Resources for worksheets

Worksheets use information from the *High-tech metal resources* map and fact sheets published by the Geological Survey of NSW. Links to the relevant fact sheets are provided in worksheets as needed. You may wish to print sheets for the class or obtain copies of the entire map. See the website for information: https://resourcesandgeoscience.nsw.gov.au/miners-and-explorers/geoscience-information/products-and-data/high-tech-metal-resources-of-nsw

Syllabus Outcomes

Physical World

PW4: Science and technology contribute to finding solutions to a range of contemporary issues; these solutions may impact on other areas of society and involve ethical considerations

Students:

b. research ways in which scientific knowledge and technological developments have led to finding a solution to a contemporary issue, e.g. improvements in devices to increase the efficiency of energy transfers or conversions

Earth and Space

ES1: Sedimentary, igneous and metamorphic rocks contain minerals and are formed by processes that occur within Earth over a variety of timescales.

Students:

- identify that sedimentary, igneous and metamorphic rocks contain minerals

ES3: Scientific knowledge influences the choices people make in regard to the use and management of the Earth's resources.

Students:

a. classify a range of the Earth's resources as renewable or non-renewable
b. outline features of some non-renewable resources, including metal ores and fossil fuels
c. describe uses of a variety of natural and made resources extracted from the biosphere, atmosphere, lithosphere and hydrosphere
d. investigate some strategies used by people to conserve and manage non-renewable resources, e.g. recycling and the alternative use of natural and made resources
e. discuss different viewpoints people may use to weight criteria in making decisions about the use of a major non-renewable resource found in Australia
f. outline the choices that need to be made when considering whether to use scientific and technological advances to obtain a resource from Earth's spheres

Additional content

Students:

- debate the economic and environmental impacts of mining and resource exploration
- describe ways in which technology has increased the variety of made resources

Rocking the Future 1: Metal from Rock - Answers

Earth's Resources

Renewable	Non-renewable
Wood	**Brick**
Paper cup	**Plastic lid**
Cotton cloth	**Metal doors**
Plants	Synthetic cloth
People	Metal/plastic/glass in phone
Water	Glass in doors
	Eyeglasses
	Metal/plastic jewellery

*Students may list a variety of resources. Ones shown in **BOLD** are listed for students to classify.*

Renewable energy for the future

Australia generated 77% of its electricity from coal and gas.

Coal and gas are renewable / non-renewable resources. (circle correct answer)

Renewables accounted for 21% of total generation. The renewable energy with the greatest increase over the year was solar.

Our high-tech future needs metals

What are high-tech metals?

1. Why are some metals considered "high-tech"? They are used in high-technology industries, so they are considered high-tech metals.

2. List at least six high-tech metals that can be produced in NSW. Copper, gold, scandium, platinum, cobalt, lithium, titanium, zirconium (also any of the Lanthanides, yttrium, ruthenium, rhodium, palladium, osmium and iridium)

The high-tech world needs metals

3.

Industry	Products made from high-tech metals
Consumer electronics	Mobile phones, tablets
Transportation	Electric vehicles, fuel-efficient aircraft
Aerospace	Satellites
Renewable energy	Solar technology, wind turbines, battery storage

Environmental sustainability

4. Explain why large-capacity batteries are needed for sustainability. Wind and solar power are intermittent. Large batteries store energy when it is produced so that it can be used later.

5. Explain how a named high-tech metal is used to improve the efficiency of a form of transport. *Answers may include:* Electric cars need lithium and cobalt for batteries and copper. Airplanes need light metals like scandium and lithium to improve strength and reduce the weight of aircraft.

Supply challenges

6. Which of the supply challenges do you think is the most important? Why? *Answers may include:* **Scarcity** – some metals are rare and hard/expensive to extract. This is an important challenge because it will cost a lot of money to create high-tech products. **Concentrated supply** – some of the metals are mainly from one country (e.g. REEs from China). That country can have a monopoly and may choose not to supply Australia. We need our own supplies to ensure that our industry can create high-tech products. **Non-ethical supply** – some countries have poor human rights (child labour) or very damaging mining practices. By creating an Australian supply of high-tech metals, we can look after people and the environment.

7. How do leading car and battery manufacturers make certain of an ethical supply of high-tech metals? Manufacturers deal directly with mining companies so that they can be sure their metals are from ethical sources.

Summary

Why do we need to use non-renewable resources for a sustainable future? We need non-renewable metals to build devices to collect renewable energy (solar panels, wind turbines) and to store energy until it is needed (batteries). Non-renewable resources are needed to build electric vehicles and in other new technologies.

Rocking the Future 2: Mining – Answers

Metal from rock

The deposits in the Murray Basin and Fifield/Nyngan belt were created by **weathering and erosion**. The original rock was weathered into small pieces and eroded by wind and water. The minerals were deposited at the current locations.

Investigate a deposit of high-tech metals

Students will have chosen one site:

Site	Metal(s)	Special features
Broken Hill	Platinum, palladium, osmium, iridium, ruthenium, gold, nickel, copper	Contains very rare platinum elements and extends for many kilometres
Cadia	Gold and copper	Among the largest deposits on Earth with over 1100 t gold and 7.8 Mt copper. Also has platinum group elements
Dubbo (Toongi)	Zirconium, hafnium, niobium, yttrium and rare earth oxides	Current mine life is 70 years. It is an alternative supply for a range of metals (most now from China)
Ginkgo and Snapper	Ilmenite, rutile, zircon → titanium and zirconium (potential for REE and thorium)	Basin contains over 115 Mt of high-quality mineral grains
Nyngan	Scandium	World first scandium-only mine. Planned production of 38 t per year for 20+ years
Owendale	Scendium	Could support scandium mining for up to 80 years
Sunrise	Cobalt, nickel, scandium	High grade scandium and one of the largest and highest grade undeveloped nickel and cobalt resources outside Africa. Collaborating with Airbus to produce 3D printing aluminium-scandium powder for aircraft
Thackaringa	Cobalt	Pyrite deposits with more than 60 000 t cobalt.

Uses for the metals at your chosen site

Metal	Main use (other uses)	Recycling	Mobile phone
Scandium	Alloy with aluminium for aircraft	Less than 1% recycled	Not present in mobile phone
Lithium	Rechargeable batteries (aluminium alloys for transport; armour plating on tanks and ships)	Less than 1% recycled – need better recovery technology.	Battery
Cobalt	Magnets and batteries (turbines, paints, enamels, pottery glazes, medical applications)	Some recycled from batteries	Battery
Rare Earth	Optics and lasers (powerful	Less than 1%	LEDs, Electronic

Elements (Sc, Y, La, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu)	magnets, batteries, catalytic converters	recycled	components, Touch screen, Battery, Speaker & microphone
Platinum Group Elements (Pt, Pd, Ir, Os, Rh, Ru)	Catalytic converters (computer hard drives, ceramic capacitors, integrated circuits, glass, jewellery, lab equipment)	Unknown %. Difficult to recycle, but this is done due to high cost	Circuit board
Copper	Building construction, electrical products, transportation equipment, consumer products, industrial machinery	25% recycled	Circuit board, Electronic components, Wires and connectors
Gold	Jewellery (currency, electronic components and connections, catalyst in industrial processes, pollution reduction, fuel cells, solar cells, medical diagnosis and treatment)	25% recycled	Circuit board, Wires and connectors

There are technical barriers to recycling that include difficulty in disassembling products for recycling, limited durability of products, complex products with many materials and rapid advances leading to to the use of newer materials (resulting in older materials being left unrecycled).

Rocking the future

Any of these sites may need to be mined to produce rare metals that are vital to advanced technology and for future sustainability. Relying on foreign sources of metals can lead to uncertain supply. Some foreign countries have poor environmental and human rights records, so buying metals from them contributes to poor conditions for people.

References:

M.J. Armstrong, P.J. Carter, M.J. Drummond, G.D. Fleming, D.B. Forster & L.M. Talbot (compilers) 2018. High-tech metal resources of New South Wales. Geological Survey of New South Wales, Maitland. Available online at https://resourcesandgeoscience.nsw.gov.au/miners-and-explorers/geoscience-information/products-and-data/high-tech-metal-resources-of-nsw

NSW Education Standards Authority (2019). *Science Years 7-10 Syllabus*. Sydney. Available online at https://www.educationstandards.nsw.edu.au/wps/portal/nesa/k-10/learning-areas/science/science-7-10-2018

This resource was produced by Australian Earth Science Education in partnership with the Department of Regional NSW's Geological Survey of New South Wales.

Resourced by

EARTH SCIENCE WESTERN AUSTRALIA