Light up the globe!

Year 8

This unit is aligned with the following Australian Curriculum learning areas: Science, English and Economics and Business

Australian Government

moneysmart.gov.au

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Light up the globe!

Introduction

Year level	8
Duration of unit	10.5 hours*
Learning areas	Science focus supported by English and Economics and Business

Unit description

This unit will help students make an informed choice on which light globe to use from the wide range of light globes now available. Their choice will be based on cost, value for money, life span of globe, light output and energy used. Students will gain an understanding of how light output and electricity (energy) consumption are measured.

They will use a light meter to compare light emitted from a variety of light globes, for example incandescent, fluorescent and halogen. They will then use the consumer information on the light globes to compare the electric power that would be used to run the light globe for 100 hours. The data collected will be processed so that students conclude which light globe is their preferred choice. They will justify their choice by presenting a pamphlet promoting their choice of light globe.

Knowledge and understanding

- Conclusions from science investigations should be based on evidence.
- Science understanding can inform consumer choices.
- Comparing products can help consumers make wise decisions.
- Individual consumer choices can have a positive or negative effect on society.

Pre-requisite knowledge

To undertake this unit student's need to be familiar with:

- energy concepts
- electricity
- converting units of measurement.

** Timings are provided as a guide only. Teachers will tailor the activities to suit the capabilities and interests of their class. The unit and student worksheets can be adapted to your needs.*

Links

The following table provides the relevant links to the Australian Curriculum learning areas, achievement standards and general capabilities.

Australian Curriculum learning areas and achievement standards	
Science	**Content descriptions**
	• **Strand: Science Understanding** — Sub-strand: Physical sciences ○ Energy appears in different forms including movement (kinetic energy), heat and potential energy, and causes change within systems (ACSSU155) • **Strand: Science Inquiry Skills** — Sub-strand: Planning and conducting ○ Measure and control variables, and select equipment appropriate to the task and collect data with accuracy (ACSIS141) — Sub-strand: Processing and analysing data and information ○ Construct and use a range of representations, including graphs, keys and models to represent and analyse patterns or relationships, including using digital technologies as appropriate (ACSIS144) ○ Summarise data from students' own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions based on evidence (ACSIS145) — Sub-strand: Communicating ○ Communicate ideas, findings and evidence-based solutions to problems using scientific language, and representations, using digital technologies as appropriate (ACSIS148)
	Achievement standards
	By the end of Year 8, students compare physical and chemical changes and use the particle model to explain and predict the properties and behaviours of substances. **They identify different forms of energy and describe how energy transfers and transformations cause change in simple systems.** They compare processes of rock formation, including the timescales involved. They analyse the relationship between structure and function at cell, organ and body system levels. Students examine the different science knowledge used in occupations. They explain how evidence has led to an improved understanding of a scientific idea and describe situations in which scientists collaborated to generate solutions to contemporary problems. They reflect on implications of these solutions for different groups in society. Students identify and construct questions and problems that they can investigate scientifically. They consider safety and ethics when planning investigations, including designing field or experimental methods. **They identify variables to be changed, measured and controlled. Students construct representations of their data to reveal and analyse patterns and trends, and use these when justifying their conclusions.** They explain how

	modifications to methods could improve the quality of their data and apply their own scientific knowledge and investigation findings to evaluate claims made by others. **They use appropriate language and representations to communicate science ideas, methods and findings in a range of text types.**
English	**Content descriptions**
	• **Strand: Literacy** — Sub-strand: Interacting with others ○ Use interaction skills for identified purposes, using voice and language conventions to suit different situations, selecting vocabulary, modulating voice and using elements such as music, images and sound for specific effects (ACELY1808) — Sub-strand: Creating texts ○ Create imaginative, informative and persuasive texts that raise issues, report events and advance opinions, using deliberate language and textual choices, and including digital elements as appropriate (ACELY1736)
	Achievement standards
	By the end of Year 8, students understand how the selection of text structures is influenced by the selection of language mode and how this varies for different purposes and audiences. Students explain how language features, images and vocabulary are used to represent different ideas and issues in texts. Students interpret texts, questioning the reliability of sources of ideas and information. They select evidence from the text to show how events, situations and people can be represented from different viewpoints. They listen for and identify different emphases in texts, using that understanding to elaborate on discussions. Students understand how the selection of language features can be used for particular purposes and effects. They explain the effectiveness of language choices they make to influence the audience. Through combining ideas, images and language features from other texts, students show how ideas can be expressed in new ways. Students **create texts for different purposes, selecting language to influence audience response. They** make presentations and **contribute actively to class and group discussions, using language patterns for effect. When creating and editing texts to create specific effects, they take into account intended purposes and the needs and interests of audiences.** They demonstrate understanding of grammar, select vocabulary for effect and use accurate spelling and punctuation.
Economics and business	**Content descriptions**
	• **Strand: Knowledge and Understanding** ○ The ways markets in Australia operate to enable the distribution of resources, and why they may be influenced by government (ACHEK027) ○ The rights and responsibilities of consumers and businesses in

Australia in terms of financial and economic decision-making (ACHEK029)

- **Strand: Skills**
  - Sub-strand: Questioning and research
    - Develop questions about an economic or business issue or event, and plan and conduct an investigation or project (ACHES032)
    - Gather relevant data and information from a range of digital, online and print sources (ACHES033)
  - Sub-strand: Interpretation and analysis
    - Interpret data and information displayed in different formats to identify relationships and trends (ACHES034)
  - Sub-strand: Economic reasoning, decision-making and application
    - Generate a range of alternatives in response to an observed economic or business issue or event, and evaluate the potential costs and benefits of each alternative (ACHES035)
    - Apply economics and business knowledge, skills and concepts in familiar and new situations (ACHES036)
  - Sub-strand: Communication and reflection
    - Present evidence-based conclusions using economics and business language and concepts in a range of appropriate formats, and reflect on the consequences of alternative actions (ACHES037)

Achievement standards

By the end of Year 8, students explain how markets operate and recognise why governments may influence the market's operation. They explain the rights and responsibilities of consumers and businesses in terms of financial and economic decision-making. They explain why different types of businesses exist and describe the different ways businesses can respond to opportunities in the market. Students describe influences on the way people work and factors that may affect work in the future.

When researching, students develop questions and gather relevant data and information from different sources to investigate an economic or business issue. They interpret data to identify trends and relationships. They propose a range of alternative responses to an issue and evaluate the costs and benefits of each alternative. They apply economics and business knowledge, skills and concepts to familiar and unfamiliar problems. Students develop and present evidence-based conclusions using appropriate texts, subject-specific language and concepts. They identify the effects of an economic or business decision and the potential consequences of alternative actions.

General capabilities **Typically, by the end of Year 8 students:**	
Literacy	• Navigate, read and view a variety of challenging subject-specific texts with a wide range of graphic representations • Interpret and evaluate information, identify main ideas and supporting evidence, and analyse different perspectives using comprehension strategies • Compose and edit longer sustained learning area texts • Use pair, group and class discussions and formal and informal debates as learning tools to explore ideas, test possibilities, compare solutions, rehearse ideas and arguments in preparation for creating texts • Use wide knowledge of the structure and features of learning area texts to comprehend and compose texts, using creative adaptations of text structures and conventions for citing others • Recognise and use aspects of language to suggest possibility, probability, obligation and conditionality • Use language to evaluate an object, action or text, and language that is designed to persuade the reader/viewer • Use a wide range of new specialist and topic vocabulary to contribute to the specificity, authority and abstraction of texts
Numeracy	• Solve complex problems by estimating and calculating using efficient mental, written and digital strategies • Identify and justify 'best value for money' decisions • Identify trends using number rules and relationships • Create and interpret 2D and 3D maps, models and diagrams • Compare, interpret and assess the effectiveness of different data displays of the same information • Convert between common metric units for volume and capacity and use perimeter, area and volume formulas to solve authentic problems • Use 12- and 24-hour systems within a single time zone to solve time problems, and place personal and family events on an extended time scale.
ICT	• Locate, retrieve or generate information using search facilities and organise information in meaningful ways • Design and modify simple digital solutions, or multimodal creative outputs or data transformations for particular audiences and purposes following recognised conventions • Use appropriate ICT to collaboratively generate ideas and develop plans • Independently select and operate a range of devices by adjusting relevant software functions to suit specific tasks, and independently use common troubleshooting procedures to solve routine malfunctions

Creative & Critical Thinking	• Pose questions to probe assumptions and investigate complex issues • Clarify information and ideas from texts or images when exploring challenging issues • Draw parallels between known and new ideas to create new ways of achieving goals • Generate alternatives and innovative solutions, and adapt ideas, including when information is limited or conflicting • Predict possibilities, and identify and test consequences when seeking solutions and putting ideas into action • Evaluate and justify the reasons behind choosing a particular problem-solving strategy • Identify gaps in reasoning and missing elements in information • Justify reasons for decisions when transferring information to similar and different contexts • Differentiate the components of a designed course of action and tolerate ambiguities when drawing conclusions • Explain intentions and justify ideas, methods and courses of action, and account for expected and unexpected outcomes against criteria they have identified
Personal & Social Capability	• Select, use and analyse strategies that assist in regulating behaviour and achieving personal and learning goals • Assess, adapt and modify personal and safety strategies and plans, and revisit tasks with renewed confidence • Assess the extent to which individual roles and responsibilities enhance group cohesion and the achievement of personal and group objectives • Assess individual and group decision-making processes in challenging situations
Ethical Understanding	• Analyse the ethical dimensions of beliefs and the need for action in a range of settings • Analyse rights and responsibilities in relation to the duties of a responsible citizen • Draw conclusions from a range of points of view associated with challenging ethical dilemmas

Cross-curriculum priorities

Sustainability

Diversity of learners

The Australian Curriculum is based on the assumptions that each student can learn and that the needs of every student are important. These needs are shaped by individual learning histories and abilities as well as personal, cultural and language backgrounds, and socio-economic factors. Teachers may adapt or plan additional learning activities depending on the multiple, diverse and changing needs of their students.

National Consumer and Financial Literacy Framework *(Note: the student learnings in the National Consumer and Financial Literacy Framework are divided into, and are applicable over, bands covering two chronological years.)*	
Dimension	**Student learnings by the end of Year 8**
Knowledge and understanding	• Analyse and explain the range of factors affecting consumer choices
Competence	• Use a range of methods and tools to keep financial records in 'real-life' contexts • Justify the selection of a range of goods and services in a variety of 'real-life' contexts
Responsibility and enterprise	• Apply informed and assertive consumer decision-making in a range of 'real-life' contexts • Discuss the legal and ethical issues associated with advertising and providing goods and services to consumers • Apply consumer and financial knowledge and skills in relevant class and/or school activities such as student investigations, charity fundraising, product design and development, business ventures and special events

Sequenced teaching and learning activities

Introducing	Resources
Activity 1: Measuring light intensity *(60 minutes)* Students consider different kinds of light globes and factors that would influence choices for purchase.	• Video clips/pictures/posters of lighting before electricity • Video resource 'Great Innovators: "Thomas Edison and the light bulb" by StoryBots' (1:29) • Peter Mason's book *The Light Fantastic* (optional) • Range of globes – incandescent, compact fluorescent, halogen and LEDs • Worksheet 1: Choosing a light globe – think-pair-share • Light meters – can be bought for around $100 each or can be downloaded as an App for iPhone or Android (some are free) • Solar cell attached to an ammeter • Ultraviolet beads (optional)
Assessment: Diagnostic Use the discussion to determine whether students can describe light and identify the different types of light globes. This activity could also allow an assessment of student understanding of how light varies in intensity, colour and types of light such as ultraviolet versus visible light.	

Developing	Resources
Activity 2: Exploring light levels *(90 minutes)* Students construct their own understanding of light intensity and how light travels. The teacher monitors student understanding and skills in processing and graphing data.	• Light meters • Worksheet 2: What are the light levels in the science laboratory? • Metre rulers, tape measures • Worksheet 3: Which type of graph? • Excel – spreadsheet
Activity 3: Comparing light sources (globes) *(90 minutes)* Students examine the choices that are available for light sources and demonstrate their prior understandings and interests. They develop insight into how each type of globe works.	• Range of light globes – incandescent, compact fluorescent and halogen globes; LED in torch • Computer access • Worksheet 4: Artificial light sources • Worksheet 5: Group research task • Print resource 1: Understanding light sources • Print resource 2: Shedding light on legislation and the environment
Assessment: Formative The teacher uses the information in the first two columns of the KWL table to modify activities. The tables constructed by student groups should reveal their research skills. This should also provide feedback to students to let them know how they are progressing	
Activity 4: Illuminating choice factors *(45 minutes)* Students brainstorm and construct a concept map that outlines the factors considered when choosing a light globe for a desk lamp.	• Completed Worksheet 1: Choosing a light globe – think-pair-share • Worksheet 6: Factors to consider when choosing a light globe
Activity 5: Fair glow *(45 minutes)* Hold a class discussion about how to plan a fair test to compare light output from various light globes.	• Completed concept map from Worksheet 6: Factors to consider when choosing a light globe • Worksheet 7: Planning a fair test • Worksheet 8: Criteria for assessment task
Activity 6: Testing outputs *(90 minutes)* Student groups design and conduct a fair test to compare the light output from two artificial light sources.	• Two different light globes of same wattage • Desk lamp • Light meter • Metre ruler • Computer access: Excel spreadsheets
Assessment: Formative Students draw conclusions from evidence collected during investigation and complete calculations, a simple measuring activity and a written paragraph to display their learning.	

Developing	Resources
Activity 7: Energy efficiency calculations *(90 minutes)* Students use an online energy efficiency calculator and learn that electricity consumption is measured in watts (W) and kilowatts (kW) and electricity is paid for in units of kilowatt hours (kWh).	• Computer access • Worksheet 9: How much does lighting cost? • Energy calculator • Energy Australia: Energy plan information • Samples of electricity bills • Energy Australia: Understanding your bill
Activity 8: Consumption comparisons *(60 minutes)* Students construct a table that compares the electricity consumption of each globe with its light output.	• A range of globes in their packaging • Computer access • Tables of data about cost and life span of different light globes • Worksheet 10: Cost of lights

Culminating	Resources
Activity 9: Reflecting on your learning *(60 minutes)* Students complete the third column of the KWL table. They promote their preferred artificial light source in the form of a promotional pamphlet, clearly identifying both scientific and consumer and financial literacy factors.	• Worksheet 4: Artificial light sources – KWL Chart • Computer access • Worksheet 11: Summative assessment task • Materials for developing pamphlets – can be created electronically
Assessment: Summative Students demonstrate achievement of financial literacy and science outcomes.	

Unit plan

Unit plan

This rubric aligns with Year 8 Australian Curriculum: Science, which is the focus of this unit. Teachers may wish to expand to include other learning areas. This rubric is intended as a guide only. It can be modified to suit teachers' needs and to be integrated into existing assessment systems.

Teachers may also wish to collect the worksheets as work samples for individual student folios.

Student's name: _____

Skill	Relevant content description(s)	Relevant activities and worksheets	Competent	Developing at level	Needs further development	Notes
The student can recognise that light is a form of energy.	Energy appears in different forms including movement (kinetic energy), heat and potential energy, and causes change within systems (ACSSU155)	Activity 1 Worksheet 1	The student demonstrates a thorough understanding of what light is and accurately identifies differences between incandescent, compact fluorescent and halogen globes and LEDs. The student accurately classifies ways of measuring light intensity as qualitative or quantitative.	The student shows a sound understanding of what light is and identifies some differences between incandescent, compact fluorescent and halogen globes and LEDs. The student successfully classifies some ways of measuring light intensity as qualitative or quantitative.	The student shows a basic understanding of what light is and describes a few differences between incandescent, compact fluorescent and halogen globes and LEDs. The student has difficulty distinguishing between qualitative and quantitative ways of measuring.	The teacher actively observes as individual students record their thoughts and notes their contributions to class discussion.
The student can use research skills to investigate a range of different light bulbs.	See ACSSU155 above.	Activities 3 and 8 Worksheet 5 Print resource 1 Print resource 2	The student communicates accurately and concisely using appropriate scientific language and with clear evidence of research on all parts of the investigation.	The student communicates using mostly appropriate scientific language and with evidence of research on parts of the investigation.	The student restates some information from student Print resource 1 with little or no evidence of research on other parts of the investigation.	

Skill	Relevant content description(s)	Relevant activities and worksheets	Competent	Developing at level	Needs further development	Notes
The student can use a light meter to measure light intensity.	Measure and control variables, and select equipment appropriate to the task and collect data with accuracy (ACSIS141)	Activity 2 Worksheet 2	The student precisely and accurately measures and records data using a light meter.	The student measures and records data using a light meter.	With teacher guidance, the student measures and records data using a light meter.	
The student can plan, conduct and report on a fair test.	See ACSIS141 above.	Activities 6 and 7 Worksheet 7 Worksheet 8 (marking criteria for teacher assessment)	The student: – accurately records the experiment to compare the light output of two light globes by addressing: Aim, Equipment, Method, Results, Discussion and Conclusion using the appropriate scientific terms and conventions (e.g. equipment set-up diagram) – demonstrates a thorough understanding of the variable being tested, measured and those being controlled – demonstrates a reflection on the investigative processes to	The student: – satisfactorily records the experiment to compare the light output of two light globes by addressing: Aim, Equipment, Method, Results, Discussion and Conclusion using mostly scientific terms and conventions (e.g. equipment set-up diagram) – demonstrates a sound understanding of the variable being tested, measured and those being controlled – demonstrates a reflection on the investigative processes to describe how modifications to	The student: – partially records the experiment to compare the light output of two light globes using some scientific terms and conventions (e.g. equipment set-up diagram) – demonstrates a partial understanding of the variable being tested, measured and those being controlled – makes statements about modifications to methods – partial use of ICT to process and present findings in a spreadsheet, calculate mean and construct a graph. The conclusion is simply a restatement of the data.	

Skill	Relevant content description(s)	Relevant activities and worksheets	Competent	Developing at level	Needs further development	Notes
			thoroughly explain how effective modifications to methods will improve the quality of data – demonstrates effective use of ICT to process and present findings in a spreadsheet, calculate mean, construct a graph and draw a conclusion consistent with the data.	methods could improve the quality of data – demonstrates satisfactory use of ICT to process and present findings in a spreadsheet, calculate mean, construct a graph and draw a conclusion.		
The student can enter data on a spreadsheet and create a graphical display.	Construct and use a range of representations, including graphs, keys and models to represent and analyse patterns or relationships, including using digital technologies as appropriate (ACSIS144)	Activity 2 Worksheet 2	The student accurately enters discrete data (light levels) and links it to a column graph to construct an accurate and appropriate representation using a spreadsheet.	The student enters discrete data (light levels) and links it to a column graph to construct an appropriate representation using a spreadsheet.	With teacher guidance, the student uses a spreadsheet to enter data and construct a column graph.	
The student can link data to the most appropriate form of graphical display.	See ACSIS144 above.	Activity 2 Worksheet 3	The student correctly identifies all data as discrete or continuous (linear relationship) and matches the best type of graph to display it.	The student identifies most data correctly as discrete or continuous and matches most types of graphs correctly.	The student has difficulty identifying data as discrete or continuous.	

Skill	Relevant content description(s)	Relevant activities and worksheets	Competent	Developing at level	Needs further development	Notes
The student can calculate the mean.	See ACSIS144 above.	Activity 2 Worksheet 2	The student uses a calculator to accurately determine the mean of three light meter readings for all locations.	The student uses a calculator to determine the mean of three light meter readings for all locations. Minor errors may occur but are corrected with little or no assistance.	With teacher guidance, the student uses a calculator to determine the mean of three light meter readings.	
The student can complete a table and graph to show a comparison between data.	See ACSIS144 above.	Activity 9 Worksheet 10	The student: – accurately and independently enters data and uses correct formulae in a spreadsheet to calculate running costs for different light bulbs – presents results accurately in a fully labelled and titled graph – makes a justified conclusion about choice of light globe for a desk lamp based on thorough consideration of results and other factors.	The student: – with teacher assistance, enters data and uses correct formulae in a spreadsheet to calculate running costs for different light bulbs – presents results in a labelled and titled graph – makes a conclusion about choice of light globe for a desk lamp based on consideration of results and some other factors.	The student: – with teacher guidance and support, enters data and uses correct formulae in a spreadsheet to calculate running costs for different light bulbs – attempts to present results in a graph – makes a statement about choice of light globe for a desk lamp based on a description of results.	

Skill	Relevant content description(s)	Relevant activities and worksheets	Competent	Developing at level	Needs further development	Notes
The student can analyse data to explain the results of an investigation.	Summarise data, from students' own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions (ACSIS145)	Activity 2 Worksheet 2	The student analyses data and provides comprehensive reasons/conclusions based on a scientific understanding of light and how it is produced, transmitted, reflected and absorbed.	The student analyses data and provides reasons/conclusions based on some relevant scientific understanding of light and how it is produced, transmitted, reflected and absorbed.	The student recalls a few facts about light.	
The student can summarise and record observations in a data table.	See ACSIS145 above.	Activity 3 Worksheet 4	The student closely watches the teacher's demonstration of a range of light bulbs and summarises observations accurately and concisely.	The student watches the teacher's demonstration of a range of light bulbs and summarises most observations. There may be some inaccuracies.	The student watches the teacher's demonstration of a range of light bulbs but their summary of observations is incomplete and/or inaccurate.	
The student can list and identify factors to consider when choosing a light bulb.	See ACSIS145 above.	Activity 4 Activity 5 Worksheet 6	The student correctly identifies the factors as objective or subjective. The student carefully groups and arranges the factors into a coherent concept map that makes the relationships between them explicit. The student lists the factors in priority order and clearly justifies choices.	The student identifies the factors as objective or subjective. The student groups and arranges the factors into a concept map that attempts to show the relationships between them. The student lists the factors in priority order with some justification.	With teacher guidance, the student identifies factors as objective or subjective. The student attempts to group and arrange some factors into a concept map. The student lists the factors in priority order but an attempt to justify is unclear.	

Skill	Relevant content description(s)	Relevant activities and worksheets	Competent	Developing at level	Needs further development	Notes
The student can calculate lighting costs and recommend money-saving changes.	See ACSIS145 above.	Activity 8 Worksheet 9	The student: – accurately calculates and enters hours of lighting use per week into the online Electrical Energy Cost Calculator – accurately calculates both weekly and yearly lighting costs for each household – thoroughly explores a range of options and recommends, with accurate justification, the most cost-effective change to reduce money spent on lighting.	The student: – calculates and enters hours of lighting use per week into the online Electrical Energy Cost Calculator, with minor errors – calculates both weekly and yearly lighting costs for each household, with minor errors – explores some options and recommends, with acceptable justification, a cost-effective change to reduce money spent on lighting.	The student: – requires teacher guidance to calculate and enter hours of lighting use per week into the online Electrical Energy Cost Calculator – calculates weekly and yearly lighting costs for each household with significant errors – makes a recommendation for a change to reduce money spent on lighting but fails to justify or an attempt to justify is unclear.	
The student can prepare and present a promotional pamphlet about a specific type of light bulb.	Suggested summative assessment ACSSU155 ACSIS141 ACSIS144 ACSIS145 ACSIS148	Activity 9 Worksheet 11 (details of summative assessment task) Worksheet 11 (teacher assessment criteria)	The student: – communicates effectively with the audience using appropriate language – demonstrates a deep and broad understanding of the wide range of factors involved in choosing artificial light sources both for individuals and society	The student: – communicates with the audience using mostly appropriate language – demonstrates an understanding of some of the factors involved in choosing artificial light sources both for individuals and society	The student: – communicates poorly with the audience – demonstrates partial/limited understanding of factors involved in choosing artificial light sources both for individuals and society – uses diagrams or graphs in an attempt to convey information	

Skill	Relevant content description(s)	Relevant activities and worksheets	Competent	Developing at level	Needs further development	Notes
			– effectively and accurately uses diagrams or graphs to convey information – explains the scientific principles behind the operation of the light globe in detail – demonstrates that economic factors include initial cost of purchase as well as ongoing running costs and the expected life span of a product – includes a comprehensive explanation of the advantages of their nominated light source and disadvantages of alternative products.	– uses diagrams or graphs to convey information – explains the scientific principles behind the operation of the light globe satisfactorily – demonstrates that economic factors include initial cost of purchase as well as one other factor – includes a description of the advantages of their nominated light source and disadvantages of alternative products.	– explains partially the scientific principles behind the operation of the light globe – demonstrates that economic factors include initial cost of purchase – includes isolated statements about advantages of their nominated light source and/or disadvantages of alternative products.	

Teacher notes

Activity 1: Measuring light intensity (60 mins)

Introduction

- **Set the scene by using one of the following tasks to stimulate interest in the topic.**
  - Show the YouTube clip 'Great innovators: Thomas Edison and the light bulb" by StoryBots
  - Recount or read a short section from Professor Peter Mason's *The Light Fantastic*, which describes how, before the invention of the light globe, young women did hand needlework in factories by candlelight. These young women generally became blind by their early twenties as a result of eyestrain.
  - Explain that the invention of the electric light globe by Sir Joseph Swan in 1878 and Thomas Edison in 1879 has changed society. Discuss how we no longer rely on natural light or burning wax, kerosene or gas for light, and the impact these changes have had.
  - Talk about Earth Hour and how it has become a focus for environmental action. Did students participate? How did they feel when they experienced no electric light for one hour? Discuss how our modern lives depend on artificial sources of light.

Explain that the assessment item at the end of the unit will be the development of a promotional pamphlet for a particular type of light globe that incorporates all the results of the research and investigations throughout the unit.

Demonstrate a range of light globes in a desk lamp, as well as a torch that uses LEDs. Students identify the differences between incandescent, compact fluorescent and halogen globes, and LEDs.

Class discussion

- Ask students: what factors do you need to consider before choosing a light globe?
- Students record their thoughts, share with a partner, and then two groups (four students) combine to discuss their thoughts using Part 1 of **Worksheet 1: Choosing a light globe – think-pair-share**.
- Discuss students' responses as a class. Students can record a list of all factors. Consider the importance of light strength or intensity.
- Raise the question: how do we tell which light source produces the brightest light?
- Remind students that there may be qualitative (non-measurable) ways we assess light strength and that there are quantitative (measurable) ways. Students record their thoughts on Part 2 of **Worksheet 1: Choosing a light globe – think-pair-share**. The whole class then shares all ideas.
- The teacher leads a class discussion using student suggestions. If possible, relate the topic to activities such as the use of light meters in professional photography.

Teacher demonstration

Demonstrate the use of a light meter or a solar cell attached to an ammeter, or use ultraviolet beads that change colour in UV light, as ways of comparing light intensity. Emphasise that in science when we conduct investigations we measure results as accurately as possible.

Optional activities

- Collaboratively develop a list of ways of measuring light from the least to the most accurate methods.
- Darken the room. Ask students to assess the size of their partner's pupils and then brighten the room and compare the size.

Diagnostic assessment

Observe as individual students record their thoughts and note their contributions to group and class discussions. Ensure that students understand what light is by having them complete Part 3 of **Worksheet 1: Choosing a light globe – think-pair-share** by inserting the correct term. Make sure students have some understanding of the difference between bright and dull light (i.e. light intensity) and can identify the different types of light.

Activity 2: Exploring light levels (90 mins)

- Demonstrate how to use a light meter. Students work in groups and use light meters to determine the brightest or dullest part of the science laboratory and present their findings in a graph. Repeat with the blinds down so that most natural light has been eliminated.

  Worksheet 2: What are the light levels in the science laboratory? provides a table on which students record three readings for each place and calculate the mean.

  Note
  Safety requirement: students should only do this activity in areas that can be reached from the floor.

- Reinforce that science is about accuracy and precision. Students describe precisely where the measurements were made. While this is a literacy activity, students could be provided with metre rulers or tape measures to record more precisely the positions in the room where the light meter readings were logged.
- Review different types of graphs and when to use each type. Revise how to enter data in a spreadsheet and create a graph. Check that students can identify when a column graph is the most suitable form of graph using **Worksheet 3: Which type of graph?**
- Students select the correct type of graph. Ensure that they do not try to present the data as a linear relationship (i.e. discuss how the data is discrete, not continuous, and that a column graph is appropriate).
- Students enter their data on a spreadsheet and create a graph showing the light levels in various parts of the room.
- Explain that as light travels from its source, it can be absorbed by surfaces, reflected or refracted. When comparing light from a source such as a globe, ensure that variables such as distance from the source are controlled. Discuss the units used for measuring light intensity and other terms used in relation to light, for example lumens. (Most school light meters measure light intensity in lux, which is defined as an illumination of one lumen per square metre.)
- On **Worksheet 2: What are the light levels in the science laborator**y? students record their proposed reasons for why a particular place is either bright or dull. This is another opportunity to evaluate student understanding and plan teaching to address any misconceptions.

Alternative activity

- Conduct a POE (Predict, Observe, Explain) activity where students predict which will be the brightest or dullest places and then test them and align their predications with reality through explanations of light and how it is produced, transmitted, reflected and absorbed.

Note

Revise Year 4 content: light from a source forms shadows and can be absorbed, reflected and refracted (ACSSU080).

Activity 3: Comparing light sources (globes) (90 mins)

Teacher demonstration of artificial light sources

Show a range of light bulbs inserted into a desk lamp such as the ones used in microscope work. If possible, use incandescent, compact fluorescent and halogen globes. Demonstrate a variety of the one type of globe (i.e. varying wattage and colours of light in compact fluorescent bulbs). Also demonstrate an LED in a torch. Discuss colour, brightness and heat production issues of artificial light sources.

- Students complete Part 1 of Worksheet 4: Artificial light sources.
- Students work in groups to construct the first two columns of a KWL chart (Know, Want to know and Learnt) about the types of light globes in Part 2 of Worksheet 4: Artificial light sources. This activity will help to ascertain student understanding and interest and provide information to shape future lessons.
- Using Worksheet 5: Group research task, students research the different scientific principles behind incandescent, fluorescent, halogen or LED light sources and construct a table of advantages and disadvantages of each. Students also consider legislation and environmental issues. Other factors for students to think about include economic issues such as the cost of purchase and running, length of life, manufacture and disposal.
- Students may find the following resources useful when conducting their research.
  - Websites such as *How stuff works* to research the types of light bulbs and how they work, for example:
    - home.howstuffworks.com/light-bulb (incandescent)
    - home.howstuffworks.com/fluorescent-lamp (fluorescent)
    - home.howstuffworks.com/question151 (halogen)
    - electronics.howstuffworks.com/led (LED)
  - **Print resource 1: Understanding light sources**
  - **Print resource 2: Shedding light on legislation and the environment**. This resource explores the legislation that was brought in to change the types of light globes available for purchase in Australia and considers a number of environmental issues related to light sources.

Activity 4: Illuminating choice factors (45 mins)

In **Worksheet 1: Choosing a light globe – think-pair-share**, students listed the factors to be considered in choosing a light globe.

- Using Worksheet 6: Factors to consider when choosing a light globe, briefly revisit this and add to the list if necessary. Students then classify these factors as objective (fact) or subjective (opinion).
- Here is an additional activity to identify objective and subjective statements. From the following list, tick the statements that are facts (objective) and circle the statements that are opinions (subjective).
  - Red is a better colour than green.
  - Plants use their green pigments to trap sunlight for making food.
  - The sun produces light by nuclear reactions.
  - People look healthier with a dark tan.
- Working in groups, students complete the next part of **Worksheet 6**. They organise the factors into a concept map where the relationships between the ideas are made explicit. The class discusses their maps. Students can record their ideas on post-it notes and then place them together in similar groups, for example sustainability, personal taste, cost, effectiveness.
- Students could list the factors in priority order and then justify their choices. This should indicate whether students are able to analyse and explain the factors that affect their consumer choices.

Activity 5: Fair glow (45 mins)

Use the concept maps from **Worksheet 6: Factors to consider when choosing a light globe** to highlight that an essential factor in selecting a light globe is that it produces light of sufficient intensity.

- Students plan, conduct and report on a fair test to compare two light globes on the basis of light output.
- Revise the essential features of a fair test. Many students in primary school will have learnt the acronym Cows Moo Softly – Change one factor, measure another factor and keep all other factors the same.
- Use Worksheet 7: Planning a fair test to revise the key points in designing a fair test.
- Make students aware that to increase the reliability of their results they will need to repeat their experiment and calculate a mean. It is also reasonable that they check their results with other groups using the same globes.
- Check that students understand what is required of the following assessment task. The marking criteria in Worksheet 8: Criteria for assessment task could also be explained. This worksheet is also referenced in the Assessment rubric.

Activity 6: Testing outputs (90 mins)

Students will work in groups to plan, conduct and record a fair test to compare the light output of two light globes.

- Provide students with a list of possible equipment including at least a desk lamp, light meter, metre rule and two different light globes of the same wattage. A free light meter can be downloaded onto an iPhone.
- Groups produce a written aim, list of equipment, method and table for results.
- The class discusses how to control variables to ensure that the comparison is fair. When the written plan has been checked, they conduct the investigation and record the results.
- Student groups then enter their results into a spreadsheet to produce a chart.
- Each group of students collaboratively presents an electronic version of an experimental report that includes results in a spreadsheet, calculation of a mean and a graph.

Activity 7: Energy efficiency calculations (90 mins)

Students can access the Electrical Energy Cost Calculator

- Students complete Worksheet 9: How much does lighting cost? Using the cost calculator to calculate the weekly and yearly lighting costs for two households, they explore options to reduce those costs. Remind students to convert the cost of the electricity to dollars to insert into the calculator.
- Students then make estimates about the lights they use in their own homes and use the calculator to work out the cost of lighting in their homes. Students explore the variables:
  - What if I turn off the night-light?
  - What if I use lower wattage bulbs in the lounge room?
- Look at the different charge rates for electricity. Replace the cost per kWh with some Australian examples, e.g. time-of-use billing can be 13.098c/kWh in off-peak, 21.34c/kWh in shoulder periods or 52.547c/kWh at peak times. What difference does this make to the weekly lighting costs for the household? For the cost of electricity in your region see Energy Australia Energy plan information
- Briefly outline the concept of a kWh (one kilowatt of electricity used continuously for an hour) as a means of measuring electricity consumption. Show students an electricity bill to demonstrate how electricity consumption is reported and calculated. Visit the Energy Australia website (Understand your bill) which explains the features of an electricity bill. You could have a discussion about the graphs comparing usage over several quarters.

Optional activity

Use the Origin Energy Efficiency tips to explore factors that influence an energy bill. Students make estimates of the use of electricity in their own homes. Again they can explore the impact of changes in behaviour such as turning lights off when not in rooms compared to leaving them running.

Discuss the value of planning and using appropriate tools to set budgets and monitor consumer behaviour. For example, discuss the impact of changing the time-of-use of activities in the Electrical Energy Cost Calculator between peak and off-peak usage.

Activity 8: Consumption comparisons (60 mins)

Show students where information about the power usage of light globes can be found on the packaging or the globes themselves. Ensure students know how to use formulae in spreadsheets. Discuss the headings that will be needed for the rows and columns of the spreadsheet they will use to compare the running costs of the different light bulbs. Use Spreadsheets for Science website to assist:

- Students are provided with the globes and packaging and construct a table to record the power in watts for each type of artificial light source. Ensure that each source will give approximately equivalent amounts of light. Students:
  - use a spreadsheet to calculate a comparison of the cost of running each light bulb over 100 hours at peak times
  - convert watts to kilowatts (divide by 1000) and multiply by 100 to find the total power that would be used in 100 hours
  - find the cost of a kWh and multiply this by the total power
  - conduct an internet search to find the cost of electricity from their local provider.
- Provide students with tables of data about the purchase cost of various light sources and their life spans. Students can also find the costs themselves. Some examples are provided on Worksheet 10: Cost of lights. Discuss how factors such as life span of a product, initial purchase price and ongoing running costs are all valid economic factors in making a purchase. Students then complete Worksheet 10: Cost of lights.
- Students process their data to present in a graph and discuss the results of the comparison of light output from light bulbs and the calculation of the cost of running various types of light sources.
- They then consider other factors such as purchase cost and expected life span and conclude about which type of light globe they would choose for a desk lamp, justifying their choices.

Activity 9: Reflecting on your learning (60 mins)

Students reflect on their learning and record their thoughts on their KWL chart: **Worksheet 4: Artificial light sources Part 2**. Highlight that they are learning about science and also about making consumer choices that take into consideration their personal finances and impacts on the environment and society.

- Students complete the third column of the KWL in Worksheet 4: Artificial light sources Part 2.

Summative assessment task

Students, in groups or individually, prepare and present a pamphlet promoting the benefits of a specific type of light globe and indicate any problems with the alternative choices.

Students display their work in a gallery walk (refer to page 2 on Social Skills and Community Building (PDF) for peer and self-assessment. **Worksheet 11: Summative assessment task** provides details for this final task.

Resources

Print resource 1: Understanding light sources

Light source	Illustration*	Scientific principles
Fluorescent tube	 Photo by Simon Eugster CC BY-SA 3.0	Fluorescent light tubes and compact fluorescent lights work by electricity passing through a gas rather than a metal filament. This requires a high voltage across the electrodes and electrical charging of some of the gas in the tube. The gas in the tube becomes plasma when the fluorescent tube is working. A starter switch and ballast were commonly used to produce the right conditions to start and maintain the current at the correct level. They often caused a flickering or humming when starting. Improvements have been made so starting is now quicker. A small quantity of mercury atoms inserted into the tube emit photons of mostly ultraviolet light when the moving electrons and ions collide with them. A coating on the inside of the tube, called phosphor, absorbs the UV light and re-emits white light (i.e. it fluoresces). Fluorescent tubes convert about 22% of electrical energy into light. Life span is 10 to 20 times that of an incandescent globe if run for several hours at a time, i.e. not switched off and on frequently. Produces between 66% and 75% less heat than the equivalent incandescent globe. Fluorescent tubes cannot be dimmed.
Halogen	 Photo by Arne Nordmann CC BY-SA 3.0	These are a variation of the incandescent globe. The tungsten filament is encased in what appears to be glass, but is actually a quartz envelope. Glass would melt at the temperatures produced. The gas inside the envelope is a halogen gas (e.g. fluorine). When the tungsten vaporises, it combines with the halogen gas and then re-deposits back on the filament. This means the filament does not readily 'burn out'. Because it runs much hotter than the incandescent, it glows brighter (i.e. produces more light for the same power), but it also gets very hot. Halogen bulbs are often small, so are used in housing that has reflectors. Life span: 2000 to 2500 hours. Touching the 'glass' of a halogen light globe with fingers is not recommended as oil deposited can result in a 'hot spot', increasing the chances of the bulb actually bursting upon failure. Because the temperature of the filament is much hotter than a regular incandescent globe, it produces a white, bright light. Halogen lamps are favoured in spotlights. Halogen globes can be dimmed.

Light source	Illustration*	Scientific principles
Incandescent globe		The filament is a thin piece of tungsten wire that has high resistance to electricity, so it becomes very hot when turned on. It becomes so hot that it glows or incandesces. The globe itself contains an inert gas, such as argon, or a vacuum (i.e. it has had the air pumped out) so that the hot wire does not burn. The frequent heating of the filament causes some of the metal to vaporise. Eventually it becomes so thin that the filament 'burns out'. Incandescent globes are cheap to manufacture but convert only 5% of the electricity to light and can convert 90% of the energy to heat. Life span: 750 to 1250 hours. Incandescent globes can be dimmed.
Light emitting diode (LED) or other	 Photo by Alan J Goulet CC BY-SA 3.0	LEDs work because of the movement of electrons in a semiconductor. So they do not have a filament, do not get hot and have a life span of about 50000 hours. The movement of electrons in the material causes the release of photons. The electrons flow in one direction only so LEDs work using direct current. The type of light (visible, invisible or particular colours) depends on the materials making up the semiconductor in the diode. The light from the diode is 'focused' because of the curved shape of the tiny plastic bulb. LEDs are used in displays, traffic lights, televisions, torches and strip lights but are generally not used as globes in domestic use. Cost and problems of managing current and heat precisely have prevented LED lighting replacing other sources in the home. LEDs are more efficient at lower temperatures. Semiconductor materials have previously been very expensive, but have been becoming cheaper and more readily available since 2000. LED lights can be dimmed.

** Image of incandescent globe from Shutterstock. All other images downloaded from Wikimedia commons*

Print resource 2: Shedding light on legislation and the environment

Use the resources listed below to assist in completing the research activity in **Worksheet 5: Group research task**.

Students consider the question: 'Is what is good for individuals always what is good for society?' This should lead to a discussion in greater depth of the environmental issues involved in choosing a light globe.

Legal considerations

Students explore the legislation that was brought in to change the types of light globes available for purchase in Australia. When the new legislation was proposed, there was much debate about the dangers of mercury in fluorescent lighting.

Visit the Australian Government Energy rating website at to learn more about the change in legislation.

Resources relating to environmental considerations for disposal of used light globes

- Royal Society of Chemistry article, Q and A: Mercury in energy-saving light bulbs
- *Scientific American* article, Are compact fluorescent light bulbs dangerous?
- Article about recycling light globes
- The solution to the issue of mercury in landfill is the recycling of fluorescent tubes. Students could be given the task of finding how they could recycle fluorescent tubes. See the Australian Government article Disposal of mercury-containing lamps and follow links to the appropriate state.
- This site informs consumers about chemical collections of fluorescent light bulbs and a range of other materials that should be disposed of responsibly. Visit fluorocycle.org.au to learn about the benefits and costs to organisations of recycling fluorescent tubes.

Worksheets

Name: ..... **Class:** ..... **Date:** .....

Worksheet 1: Choosing a light globe – think-pair-share

Part 1

List the factors you think should be considered before choosing a light globe.

_____

_____

_____

Add factors resulting from sharing with a partner, a group of four and the class.

_____

_____

_____

Use this table to list and then classify the ways we can measure or assess light intensity. Two examples have been given.

Part 2

Qualitative (non-measurable) ways	Quantitative (measurable) ways
How much do I have to squint or peer because of the light levels?	What is the reading on the light meter?

Name: ..... **Class:** ..... **Date:** .....

Worksheet 1: Choosing a light globe – think-pair-share (cont)

Part 3

Fill in the gaps:

Light is a type of _____ . It travels in straight _____ from its source, for example the sun, into our _____.

Our eyes are able to detect light so that we _____ .

Black surfaces absorb _____ the light that falls on them.

White surfaces _____ all the colours of light that fall on them.

Coloured surfaces both _____ and reflect light of various colours.

All incoming light can be reflected from the surface of water and _____ .

Lenses such as reading or magnifying glasses can refract or _____ the light rays so as to make things appear larger.

Name: ..... **Class:** ..... **Date:** .....

Worksheet 2: What are the light levels in the science laboratory?

Use the light meter to measure light intensity in the science laboratory. For each location, record the exact position in the room using a ruler or tape measure. Then take the reading three times and calculate the mean.

Location including measurements	Reading 1 (R1)	Reading 2 (R2)	Reading 3 (R3)	Mean (R1+R2+R3)/3	Highest reading	Lowest reading

Repeat the exercise using the same locations but this time with the blinds closed.

Location including measurements	Reading 1 (R1)	Reading 2 (R2)	Reading 3 (R3)	Mean (R1+R2+R3)/3	Highest reading	Lowest reading

Name: ..... **Class:** ..... **Date:** .....

Worksheet 2: What are the light levels in the science laboratory? (cont)

Reasons why _____ is the brightest location in the science laboratory:

_____

_____

_____

_____

_____

Reasons why _____ is the dullest location in the science laboratory:

_____

_____

_____

_____

_____

_____

What can you conclude about the differences between the light readings when the blinds are open and when they are closed?

_____

_____

_____

_____

_____

_____

Name: ..... **Class:** ..... **Date:** .....

Worksheet 3: Which type of graph?

Draw lines to link the data to the best type of graph to display it.

Data	Graph type
Sources of energy used for electricity generation in Australia (as a percentage)	Line graph
Amount of electricity consumed in a household in the current quarter, the previous quarter and the same period a year ago	Sector graph
The rate of electricity being used in a household measured at ten-minute intervals across a 24-hour period	Histogram
Average energy consumption of Australian households over the last 100 years	Column graph
Number of households who purchase 5, 10, 15 or 20 light globes per year	Line graph

Name: ..... Class: ..... Date: .....

Worksheet 4: Artificial light sources

Part 1

Watch the demonstration of the different types of light globes and record your observations.

Source	Fluorescent	Halogen	Incandescent	LED or other
Observations could include: — What does the globe look like? — How strong is the light? — What colour is the light? — Does it emit heat?				

Part 2

Working in groups, complete the first two columns of the KWL about artificial light sources/globes. The last column will be completed later in the unit.

Know	Want to know	Learnt
Everything I already know about the different types of light globes/sources	What do I want to find out about the different types of light globes/sources?	What did I learn about light globes/sources?

Name: ..... **Class:** ..... **Date:** .....

Worksheet 5: Group research task

Research the scientific principles behind each of the different light sources and the advantages and disadvantages of each. Also consider the legislation and environmental issues. Other factors to think about include economic issues such as the cost of purchase and running, length of life, manufacture and disposal.

Light source	Fluorescent	Halogen	Incandescent	LED or other
Scientific principles applied				
Advantages				
Disadvantages				
Legislation				
Environmental issues				
Additional information				

Name: ..... **Class:** ..... **Date:** .....

Worksheet 6: Factors to consider when choosing a light globe

List all the factors that individuals should consider when choosing a light globe. Refer to **Worksheet 1: Choosing a light globe – think-pair-share**.

Divide into objective and subjective factors.

Objective factors	Subjective factors

Concept map of all factors considered when choosing a light globe

Work in a small group and construct a concept map of the factors. Group and arrange them to show the relationships between them. Factors may be classified as environmental, economic, legal, personal preference or other.

Name: ..... **Class:** ..... **Date:** .....

Worksheet 7: Planning a fair test

The main features of a fair test include:

— a question that can be scientifically investigated – investigation expressed as a hypothesis is optional
— a variable being tested that can be changed
— a variable that can be measured to give the results
— the factors (controlled variables) that must be kept the same.

Example

Question	Does dilute fertiliser make radish plants grow faster?
Hypothesis	Radish plants given dilute fertiliser will grow taller than plants grown without fertiliser.
Variable tested	Addition of dilute fertiliser
Variable measured	Height of plants
Factors controlled or kept the same	Type and size of plant seedlings, amount of light, amount of water, temperature, size of container, amount of breeze

My plan for a fair test to compare the light output of two light globes

Question	
Hypothesis (optional)	
Variable tested	
Variable measured	
Factors controlled or kept the same	

Name: ..... **Class:** ..... **Date:**.....

Worksheet 8: Criteria for assessment task

Marking criteria

Student group self-assessment	Not addressed: E	Poor: D	Average: C	Good: B	Excellent: A
Experimental record addresses Aim, Equipment, Method, Results, Discussion and Conclusion using the appropriate scientific terms and conventions, e.g. equipment set-up diagram.					
Students have demonstrated an understanding of the variables being tested and measured and those being controlled.					
Students have demonstrated that they have reflected on the investigative method and/or group processes and are aware of limitations and areas for improvement.					
Students have demonstrated effective use of ICT to process and present findings in a spreadsheet, calculate mean, construct a graph and have drawn a conclusion consistent with the data.					

Name: ..... **Class:** ..... **Date:**.....

Worksheet 8: Criteria for assessment task (cont)

Marking criteria (cont)

Teacher assessment	Not addressed: E	Poor: D	Average: C	Good: B	Excellent: A
Experimental record addresses Aim, Equipment, Method, Results, Discussion and Conclusion using the appropriate scientific terms and conventions, e.g. equipment set-up diagram.					
Students have demonstrated an understanding of the variables being tested and measured and those being controlled.					
Students have demonstrated that they have reflected on the investigative method and/or group processes and are aware of limitations and areas for improvement.					
Students have demonstrated effective use of ICT to process and present findings in a spreadsheet, calculate mean, construct a graph and have drawn a conclusion consistent with the data.					

Name: ..... Class: .....Date:.....

Worksheet 9: How much does lighting cost?

Read the two scenarios below.

Scenario 1 – The Bright family

Mr and Mrs Bright and their four children love to be in bright spaces. The four children all have night-lights, which they leave on all day. They also have two 150-watt movement sensor floodlights that they leave on all the time, but which tend to be activated about 10% of the time. Mrs Bright goes to work and leaves Mr Bright at home to mind the four children. The children each have their own bedroom with a typical fluorescent light bulb that runs for six hours a day. Four 60-watt incandescent light globes are used in the dining room for two hours a day and the kitchen uses two typical fluorescent bulbs for three hours a day. The microwave has an appliance bulb. It is frequently left with the door open, so it operates seven hours a day. Appliance bulbs in the oven and fridge are used on average one hour a day in total. Mr Bright tends to forget to turn off the 25-watt incandescent light in the en suite so it runs for ten hours a day. He leaves the bedroom 60-watt incandescent light on at the same time. The bathroom has a typical fluorescent light that is used for two hours a day. Electrical Extraordinary is the family's electricity supply company. It charges 34.4 cents per kWh.

Scenario 2 – Mr and Mrs Empty-nesters

Mr and Mrs Empty-nesters live in a two-bedroom apartment and are very conscious of not wasting money. They use two typical fluorescent tubes in the kitchen/living area for four hours a day. Their bedroom has a 32-watt fluorescent tube used for two hours a day. The bathroom uses a typical incandescent bulb for one hour a day. They do not have a microwave, but the fridge would be open for 20 minutes a day. They use Cheap Energy as their electricity supply company supplier. It charges 32.3 cents per kWh.

Name: ..... Class: .....Date:.....

Worksheet 9: How much does lighting cost? (cont)

Calculate the following costs for each family using the Electrical Energy Cost Calculator
Some examples have been provided to assist in completing the calculations.

Calculation	The Bright family	Mr and Mrs Empty-nesters
Convert the electricity cost provided by the electrical company for each family in cents to dollars and add into the top of the calculator.		
Use the information provided in the scenario to calculate the number of hours each type of lighting is used in one week.	Night-lights (4): 24 hours x 7 days = 168 hours per week	
Enter the hours calculated in the step above into the Electrical Energy Cost Calculator *Note: the calculator may need to be run a couple of times.*		
Calculate the weekly lighting costs for each household.		
Calculate the yearly lighting costs and explore options to reduce those costs.		
For each household, recommend the most cost-effective change they could make to reduce the amount of money spent on lighting.		

Name: ..... **Class:** ..... **Date:**.....

Worksheet 10: Cost of lights

Light	Cost of package	Cost per item	Life span (h)	**Cost per year** (assume used for 500 h per year)	Running cost/h
MR16 Dichroic Osram IRC- twin pack 35 watt	$19.95				
T2 Twister Cool White Spiral Compact Fluorescent Lamps (Twin Pack) 7 watt	$10.50				
T5 Circular Fluorescent Lamps (10 Pack) 32 watt 3000 hours	$93.50				

Name: ..... **Class:** ..... **Date:**.....

Worksheet 11: Summative assessment task

In groups or individually, you will prepare and present a pamphlet promoting the benefits of a specific type of light globe and indicate any problems with the alternative choices.

You need to:

- communicate effectively using scientific terms accurately and appropriately
- address the wide range of factors (individual, social, economic and environmental) that are considered when choosing a light globe
- use diagrams and/or graphs to convey information or data
- show an understanding of the scientific principles applied in the types of light sources
- demonstrate economic factors involved when choosing a light globe
- include the advantages of the nominated light source and disadvantages of alternative products.

The resulting pamphlet will be assessed by your:

- peers
- teacher
- self.

The following criteria sheets will be used to assess your pamphlet:

- peer assessment of pamphlet
- teacher assessment of pamphlet
- self-assessment of pamphlet.

Name: ..... **Class:** ..... **Date:**.....

Worksheet 11: Summative assessment task (cont)

Peer assessment of pamphlet

Student/group being assessed: _____ Student/group assessing: _____

Tick the cell that best shows the achievement level demonstrated in the pamphlet.

Criteria	Not addressed E	Poor D	Average C	Good B	Excellent A
Communicates effectively with the audience using appropriate language					
Demonstrates an understanding of the wide range of factors involved in choosing artificial light sources both for individuals and society					
Effectively and accurately uses diagrams or graphs to convey information					
Explains the scientific principles behind the operation of the light globe					
Demonstrates that economic factors include initial cost of purchase as well as ongoing running costs and the expected life span of a product					
Includes the advantages of the nominated light source and disadvantages of alternative products					

Overall: A/B/C/D/E

Warm feedback: _____

Cool feedback: _____

Name: ..... Class: .....Date:.....

Worksheet 11: Summative assessment task (cont)

Teacher assessment of pamphlet

Student/group being assessed: _____

Tick the cell that best shows the achievement level demonstrated in the pamphlet.

Criteria	Not addressed E	Poor D	Average C	Good B	Excellent A
Communicates effectively with the audience using appropriate language					
Demonstrates an understanding of the wide range of factors involved in choosing artificial light sources both for individuals and society					
Effectively and accurately uses diagrams or graphs to convey information					
Explains the scientific principles behind the operation of the light globe					
Demonstrates that economic factors include initial cost of purchase as well as ongoing running costs and the expected life span of a product					
Includes the advantages of the nominated light source and disadvantages of alternative products					

Overall: A/B/C/D/E

Comment: _____

_____

Name: ..... Class: ..... Date: .....

Worksheet 11: Summative assessment task (cont)

Self-assessment of pamphlet

Student/group: _____

Tick the cell that best shows the achievement level demonstrated in the pamphlet.

Criteria	Not addressed E	Poor D	Average C	Good B	Excellent A
Communicates effectively with the audience using appropriate language					
Demonstrates an understanding of the wide range of factors involved in choosing artificial light sources both for individuals and society					
Effectively and accurately uses diagrams or graphs to convey information					
Explains the scientific principles behind the operation of the light globe					
Demonstrates that economic factors include initial cost of purchase as well as ongoing running costs and the expected life span of a product					
Includes the advantages of the nominated light source and disadvantages of alternative products					

Overall: A/B/C/D/E

How I/we could have improved: _____

Solutions

Worksheet 1: Choosing a light globe – think-pair-share

Part 1

Some factors that should be considered before choosing a light globe may include: wattage (amount of energy consumed), light output (lumens), base shape of bulb to fit a specific fixture, colour temperature rating, lifetime cost (initial cost plus cost of operation), specific use and location of bulb, controllability (dimmers, sensors), efficiency, performance, quality, sustainability.

Part 2

More examples have been added to this table. Students' responses will vary.

Qualitative (non-measurable) ways	Quantitative (measurable) ways
How much do I have to squint or peer because of the light levels?	What is the reading on the light meter?
An environment is dreary when lighting is insufficient but proper lighting creates a pleasant atmosphere.	Photometer to test brightness of a room or to set up a photo shoot
Size of pupils in the eye – pupils dilate or constrict depending on the light intensity.	

Part 3

Fill in the gaps:

Light is a type of ***energy***. It travels in straight ***lines*** from its source,

for example: the sun, into our ***eyes***.

Our eyes are able to detect light so that we ***see***.

Black surfaces absorb ***all*** the light that falls on them.

White surfaces ***reflect*** all the colours of light that fall on them.

Coloured surfaces both ***absorb*** and reflect light of various colours.

All incoming light can be reflected from the surface of water and ***mirrors***.

Lenses such as reading or magnifying glasses can refract or ***bend***

the light rays so as to make things appear larger.

Worksheet 2: What are the light levels in the science laboratory?

Students use a light meter to measure the light intensity at various locations in their science laboratory. The readings are recorded in the table provided and students give reasons as to why certain locations in the laboratory are the brightest or dullest. They also note the differences in the light meter readings when the blinds are open and when they are closed.

Some reasons may include:

- distance from light source (sun and/or artificial sources)
- amount of light from the source
- amount of light falling on a surface and amount reflected
- colour and reflectance of surfaces.

Worksheet 3: Which type of graph?

Data	Graph type
Sources of energy used for electricity generation in Australia (as a percentage)	Sector graph
Amount of electricity consumed in a household in the current quarter, the previous quarter and the same period a year ago	Column graph
The rate of electricity being used in a household measured at ten-minute intervals across a 24-hour period	Line graph
Average energy consumption of Australian households over the last 100 years	Line graph
Number of households who purchase 5, 10, 15 or 20 light globes per year	Histogram

Worksheet 4: Artificial light sources

Part 1

Students record their observations about the teacher demonstration of artificial light sources. Their observations might include:

Source	Fluorescent (tube and/or CFL)	Halogen	Incandescent	LED or other
Observations: – What does the globe look like? – How strong is the light? – What colour is the light? – Does it emit heat?	– White bulb (may be tubular or spiral) – Available in a variety of colour temperatures, for example: warm white, cool white, daylight – Emits less heat than incandescent globe – A 12-W CFL has a light output of 750 lumens (comparable to 60-W incandescent bulb)	– Quartz envelope encasing a tungsten filament – Produces a bright, white light – Gets very hot but produces bright light	– Pear-shaped bulb with filament inside – Light is brighter with more watts (energy) – Produces a warm, yellow-white light – Emits heat (most of the electrical energy is converted to heat rather than light)	– Curved bulb – Light brightness (lumens) requires fewer watts – Popular colours are warm, soft and bright white – They do get hot but the heat is pulled away by a heat sink in the base of the bulb and dissipates into the air

Part 2

KWL about artificial light sources/globes. Students record individual responses under the following headings:

- **K**now: Everything I already know about the different types of light globes/sources
- **W**ant to know: What do I want to find out about the different types of light globes/sources?
- **L**earnt: What did I learn about light globes/sources?

Worksheet 5: Group research task

Students work in groups to research the different light sources and record information in the table provided. They may use student Print resource 1 and research sites listed in Activity 3.

Examples of possible answers

Light source	Fluorescent	Halogen	Incandescent	LED or other
Scientific principles applied	Electrodes take electrical energy and generate moving electrons, which collide with mercury in the tube to make UV light. The white phosphor coating of the tube converts the UV light into visible light that we can see.	Tungsten filament encased in a quartz envelope of a halogen gas, a variation of the incandescent globe	Thin tungsten filament with a high resistance to electricity, becomes white hot and gives out light	Movement of electrons in a semiconductor. LEDs are part of the family of 'solid state' electronic components that only allow electricity to flow in one direction, with the side effect of creating light when current is passed through them.
Advantages	– Energy efficient (produces between 66% and 75% less heat than equivalent incandescent bulb) – Moderately long life (life span 10–12 times that of an incandescent bulb) – Reasonably priced – CFLs use only 20% of the electricity of traditional incandescent light bulbs to	– Produce a high-quality light that is intense and bright – Work well in cold climates – Mercury free – Somewhat more energy efficient than incandescent bulbs	Cheap to manufacture	– Most energy efficient option – Long life span (50000 hours) – Produce a high-quality light in a variety of brightness and colour temperatures – Low operational costs – Mercury free – Do not get hot

Light source	Fluorescent	Halogen	Incandescent	LED or other
	produce the same amount of light – Using less energy means lower electricity bills.			
Disadvantages	– Contain very small amounts of mercury – Aren't rated for cold climates where they may take time to warm up before operating at full capacity	– Far less energy efficient than LED and CFL bulbs so more expensive to operate – Produce a lot of heat so can affect the type of fixtures they are used in – Don't last as long as LEDs and CFLs	– Not energy efficient (converts only 5% of electricity to light and gives out a lot of heat) – Shorter life span (750–1250 hours)	Expensive
Legislation *(see research sites listed in Activity 3)*		More efficient types will continue to be available but the least efficient of this group will be phased out	A mandatory minimum energy performance threshold for normal light bulbs took effect in Australia in November 2009. Any light bulbs with an efficiency level of less than 15 lumens per watt were targeted. There was an import restriction on these bulbs from 1 Feb 2009 and a phase-out timetable is in place.	
Environmental issues *(see research sites listed in Activity 3)*	– Should be recycled at special depots to prevent ending up in landfill		Waste of energy	
	– Using less			

Light source	Fluorescent	Halogen	Incandescent	LED or other
	energy means reduced greenhouse gas emissions			
Additional information	Most cannot be dimmed or be used in lighting with movement sensors	Can be dimmed, favoured in spotlights and for sensor-control function	Can be dimmed	Can be dimmed

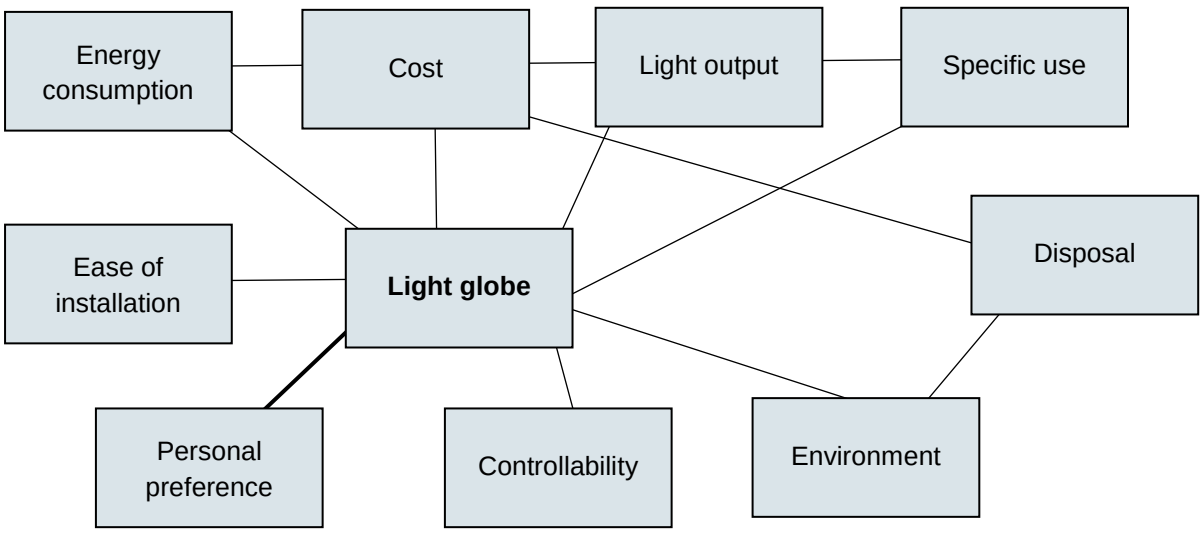
Worksheet 6: Factors to consider when choosing a light globe

Below are some examples of possible answers for this worksheet.

Objective factors (fact)	Subjective factors (opinion)
Wattage (energy consumption/efficiency)	Ease of installation in home
Lumens (light output/intensity)	Disposal issues
Cost (initial and lifetime)	Personal preference
	Controllability (dimmer, timer, sensor)
	Specific use

Concept map

This is an example of the type of concept map students might create.



Worksheet 7: Planning a fair test

Student investigation: My plan for a fair test to compare the light output of two light globes

One example is included on the worksheet. Below is another example of how this could be filled in. Students' answers will vary.

Question	Do different brands of light globes have the same light output?
Hypothesis	More expensive light globes will have a greater light output.
Variable tested	Brand/cost of light globe
Variable measured	Light intensity at a specified distance (20cm)
Factors controlled or kept the same	Wattage, lumens, same darkened room, same light socket and same amount of electricity

Worksheet 8: Criteria for assessment task

Students produce a written aim, list of equipment (for example: desk lamp, light meter, metre rule, two different light globes), then conduct the investigation and record results, calculate a mean and construct a graph.

Worksheet 9: How much does lighting cost?

Students are given two scenarios and use the online Electrical Energy Cost Calculator (see teacher notes) to calculate the weekly lighting costs for two households.

Below is an example of how this could be calculated.

Calculation	The Bright family	Mr and Mrs Empty-nesters
Calculate the number of hours each type of lighting is used in one week and enter the hours into the Electrical Energy Cost Calculator	Night-lights (4) 24 × 7 = 168 Floodlights (assume 2): 17 Fluorescent bulbs children (4): 6 × 7 = 42 Dining room (4): 2 × 7 = 14 Fluorescent bulbs kitchen (2): 3 × 7 = 21 Appliance light m/wave: 7 × 7 = 49 Appliance lights oven and fridge (2): 7 En suite: 10 × 7 = 70 Bedroom: 10 × 7 = 70 Fluorescent bulb (bathroom):	Fluorescent tubes kit/din (2): 4 × 7 = 28 Fluorescent bedroom (1x 32 W): 2 × 7 = 14 Bathroom: 7 Fridge: 2

Calculation	The Bright family	Mr and Mrs Empty-nesters
	2 × 7 = 14 *Note: 150-W floodlight and 40-W fluorescent selected for calculation of weekly lighting costs*	
Convert the electricity cost in cents to dollars and add into the calculator.	34.4 cents/kWh = $0.344/kWh	32.3 cents/kWh = $0.323/kWh
Calculate the weekly lighting costs for each household.	*Note: the calculator needs to be run more than once to obtain the total.* $7.84 + $2.36 = $10.20	Total = $1.02
Calculate the yearly lighting costs and explore options to reduce those costs.	$10.20 × 52 = $530.40	$1.02 x 52 = $53.04
For each household, recommend the most cost-effective change they could make to reduce the amount of money spent on lighting.	The Bright family need to replace their traditional light bulbs with more energy efficient type bulbs such as compact fluorescents (CFLs) that produce the same amount of light. For example: – 150-W floodlight with an 80-W MVH – 60-W incandescent with a 12-W CFL – typical fluorescents with CFLs – 25-W incandescent with a 5-W CFL. They need to consciously turn off lights when not in use to avoid wasting electrical energy (and money). The initial cost of purchasing alternative light bulbs will be offset through reduced energy use and savings on electricity bills. They could also look at changing to a cheaper electricity provider.	The Empty-nesters are already consciously making an effort to avoid wasting money spent on lighting, but they could replace the incandescent bulb in the bathroom with a more energy efficient 12-W CFL, and the typical fluorescents in the kitchen/dining and bedroom areas with lower wattage CFLs to provide the same amount of light but with reduced electricity costs.

Worksheet 10: Cost of lights

Example

*****Students conduct an internet search to find the cost of electricity **($D)** from their local provider. In this example, 34.221 cents or $0.34221/kWh has been used.

Light	Cost of package	Cost per item	Life span (h)	*Cost per year (assume used for 500 h/year)	Running cost/h
MR16 Dichroic Osram IRC-twin pack 35 watt	$19.95	19.95 ÷ 2 = $10	5000	35 ÷ 1000 × 500 × **$D** 35 ÷ 1000 × 500 × 0.34221 = $5.99	$5.99 ÷ 500 = $0.01198
T2 Twister Cool White Spiral Compact Fluorescent Lamps (Twin Pack) 7 watt	$10.50	10.50÷ 2 = $5.25	10000 hours	7 ÷ 1000 x 500 × 0.34221 = $1.20	$1.20 ÷ 500 = $0.0024
T5 Circular Fluorescent Lamps (10 Pack) 32 watt 3000 hours	$93.50	93.50 ÷ 10 = $9.35	3000	32 ÷ 1000 x 500 × 0.34221 = $5.48	$5.48 ÷ 500 = $0.01096

Worksheet 11: Summative assessment task

Students, in groups or individually, prepare and present a pamphlet promoting the benefits of a specific type of light globe and indicate any problems with the alternative choices. This worksheet provides details of the task as well as peer, teacher and self-assessment criteria. Teachers may also refer to the Assessment rubric for details.