DISCOVERING SCIENCE 9
TEACHER'S RESOURCE

UNIT 4: SPACE EXPLORATION

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McGraw-Hill Ryerson

UNIT 4: OVERVIEW

Unit 4 will help the students appreciate the unimaginably large size, distances, and number of features found in the universe. The unit begins with a theory of how the universe might have begun and how it may be continuing to expand. Students learn about stars, including our Sun, the solar system, and interactions of Earth, the Moon, and the Sun. An opportunity is provided for students to consider Aboriginal knowledge of the solar system and how it has contributed to the body of knowledge called astronomy. Students also learn how our understanding of the universe has grown through the development of technology, and they identify some possible directions for future developments and exploration.

Chapter 10: Scientific evidence suggests the universe formed about 13.7 billion years ago.

Understanding how the universe began is an important first step in studying features in space. Chapter 10 begins with a description of evidence that led to a theory of how a single event may have begun the formation of the universe. After an initial activity designed to elicit the background knowledge and preconceptions of the students, analogies are used to explain the findings of Edwin Hubble, namely evidence for the expanding universe. The students are led into discussion about the Big Bang theory, and the astronomical evidence supporting the theory, including spectral analysis and cosmological background radiation. The latter part of this chapter addresses the formation of galaxies and star clusters. The students are introduced to concepts such as the number and types of galaxies. The purpose reinforces the concept of scale in the universe, specifically the unimaginably large numbers of galaxies (and the logical connection to numbers of stars), as well as giving an indication of the idea of vast distances in space.

Chapter 11: The components of the universe are separated by unimaginably vast distances.

The principle focus of chapter 11 is the components of the universe and the vast distances that separate them. The first part of the chapter deals with the most familiar objects in the night sky: stars. This section of the chapter details the birth, evolution, and death of stars in our galaxy. In addition, students learn how stars are classified based on composition, mass, colour, temperature, and luminosity (although not technically equivalent, the term brightness is used to make the concepts accessible to the students). Students use the Hertzsprung-Russell diagram to make comparisons and classifications of stars. The Doppler effect is introduced to illustrate the concept of star motion relative to Earth.

The second part of chapter 11 describes the components of our solar system and reinforces and expands on the concepts and features introduced in earlier grades. Concepts such as the shape of planetary orbits, scale, and distance are addressed with a variety of activities. The last part of the chapter deals with the measurement of distances in space. The techniques of triangulation and parallax are introduced through text and activities. Studying how distances in space are determined emphasizes the concept of indirect measurement. This becomes a natural segue into the next chapter, which deals with the ways in which humans can gather data about distant places without having to physically go there.

Chapter 12: Human understanding of Earth and the universe continues to increase through observation and exploration.

The focus of chapter 12 is the relationship between humans and the universe. A connection is shown between the desire for understanding, advances in technology, and explanation of observed data. Chapter 12 begins with a review of historical astronomy and the way celestial bodies have been used for millennia to mark the passage of time. This leads into a description of the Earth-Moon-Sun system and the way all three interact. Concepts such as seasons, tides, and eclipses are explained. The middle part of the chapter illustrates Aboriginal perspectives of Earth, Moon, and Sun interrelationships. Students learn about the concept of holistic views of space and the way physical and spiritual realms of the universe interconnect. Chapter 12 concludes with an overview of human efforts to explore space. Beginning with ground-based technology, and progressing to satellites, probes, and rovers, this section defines human ingenuity in our quest for knowledge about the solar system and beyond. This section addresses the many issues associated with space travel, including safety and economic risks and benefits, as well as moral and ethical concerns. In addition, the imaginations of the students will be captured by the introduction of the newest ideas for space travel.

MULTIPLE INTELLIGENCES CORRELATION FOR UNIT 4 ACTIVITIES AND INVESTIGATIONS

The table below shows the multiple intelligences engaged in the activities and investigations for this unit, in order to help you plan for differentiated instruction in your science lessons, as your students require. For more information about differentiated instruction and multiple intelligences, see the Introduction and Implementation section in this Teacher's Resource.

Multiple Intelligences:	VL	VS	BK	MR	LM	N	E	IA	IE
UNIT 4: Space Exploration									
Find Out Activity: What Do You Know About the Universe?	■	■					■	■	■
Chapter 10: Scientific evidence suggests the universe formed about 13.7 billion years ago.									
Find Out Activity 10-1A: A Model of the Expanding Universe	■	■	■						
Find Out Activity 10-1B: The Universe in a Spoonful of Sand	■	■	■						■
Find Out Activity 10-1C: Investigating the Relative Motion of Galaxies in the Expanding Universe	■	■	■						■
Find Out Activity 10-2A: Matter in Motion	■	■	■						■
Find Out Activity 10-2B: Modelling Galactic Distances		■			■				■
Conduct an Investigation 10-2C: Galaxy Grazing		■	■		■				■
Chapter 11: The components of the universe are separated by unimaginably vast distances.									
Find Out Activity 11-1A: Light Beam Behaviour	■	■			■				■
Find Out Activity 11-1B: Detecting the Doppler Effect	■	■	■		■				■
Conduct an Investigation 11-1C: Classifying Stars Using the Hertzsprung-Russell Diagram	■	■							■
Find Out Activity 11-1D: Spying Spectra	■	■			■				■
Find Out Activity 11-2A: Easy Ellipses		■	■		■				
Find Out Activity 11-2B: The Length of the School Year on Different Planets					■				■
Conduct an Investigation 11-2C: Strolling Through the Solar System	■	■	■				■		■
Find Out Activity 11-3A: Pointing in the Right Direction	■	■	■						■
Find Out Activity 11-3B: How Close Is the Sun?		■			■				
Conduct an Investigation 11-3C: How Wide Is the Sun?	■	■	■		■	■			■
Chapter 12: Human understanding of Earth and the universe continues to increase through observation and exploration.									
Think About It 12-1A: Constructing Constellations		■						■	
Find Out Activity 12-1B: Seeing the Reasons for Seasons		■	■						■
Conduct an Investigation 12-1C: Modelling Moon Movement		■	■						■
Find Out Activity 12-2A: Lunar Months							■	■	■
Find Out Activity 12-2B: Aboriginal Knowledge Through Stories							■	■	■
Find Out Activity 12-3A: Build Your Own Telescope	■	■	■		■				■
Find Out Activity 12-3B: Roving Mars		■							
Conduct an Investigation 12-3C: Calculating the Thrust of a Balloon Rocket	■	■	■		■				■
Conduct an Investigation 12-3D: The Great Space Debate	■							■	■
Unit 4 Project: Designing a Mining Town for the Moon	■	■			■	■		■	■
Unit 4 Integrated Research Investigation: "It's a Bird, It's a Plane, It's an Asteroid!"	■	■			■	■	■		■

Multiple Intelligence codes:
VL = Verbal-Linguistic Intelligence; VS = Visual-Spatial Intelligence; BK = Body-Kinesthetic Intelligence; MR = Musical Rhythmic Intelligence; LM = Logical-Mathematical Intelligence; N = Naturalist Intelligence; E = Existential Intelligence; IA = Intrapersonal Intelligence; IE = Interpersonal Intelligence

Planning Chart for Activities and Investigations for Unit 4: Space Exploration

ACTIVITY/ INVESTIGATION	ADVANCE PREPARATION	APPARATUS/MATERIALS	TIME REQUIRED
UNIT 4: Space Exploration			
Find Out Activity: What Do You Know About the Universe?	No advance preparation necessary.	For each group: – chart paper – felt pens	• 15 min
Chapter 10: Scientific evidence suggests the universe formed about 13.7 billion years ago.			
Find Out Activity 10-1A: A Model of the Expanding Universe	• 1 day before: – Prepare materials.	For each group: – large, round balloon – twist-tie – felt pen	• 20 min
Find Out Activity 10-1B: The Universe in a Spoonful of Sand	• 1 week before: – Prepare the 1 cm^3 box. – Prepare the sand (clean). – Gather materials.	For each group: – 100 mL sand – one 0.5 mL measuring spoon – paper For whole class: – 1 cm^3 box	• 30 min
Find Out Activity 10-1C: Investigating the Relative Motion of Galaxies in the Expanding Universe	• 1 week before: – Gather materials (prepare 25 cm lengths of string).	For each group: – large, round balloon – twist-tie – felt pen or ballpoint pen – 25 cm of string – ruler	• 30 min
Find Out Activity 10-2A: Matter in Motion	• 1 week before: – Gather materials.	For each group: – 600 mL beaker – water – medicine dropper – small samples of food colouring, cocoa powder, and powdered milk	• 30 min
Find Out Activity 10-2B: Modelling Galactic Distances	• 1 week before: – Gather maps of area near your school.	For each group: – map of your school and the immediate vicinity, with scale – map of your local region	• 20 min
Conduct an Investigation 10-2C: Galaxy Grazing	• 1 week before: – Obtain magnetic marbles.	For each group: – two magnetic marbles	• 45 min
Chapter 11: The components of the universe are separated by unimaginably vast distances.			
Find Out Activity 11-1A: Light Beam Behaviour	• 1 week before: – Gather materials. • Day of instruction: – Ensure light sources are working and have backup batteries.	For whole class: – television – infrared remote control – flashlight – water glass, or beaker – fine powder (baby powder, alum, or corn-starch) – water	• 20 min
Find Out Activity 11-1B: Detecting the Doppler Effect	• 1 week before: – Prepare material, including cutting Wiffle balls to allow placement of noise-makers.	For each group: – electronic noise-maker (with battery) – Wiffle ball (baseball or softball size), with a small opening cut by you – ~3 m twine or strong string – masking tape	• 15 min

ACTIVITY/ INVESTIGATION	ADVANCE PREPARATION	APPARATUS/MATERIALS	TIME REQUIRED
Conduct an Investigation 11-1C: Classifying Stars Using the Hertzsprung-Russell Diagram	• Day of instruction: – Prepare copies of BLM 4-20, Classifying Stars Using the Hertzsprung-Russell Diagram	For each group: – pencil – Hertzsprung-Russell diagram – graph paper	• 45 min
Find Out Activity 11-1D: Spying Spectra	• 1 week before: – Prepare and practice with the apparatus (i.e., gas discharge tubes). – Test a variety of angles for holding the tube so you may instruct the students who are having difficulty. – Assemble spectroscopes. • Day of instruction: – Test all the materials, and light sources.	For each group: – spectroscope – four different light sources (for example, Sun, fluorescent, incandescent, ultraviolet, energy-saver lamp, frosted light, holiday lights) – gas discharge tubes (for example, mercury, xenon, hydrogen, sodium) – paper – pencil – ruler – pencil crayons	• 45 min
Find Out Activity 11-2A: Easy Ellipses	• 1 week before: – Prepare the materials.	For each group: – cardboard square (30 cm × 30 cm) – blank piece of paper (28 cm × 21.5 cm) – ruler – clear adhesive tape – pencil – string (or thread) about 20 cm long – 2 pushpins	• 30 min
Find Out Activity 11-2B: The Length of the School Year on Different Planets	No advance preparation necessary.	For each group: – pencil – paper – calculator – graph paper	• 30 min
Conduct an Investigation 11-2C: Strolling Through the Solar System	• 1 week before: – Purchase the materials to be used for planetary models. • 1 day before instruction: – Check weather reports, if activity is to take place outside. If the activity is inside, ensure you have booked space for it. • Day of instruction: – Prepare the materials, including the cardboard squares.	For each group: – materials to model the Sun and planets: ball bearing, or similar-sized ball (~2.8 mm diameter), baby powder, coarse and fine-grained sand, salt, cake sprinkles, and small candies or decorations – 10 index cards – clear adhesive tape - 10 sticks (at least 15 cm long) – measuring tape (100 m)	• 60 min
Find Out Activity 11-3A: Pointing in the Right Direction	• 1 week before: – Construct the astrolabes using BLM 4-30, Pointing in the Right Direction. • 1 day before instruction: – Collect materials, including compasses, and objects to be placed in room. Determine how and where the objects will be placed.	For each group: – astrolabe – directional compass – pen – paper	• 30 min
Find Out Activity 11-3B: How Close Is the Sun?	• Day of instruction: – You may need to provide protractors for the students.	For each group: – pen – paper – calculator – ruler – protractor	• 20 min

ACTIVITY/ INVESTIGATION	ADVANCE PREPARATION	APPARATUS/MATERIALS	TIME REQUIRED
Conduct an Investigation 11-3C: How Wide Is the Sun?	• 1 week before the activity: – Prepare the cardboard squares. – Cut out small aluminum foil squares. – Gather all the materials (i.e., metre sticks, tape, etc).	For each group: – metre stick – 2 squares of cardboard (20 cm × 20 cm), one with a 1 cm diameter hole – white paper (6 cm × 6 cm) – aluminum foil (4 cm × 4 cm) – clear adhesive tape – pin, or mechanical pencil – ruler – pencil – calculator	• 45 min
Chapter 12: Human understanding of Earth and the universe continues to increase through observation and exploration.			
Think About It 12-1A: Constructing Constellations	• 1 week before the activity: – Prepare a class set of star sheets.	For each student: – pen – pencil crayons – star sheet (from teacher)	• 20 min
Find Out Activity 12-1B: Seeing the Reasons for Seasons	• 1 week before the activity: – Gather materials. • Day of instruction: – Check that all light bulbs and electrical sockets are working. – Demonstrate the proper set-up and handling of equipment.	For each group: – pencil – ruler – 216 mm × 279 mm sheet of paper – 60 W light bulb – portable socket – poster tube or similar cardboard roll (about 50 cm long; the diameter should be slightly larger than the light bulb) – volleyball or basketball – protractor or astrolabe	• 30 min
Conduct an Investigation 12-1C: Modelling Moon Movement	• 1 week before the activity: – Prepare the Moon models. • Day of instruction: – Provide one prepared Moon for each group. – Ensure the lamp is operational and located in a spot that is visible by all groups.	For each group: – Styrofoam™ ball (half black, half white) – pencil – lamp with bulb – paper	• 45 min
Find Out Activity 12-2A: Lunar Months	• 1 week before: – Book library or computer lab, if desired. – You may also wish to arrange a visit to a cultural centre or museum or a visit with a local Aboriginal elder or other knowledgeable person.	For each group: – access to the Internet and/or other research material – art supplies, such as heavy paper, paints, and felt pens	• 60–90 min
Find Out Activity 12-2B: Aboriginal Knowledge Through Stories	• 1 week before: – Book library or computer lab, if desired. – You may also wish to arrange a visit to a cultural centre or museum or a visit with a local Aboriginal elder or other knowledgeable person.	For each group: – access to the Internet and/or other research material	• 60–120 min

ACTIVITY/ INVESTIGATION	ADVANCE PREPARATION	APPARATUS/MATERIALS	TIME REQUIRED
Find Out Activity 12-3A: Build Your Own Telescope	• 1 week before the activity: – Have the lenses and all the construction materials ready. – Bring in the materials. If the students are supplying the materials, ensure you have some extras for those who forget.	For each group: – ruler – pencil – one toilet paper tube (~4 cm in diameter) – one paper towel tube (~4.3 cm in diameter) – scissors – two convex lenses, approximately 4.5 cm in diameter – clear adhesive tape – metre stick – page of small-print text (such as a page of a newspaper or magazine)	• 60 min
Find Out Activity 12-3B: Roving Mars	• 1 week before the activity: – Book the computer lab for Internet access.	For each group: – Internet access	• 30–60 min
Conduct an Investigation 12-3C: Calculating the Thrust of a Balloon Rocket	• 1 week before the activity: – Gather materials. • Day of instruction: – Ensure the anchor string is securely attached to the ceiling.	For each group: – 4 m of string – plastic drinking straw – clear adhesive tape – balloon – twist-tie – 10 small washers of the same size – scale (or triple-beam balance) – paper clip	• 45–60 min
Conduct an Investigation 12-3D: The Great Space Debate	• 1 week before the activity: – Arrange for your class to have access to Internet and/or research materials.	For each group: – Internet access and/or research materials	• 60–120 min
Unit 4 Project: Designing a Mining Town for the Moon	• 3 days before: – Assign groups and have students get started thinking about their plans. – Discuss different presentation formats with your class. Encourage students to try something new for the activity, and discuss their ideas before beginning the activity.	For each group: – paper for drawings – art supplies, such as felt pens, paints, etc. – materials for the scale model	• 60–120 min
Unit 4 Integrated Research Investigation: "It's a Bird, It's a Plane, It's an Asteroid!"	• 1 week before: – Arrange for your class to have access to research materials.	For each group: – Internet access – access to the library	• 60–120 min

SUGGESTED UNIT PLAN FOR UNIT 4: SPACE EXPLORATION

SECTION #	TOTAL TIME FOR THE SECTION	INTRODUCING THE SECTION	TEACHING THE SECTION	ASSESSING THE SECTION
Unit Opener and Getting Started	50 min	15 min	20 min	15 min
10.1 Exploring the Early Universe	140 min	20 min	100 min	20 min
10.2 Galaxies	80 min	20 min	40 min	20 min
11.1 Stars	170 min	20 min	120 min	30 min
11.2 The Sun and Its Planetary System	230 min	20 min	180 min	30 min
11.3 Measuring Distances in Space	170 min	20 min	120 min	30 min
12.1 Earth, Moon, and Sun Interactions	170 min	20 min	120 min	30 min
12.2 Aboriginal Knowledge of the Solar System	80 min	20 min	40 min	20 min
12.3 Exploring Space: Past, Present, and Future	230 min	20 min	180 min	30 min
Unit 4 Project	120 min	n/a	120 min	n/a
Integrated Research Investigation	60 min	n/a	60 min	n/a
Review	60 min	n/a	60 min	n/a

TALKS AND TOURS

Speaker and field trip recommendations for Unit 4:

- Invite people who work in technical fields like engineering and heavy-duty mechanics to come and discuss technologies for space travel.
- Visit a business or industry that specializes in the use of robotics or computer technologies. These venues may provide examples of applications used in space.
- Invite a speaker from the local college or university to discuss the latest discoveries in space exploration.
- Visit a planetarium or exhibit about the universe and/or space.

Teaching Notes
for
Pages 346 to 477 of the Student Book