C – Education Project 1: Experiment for Level 4 Students

Experiment for students addressing WA Curriculum Framework (Level 4 students)

- Photograph a celestial object using a telescope and research basic facts.

Summary of experiment trial

This experiment was trialled using the Meade LX-200R over the period February 22 – 25, 2008. It was determined that this experiment is viable.

The experiment instructions were revised to suggest students begin with nearby (Solar System) objects and progress to other bright objects such as bright nebulae (e.g. Messier 42 – Great Orion Nebula) or large clusters (e.g. Omega Centauri, 47 Tucanae) before attempting more difficult targets such as faint nebulae or asteroids.

Notes were also added to the experiment instructions recommending ranges of exposure times for the suggested initial observation targets.

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Education Project 1: Experiment for Level 4 Students (Year 8 – 9)

Outline

This experiment is designed to be suitable for students working at a level consistent with Level 4 Outcomes of the WA Curriculum Framework.

In this experiment students will complete a series of tasks consisting of locating a celestial object, capturing an image and conducting research to create a "fact sheet" with relevant information.

Science Learning Outcome: Earth and Beyond

"Students understand how the physical environment on Earth and its position in the universe impact on the way we live."

Earth and Beyond Level 4 Description

The student understands processes that can help explain and predict interactions and changes in physical systems and environments.

At this level:

Students begin to explain their observations of the world in terms of an abstract idea or non-observable event. They connect the changing aspects of physical systems with terrestrial, atmospheric and astronomic processes. They identify the interactions between them. They compare components and features of physical systems and how they can change catastrophically. They analyse less-familiar scenarios, explore events and the interactions and affects of change to an object.

Relationship between the earth, our solar system and the universe

Students compare components, processes and features of our universe, their interactions and effects. They describe the seasons and explain the effects on the environment and people's lives: for example, how tides might result from the pull of the moon on the earth's water bodies and how this might affect fishing and boating patterns. They compare and contrast asteroids, comets and meteors in terms of size and frequency and identify similarities and differences between planets.

Students use their understanding of gravity to explain changes in their own environment and in the solar system. They recognise that the greater the mass of a planet, the greater the force of gravity on its surface and can compare the moon and the earth in terms of gravity and mass.

Curriculum Framework Links

This project addresses the following Curriculum Framework (WA) outcomes:

Overarching Outcomes:
OA1 – Students will use language to understand, develop and communicate information and interact with others. Students will learn about objects in our galaxy and will summarise this knowledge and communicate it to others.
OA12 – Students are self-motivated and confident in their approach to learning and able to work individually and collaboratively. Students will work individually but will discuss the material with their peers while completing tasks. Investigations and activities will be collaborative efforts but reporting will be individual efforts.

Core Shared Values:
V 1.4 – Knowledge. Each person should recognise the tentative and limited nature of knowledge. Not all investigations will be to test hypotheses. Some will be used to learn by discovery.

Working Scientifically Outcomes:
1. Investigating: Investigate to answer questions about the natural and technological world using reflection and analysis to prepare a plan; to collect, process and interpret data, to communicate conclusions; and evaluate their plan, procedures and findings.
2. Communicating: Communicate scientific understanding to different audiences for a range of purposes. Present and communicate science information using scientific language. Access and organise information.

Science Concepts:
6. Earth and Beyond: Students explore relationships between Earth / Solar System / Universe

Student Project – Investigating the Universe

Introduction
You will use a telescope over the internet to observe and photograph celestial objects. A celestial object is a planet, asteroid, star or star cluster, galaxy, nebula etc.

Aims

- Identify a celestial object which will be visible at the time observations are made.
- Locate and photograph the object using the telescope via computer control.
- Research and record relevant data about the object.

Equipment
Computer with internet access to control the telescope. Refer to connection instructions for the particular telescope system to be used for this experiment.

Preparation
For an introductory session the rise and set times of the Moon and the planets can be found in major newspapers, usually on the Weather page.

Method
1. Choose a celestial object to investigate. See the section below on choosing an object.
2. Verify that it will be visible on the day observations are to be made. It is often best if the object is close to being overhead during the observing session.
3. Using the telescope, locate the object.
4. Take a photograph of the object.
5. Research relevant data about the object and create a fact sheet. Include the photograph on your fact sheet along with the details you have discovered, and a description of the main features of the object.

Choosing a celestial object

Choosing a planet:
Planet rise/set times can be found in a newspaper, an Astronomical Almanac or online. For example, SkyandTelescope.com has rise and set times for the Sun, Moon and planets once you enter your location details.
Website: http://skyandtelescope.com/observing/almanac

Saturn

Choosing a minor planet:

Asteroid - Gaspra

"Minor planet" is the name given to smaller objects in the Solar System such as asteroids and comets. If choosing a minor planetary body such as an asteroid, where rise and set times aren't easily found a selection can be made by choosing an object which is at opposition on a date close to the observing date. This means it will be somewhere overhead in the night sky, and the next step will be to locate it. Note that minor planets are generally more difficult to identify against a starry background.

Choosing a star:
Stars appear as tiny points of light, even in a very large telescope because of the very great distances they are from us. You may find each star has several different names because of the different naming schemes in use. Most often you will find there is a common or "proper" name as well as a name associated with the constellation (group of stars) to which the star belongs.


Sirius

For example the brightest star in the sky is Sirius. Sirius is the common or "proper" name. It is also sometimes called the "dog star" because it forms part of the constellation *Canis Major*. "*Canis*" is Latin for "dog" ("*Major*" means "greater") hence the name "dog star" for Sirius. As it is the brightest star in the constellation *Canis Major*, it is called the *Alpha* (α) star, so it also has the name *Alpha Canis Majoris*, in the Latin form as a scientific name known as the Bayer System. The abbreviation of this name is "α CMa". The other stars listed below have similar designations.

Sirius (α CMa, Alpha Canis Majoris) – a very bright star
Rigel (β Ori, Beta Orionis) – a blue supergiant, brightest star in Orion
Betelgeuse (α Ori, Alpha Orionis) – a red supergiant, 2^{nd} bright star in Orion
Antares (α Sco, Alpha Scorpii) – a red supergiant, the "heart of the Scorpion"
Alpha Centauri (α Cen) – the brighter of the two "pointers", a double star
Alpha Crucis (α Cru) – the bottom star of the Southern Cross, a double star

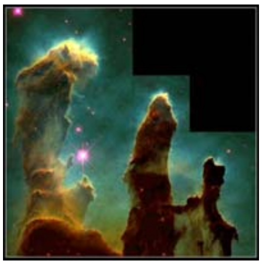
Choosing a Star Cluster:


Omega Centauri

Star clusters are groupings of stars. Globular clusters are groups of many thousands of stars in a spherical shape. Open clusters are very different from globular clusters in that the stars are generally much younger and the cluster usually contains up to a few hundred stars.

Some interesting clusters include:
Omega Centauri (ω Cen, NGC 5139) –globular cluster near the Southern Cross
The "Jewel Box" (NGC 4755) – open, bright cluster in the Southern Cross
The Pleiades (Seven Sisters) – open cluster dominated by hot blue stars
The Hyades – open cluster near to Earth, only 151 light years away
Messier 80 (M80, NGC 6093) – globular cluster in Scorpius

Choosing a Nebula:
Nebulae are clouds of gas, dust or plasma and often form star-forming regions. Nebula is a Latin word meaning "mist". There are different types of nebula. Some nebulae emit light of their own, while others reflect the light of nearby stars, and some are dark nebula which are seen as dark clouds in front of distant stars or in front of emission nebulae.


M16 - Eagle Nebula

Some possible choices include:
Eagle Nebula (M16, NGC 6611) – bright nebula containing the "Pillars of Creation"
Orion Nebula (M42, NGC 1976) – bright multicoloured nebula in Orion
Horsehead Nebula (NGC 2024) – dark nebula which looks like a horse's head
Eta Carinae Nebula (NGC 3372) – large bright nebula surrounding several open clusters
Blue Planetary (NGC 3918) – Planetary nebula near the Southern Cross

Name: ________________________ **Date:** ___________________

Class: ________________________

Title: Fact sheet - _______________________________

Data:

Bibliography:

Teacher's Guide

This project offers students the opportunity to choose an object, view it through a remotely operated telescope, capture an image and gather information to present in the form of a summary or "fact sheet" (see attached example). The project can be conducted as an individual or a group exercise, depending on constraints imposed by time and student numbers.

The exercise is a variation on the idea of selecting and researching an object. Using rise and set times to consider when something would be visible by comparison to the planned observing time, identifying the part of the sky in which the object is located and creating an awareness that there are celestial coordinate systems in use for locating objects much as latitude and longitude are used on Earth for locating places adds an extra dimension to the project. The vast array of possible targets permits every student to select a different object if permitted by time and student numbers.

One of the key ingredients in making this a successful exercise is prior preparation on the part of the student in selecting which object(s) to find using the telescope. Rise and set times of the planets are given in major daily newspapers, astronomy almanacs and can also be found online at websites such as SkyandTelescope.com. Planetarium software such as the free program "Stellarium" (www.stellarium.org) can also be used to locate objects in the sky at particular times.

While the telescope and associated software makes locating an object relatively easy, much time will be saved by prior preparation and investigation to determine whether an object will be visible. This is particularly true of smaller objects such as asteroids and comets which may not be in the telescope database but which can be located by entering the correct coordinates to aim the telescope at the object rather than using the "goto" function.

This also allows provision for a range of ability levels within a class as the higher achievers may benefit from being set a task to determine the correct coordinates and locate the object in that way rather than selecting the object from a menu and letting the "goto" feature do all the work.

It is suggested that students start with "nearby" objects such as the Moon or one of the planets – Mars, Jupiter, or Saturn – or some other bright object such as the Orion Nebula (M42) or a bright star cluster (Omega Centauri, or 47 Tucanae). Students will need to set their exposure time depending on the brightness of their target – very short exposures (less than 1 second) for the Moon and the planets but longer exposures (up to 30 seconds) for bright nebulae and clusters. It should also be noted that "popular" targets such as the Horsehead Nebula require some experience to locate and photograph and that there are many other, easier, targets (e.g. planets, their moons, bright nebulae, star clusters) which should be attempted prior to attempting the more difficult (e.g. faint nebulae, asteroids).

Many factors affect the image quality, including light "pollution" (e.g. background light from streetlights), weather and temperature. With some care students can obtain reasonable images but should be cautioned not to expect the same quality as photos published in magazines.

Links to the WA Curriculum Framework are given on the first pages of this document.

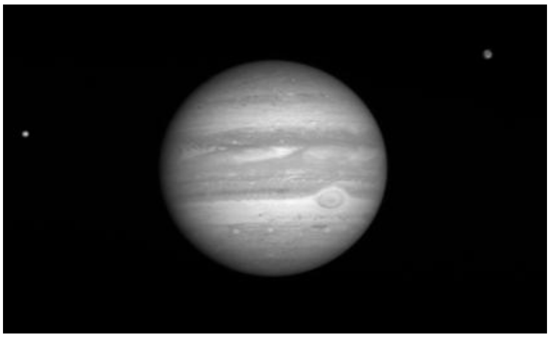
Sample Fact Sheet

Name: ________________________ **Date: ___________________**

Class: ________________________

Title: Fact sheet - _Jupiter_______________________

Data:



Distance from Sun: 778 million km

Radius: 71,492 km

Surface gravity: 20.87 m/s²

Length of day: 9.925 hours

Length of year: 4330.6 Earth days

Tilt of axis: 3.12 degrees

Temperature: -148°C

Atmosphere: Hydrogen, Helium

Jupiter is the 5th planet from the Sun in the Solar System. It is named after the King of the Roman gods.

It's gravity is 2.14 times Earth's gravity so that if you weighed 50kg on Earth, you would weigh 107kg on Jupiter.

Jupiter rotates faster than Earth as its day is only about 10 hours long but one year is over 4300 days in length.

Jupiter's axis is tilted at 3.12 degrees compared to Earth's tilt of 23.5 degrees. This means there would not be seasons on Jupiter because one hemisphere of the planet is never much closer to the Sun than the other hemisphere during a year.

Because it is so far from the Sun the surface temperature is very cold at -148°C.

On Earth our atmosphere is mainly Nitrogen and Oxygen but Jupiter's atmosphere is mostly Hydrogen and Helium.

Jupiter has 62 moons compared to our single moon. The four largest are Io, Europa, Ganymede and Callisto. They were discovered by Galileo Galilei in 1610. These four Moons can be seen from Earth using a Telescope. Two of the moons can be seen in the picture.

(Example photo courtesy NASA/JPL)

Bibliography:

http://solarsystem.nasa.gov/planets/profile.cfm?Object=Jupiter

Student Feedback Sheet

Marking Scheme:

Level	Criterion	Achieved	Comment
Investigating			
3	* Plans for investigations, showing some awareness of the need for fair testing; and makes simple predictions (not guesses) based on personal experience. * Uses simple equipment in a consistent manner using standard measurements and records data such as in simple tables, diagrams or observations. * Displays numerical data as tables or graphs, such as bar graphs, and identifies patterns in data and summarises the data. * Identifies difficulties experienced in doing the investigation.		
4	* Plans for the types of observations that need to be made. * Takes care with data collection so that data are accurate; uses repeated trails or replicates; and uses independent variables that are usually continuous. * Makes conclusions which summarise and explain patterns in the data. * Makes general suggestions for improving the investigation.		
5	* Interprets a situation, formulates a question or hypothesis for testing, and plans an experiment in which several variables are controlled. * Uses equipment that is appropriate for the task; and uses preliminary trials of the investigative procedure to improve the procedure or measurement techniques. * Makes conclusions which are consistent with the data and explains patterns in the data in terms of scientific knowledge. * Suggests specific changes that would improve the techniques used or the design of the investigation.		
Communicating Scientifically			
	* Selects, processes and evaluates information from many sources confidently to construct scientifically-complex and credible presentations. * Participates in interactive formal and extended presentations * Makes formal written presentations such as scientific reports.		
Earth and Beyond			
3	* Identifies components, processes and features of our universe.		
4	* Can compare components, processes and features of our universe, their interactions and effects. * Can identify similarities and differences between planets.		
5	* Uses models and concepts to explain components, processes and features of the universe. * Can identify similarities and differences in the orbit and characteristics of planets, such as atmosphere, intensity of solar radiation, rotational speed and tilt of axis and provide reasons why such features enable life to exist on the earth.		

References:

Curriculum Council 1998, *Curriculum framework for kindergarten to year 12 education in Western Australia*, Curriculum Council, Osborne Park.

Curriculum Council 2005, *Curriculum Framework Progress Maps - Science*, Curriculum Council, Osborne Park.

NASA's Solar System Exploration: Planets: Jupiter, Retrieved August 10, 2007, from http://solarsystem.nasa.gov/planets/profile.cfm?Object=Jupiter

Images courtesy NASA/JPL.