



## 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>

Students use information from the [High-tech metals map](#) (Sources and uses of high-tech metals) to complete the questions.

## Syllabus Outcomes

### Chemical World

CW2 The atomic structure and properties of elements are used to organise them in the Periodic Table.

Students:

- relate the properties of some common elements to their position in the Periodic Table
- predict, using the Periodic Table, the properties of some common elements

### Physical World

PW4 Energy conservation in a system can be explained by describing energy transfers and transformations (ACSSU190)

- discuss viewpoints and choices that need to be considered in making decisions about the use of non-renewable energy resources

## Answers

1. Circle the correct option to complete the sentences:

- Metals are typically **solid** / liquid / gas.
- They have a dull / **shiny** appearance because metals reflect light.
- Metals are brittle / **malleable** and **ductile** / inflexible with good electrical and heat **conductivity** / insulation.

2. Some metals are particularly useful in high-tech industry because they have unique properties.

- Unique chemical properties: **Conductivity, high melting point**
- Unique physical properties: **Strength, density and hardness**

3. List some products that rely on high-tech metals in their construction. **Mobile phones, lithium-ion batteries, satellites and hybrid vehicles**

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4. Which high-tech metals are really groups of metals? REE (Rare Earth Elements) and PGE (Platinum Group Elements)
5. Where do these groups occur on the periodic table? Rare Earth Elements are mainly lanthanides, in row 6 of the periodic table; Platinum Group Elements are in columns 8-10 and rows 5-6.
6. Fill in the table below to summarise properties, sources and uses of high-tech metals

High-tech metal	Properties	Main sources	Uses
Lithium	Soft and silver-coloured; reacts vigorously with water	Australia, Chile and Argentina from igneous rocks and mineral springs and brines	Rechargeable batteries; also alloyed with Al for transport or Mg and Al for armour plating
Scandium	Low density, high melting point, burns easily and dissolves in water	Obtained as a by-product of mineral processing. NSW has deposits	Alloyed with Al for aerospace industry.
Cobalt	Magnetic, high melting point, resistant to corrosion	Democratic Republic of Congo; found in Cu and Ni deposits and Mn nodules on ocean floor	Magnets and metal-ion batteries (cathode), alloys in turbines, colourant for paint, glazes and enamels
Rare Earth Elements	“Unique” chemical, nuclear, electrical, magnetic and luminescent properties	Mainly produced in China, but Australia is second largest supplier. Found in a range of geological deposits	High performance optics and lasers, magnets, batteries and catalytic converters
Platinum Group Elements	Resistant to corrosion and oxidation, high melting point, electrical conductivity, catalytic activity	Russia and South Africa	Car industry for catalytic converters; also used for computer hard drives, ceramic capacitors, circuits, glass, jewellery and lab equipment
Copper	Easily stretched and shaped, resists corrosion, efficient conductor	Global (Chile, Peru, China, DRC and USA are top 5 producers)	Building construction, electrical and electronic products, transport equipment, industrial machinery and general products.
Gold	Highly ductile, easily shaped, resistant to corrosion and efficient conductor	Global (China, Russia, Australia, USA and Canada top 5 in 2019)	Jewellery, currency, electrical components and connections, nano-particles as catalysis, etc.

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7. Do you think it is important for Australia to mine high-tech metals? Justify your answer using information from the table in question 6. *Answers will vary and should refer to the information in Q6. E.g. Australia needs to develop sources of high-tech metals so that we are not dependent on foreign supplies. Some foreign suppliers (such as DRC) have poor human rights records and no environmental oversight to their mining. We need high-tech metals so that Australia can manufacture products that we have come to rely upon such as rechargeable batteries, renewable energy infrastructure (wind turbines) and mobile phones.*
8. High-tech metals are valuable. Do we effectively recycle these elements? Explain the current recycling status and opportunities. *Gold and copper are cost-effective to recycle and 25% of these metals comes from recycling. Platinum and palladium are difficult to recycle, but so scarce that they are recycled. We need to recycle other elements, especially lithium. Barriers include the difficulty with disassembling products for recycling, different types of materials that are hard to recycle and rapid development of new materials which renders older ones obsolete.*

#### 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>

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