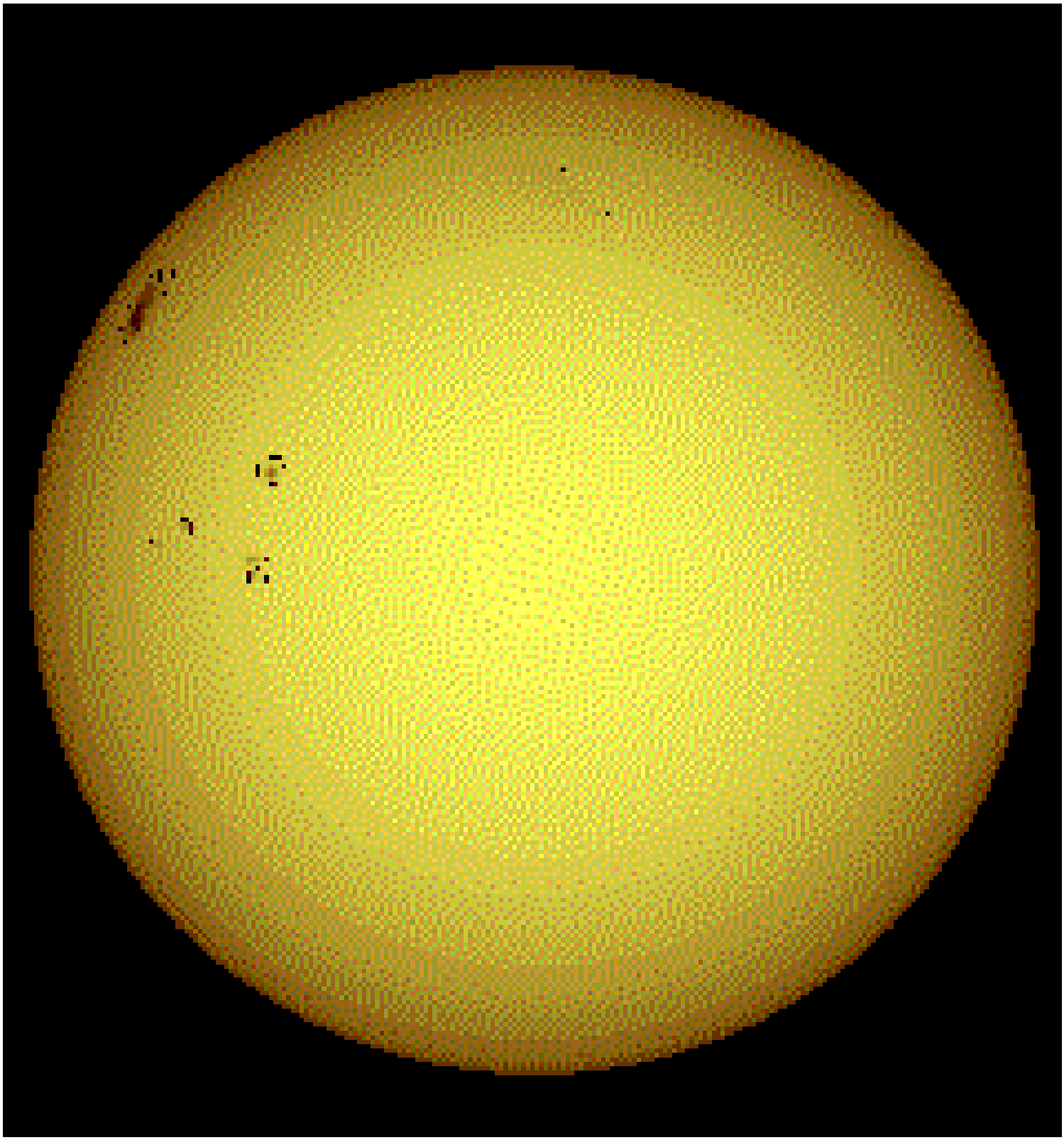
Time Conversion Chart

UTC = Universal Coordinated Time EST = Eastern Standard Time

GMT = Greenwich Mean Time EDT = Eastern Daylight Time

UTC/GMT "Z" Time	EST	EDT	UTC/GMT "Z" Time	EST	EDT
0000	7 p.m.	8 p.m.	1200	7 a.m.	8 a.m.
0100	8 p.m.	9 p.m.	1300	8 a.m.	9 a.m.
0200	9 p.m.	10 p.m.	1400	9 a.m.	10 a.m.
0300	10 p.m.	11 p.m.	1500	10 a.m.	11 a.m.
0400	11 p.m.	Midnight	1600	11 a.m.	Noon
0500	Midnight	1 a.m.	1700	Noon	1 p.m.
0600	1 a.m.	2 a.m.	1800	1 p.m.	2 p.m.
0700	2 a.m.	3 a.m.	1900	2 p.m.	3 p.m.
0800	3 a.m.	4 a.m.	2000	3 p.m.	4 p.m.
0900	4 a.m.	5 a.m.	2100	4 p.m.	5 p.m.
1000	5 a.m.	6 a.m.	2200	5 p.m.	6 p.m.
1100	6 a.m.	7 a.m.	2300	6 p.m.	7 p.m.

This image was taken November 15 2004 at the SCCC and can be used in an emergency



GRAVITY DISCOVERY CENTRE	PUBLIC ENDOWMENT TRUST

Overarching Major Learning Outcomes

There are opportunities to assess students in the following outcomes when taking part in this program.

OLO 7: Students understand and appreciate the physical, biological and technological world and have the knowledge and skills to make decisions in relation to it.

OLO 5: Students describe and reason about patterns, structures and relationships in order to understand, interpret, justify and make predictions.

OLO 6: Students visualise consequences, think laterally, recognise potential patterns and are prepared to test options.

Science Major Learning Outcomes

Working Scientifically

1. Investigating skills

Students investigate and answer questions about the natural and technological world. They use the skills of scientific investigation, reflection and analysis to prepare a plan for their investigation; to collect, process and interpret data: to communicate their conclusions

2. Communicating Scientifically

Students communicate scientific understandings to different audiences for a range of purposes.

3. Applying Science in Daily Life

Students apply and evaluate scientific knowledge, skills and understanding across arrange of contexts.

Using Science in Society

Science understands that science is a human activity which influences all people as a part of their daily lives.

Understanding concepts

1. Earth and Beyond

Students understand the physical world around them and its impact on the way we live.

2. Energy and Change

Students understand the scientific concept of energy and explain that energy is vital to our existence and quality of life.

Student Outcome Statements

Students typically in years 8-10, will be performing at levels 3-6.

Investigating scientifically levels 4/5

Planning:

Identifies the variables to be changed, the variable to be measured and at least one variable to be controlled. In a descriptive study plans are made for the necessary types of observations

Analyses problems, formulates a question or hypothesis for testing and plans an experiment in which several variables are controlled.

Conducting:
1. Takes care with data collection so that data is accurate, uses repeated trials and uses independent variables that are usually continuous.
2. Uses equipment that is appropriate for the task and uses preliminary trials of the investigative procedure to improve the procedure or measurement techniques.

Processing Data:
1. Calculates averages from repeated trials, plots data as line graphs where appropriate and makes conclusions which both summarise and explain the patterns in the data.
2. Makes conclusions which are consistent with the data and explains the patterns in the data in terms of scientific knowledge.

Evaluating:
1. Makes general suggestions for improving the data
2. Suggests a specific change that would improve the techniques used or the design of the investigation.

Earth and Beyond
1. Understands processes that can explain and predict interactions and changes in physical systems and environments.
2. Understands models and concepts that explains earth and space systems and that resource use is related to the geological and environmental history of the earth and universe.

Energy and Change
1. Understands that energy interacts differently with different substances and this can affect the use and transfer of energy.
2. Understand models and concepts used to explain the transfer of energy in an energy equation.

General notes on ' levelling"

Level Descriptors
2 Describes a number of features but does not **relate** them

3 Describes **patterns** and makes **generalisations** from **concrete** experience

4 Describes **non observable** properties or events

5 Explains in terms of a **concept.**

Educational Programs	Rubric	Sun Spots

gravity DISCOVERY CENTRE

PUBLIC EDUCATION ENDOWMENT TRUST

Question	**level 3**	**level 4**	**level 5**	**level 6**
3. Does there appear to be movement on the suns surface?	*			
4. If there is movement, is it random or does it have some kind of pattern that you could describe. Describe the pattern. And try to explain how and why these movements might be happening.	Covers the movements in the corona as viewed around the perimeter including solar flares.. Movements of surface features such as light intensity and sun spots **Energy And Change**	associates movements in the surface nuclear reactions and heat **Energy And Change**	associates sunspot movement with the suns rotation associates movements in the surface nuclear reactions and radiant pressures of EMR **Energy And Change**	Explains how theses movements occur in terms of the suns rotation and nuclear reactions and magnetic fields created by moving charges **Energy And Change**
6. Use the computer software or rulers and calculators to help you find the length and area of several sunspots. (See Appendix 3 for help on how to do this if you are uncertain on how to use a proportion (two equivalent ratios) to solve for the actual size of the sunspots) Use this space and the next page for working out your answers	Correctly doing the task not using the software then they would be working at this level in **Processing Data:**		if the student works out how to use the software and does so by themselves then they would be working at this level in **Processing Data:**	

Question	level 3	level 4	level 5	level 6
7. Use the data supplied in APPENDIX 2 to make a detailed statement on the comparative sizes of sunspots and the diameter of the Earth Approximately how many Earth diameters would fit inside the Sun's diameter? Show your work; circle your answer.	correctly carrying out the task using the help provided in the appendix **Processing Data:**	correctly carrying out the task without the help provided in the appendix **Processing Data:**		
8. Use the image scale to estimate the size of two other sunspots; record the estimated size of these sunspots in the data table Circle and label the two sunspots (e.g., "No. 2," "No. 3") if you are using the hardcopy sun image.	correctly carrying out the task using the help provided in the appendix **Processing Data:**	correctly carrying out the task without the help provided in the appendix **Processing Data:**		
The hardcopy and computer solar image is really a *scale model* of the Sun. Use the Sun's scale model diameter and actual diameter to determine the scale of the image. (See APPENDIX 4 for help on how to do this if you are uncertain on how to use a proportion (two equivalent ratios) to solve for the actual size of the sunspots)	correctly carrying out the task using the help provided in the appendix **Processing Data:**	correctly carrying out the task without the help provided in the appendix **Processing Data:**		