

RARE EARTH ELEMENTS AND TECHNOLOGY

GRADE 8 AND UP READING

Improve students' literacy skills

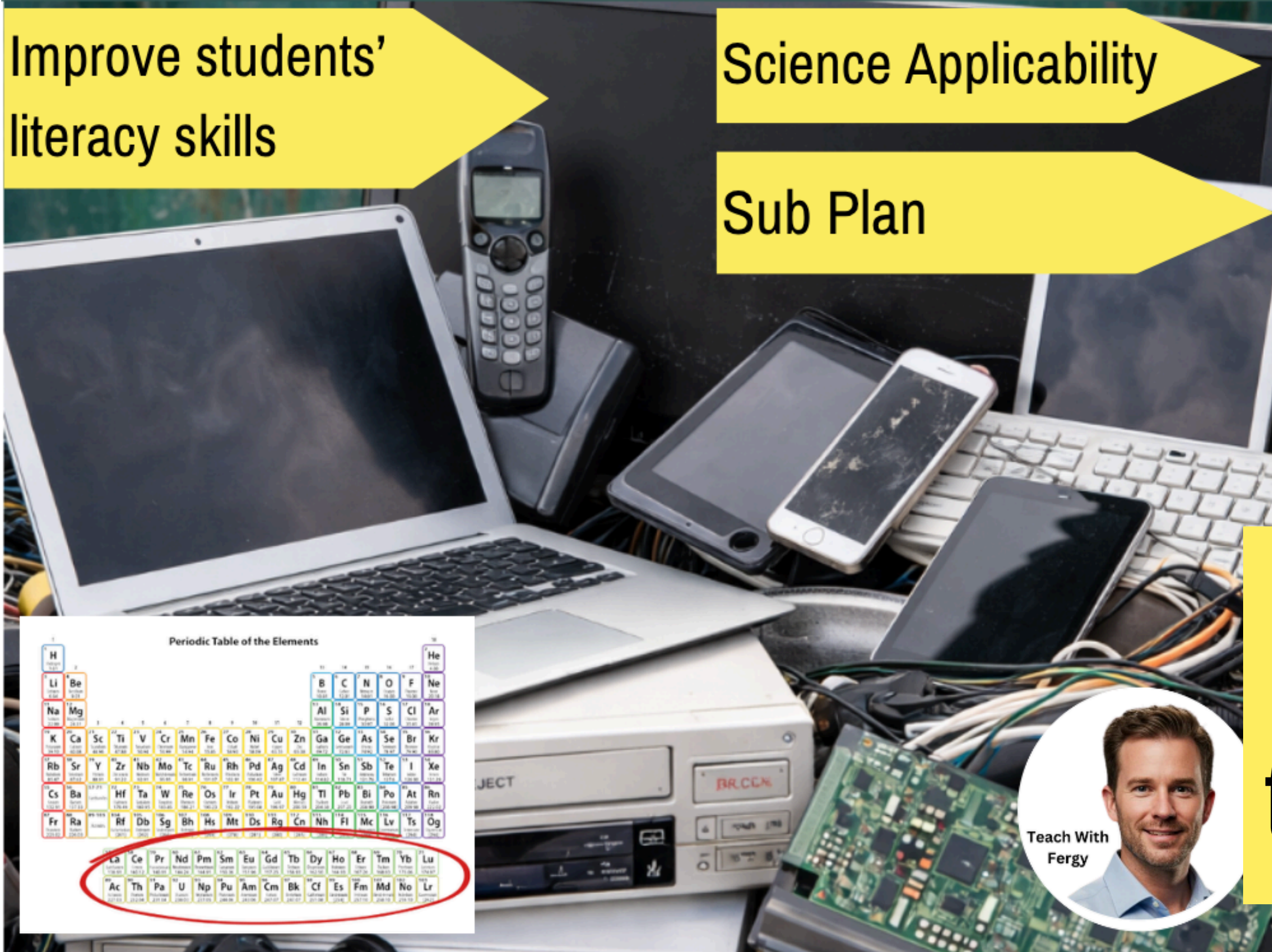
Science Applicability

Sub Plan

Reading Comment

Extremely satisfied - Great resource to work on student reading comprehension and it tied into the topic I was teaching. My students have been struggling with reading and I've been incorporating more reading into my lessons. Thank you for the resource.

SCROLL
to take a look inside!



Periodic Table of the Elements

1																	18
H																	He
3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		
Li	Be	B	C	N	O	F	Ne	Na	Mg	Al	Si	P	S	Cl	Ar		
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72
Cs	Ba	La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	
87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
Fr	Ra	Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr	

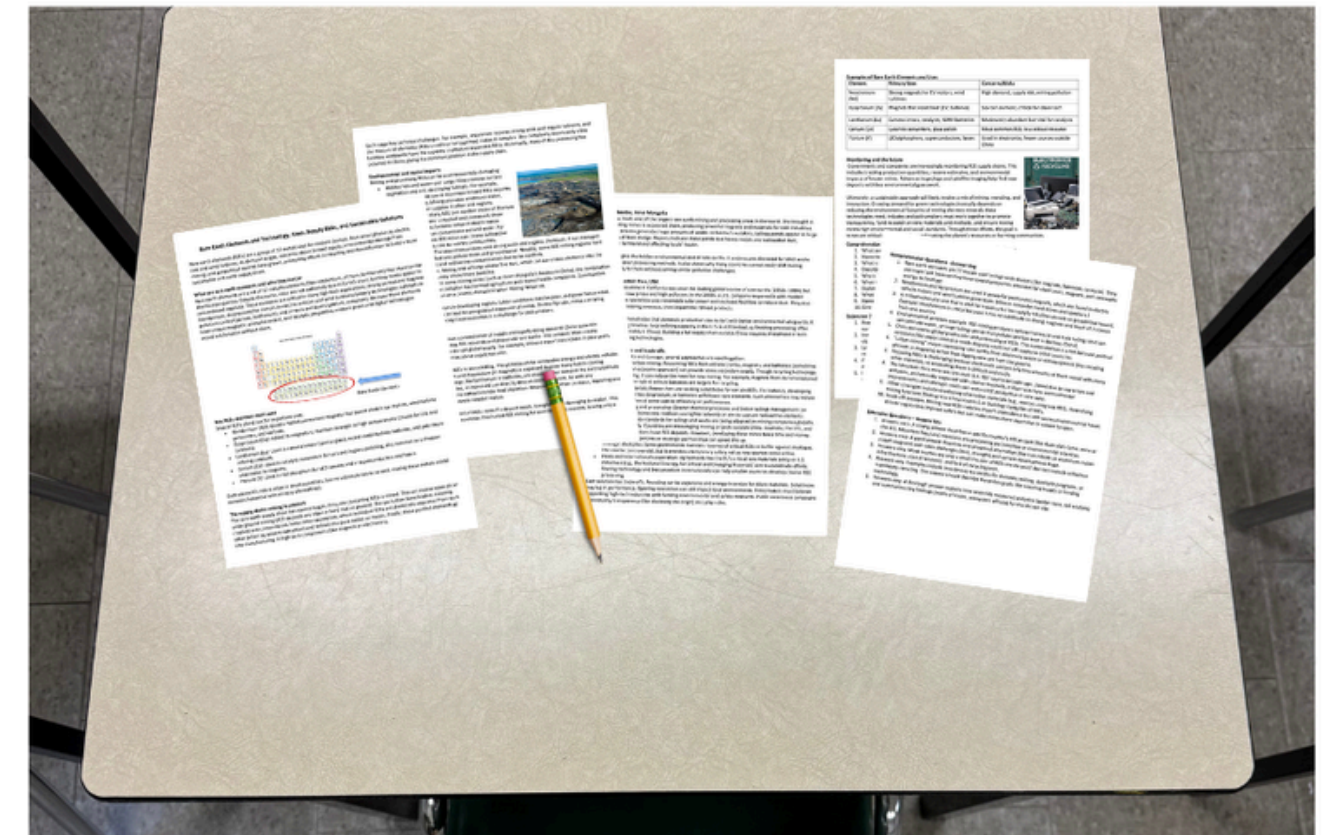


THE PROBLEMS YOU FACE

- Limited time to teach scientific literacy and strengthen students' reading and analysis skills.
- Need meaningful extension activities to engage fast-moving learners.
- Difficulty creating effective last-minute sub plans that still support student learning.

CLASSROOM READY

- Questions and Answer Key
- **No Prep, Ready-to-Use:** Print or assign digitally with Google Docs, Microsoft Word, and PDF formats for flexible classroom use
- **Includes Varied Question Types:** Knowledge, thinking, connecting, application, and open-ended questions.



What Will Your Students Learn?

READING COMPREHENSION ARTICLE & QUESTION BUNDLE

Article with
Comprehension
Questions

Grade 8 and Up

Print & Digital

- What Are Rare Earth Elements (REEs)?
- Key Rare Earth Elements and Their Uses
- Rare Earth Elements in Technology (EVs, Wind Turbines, Electronics)
- The Rare Earth Supply Chain (Mining → Processing → Manufacturing)
- Critical Minerals and Supply Risk
- Environmental Impacts of Mining and Processing
- Radioactive Waste and Chemical Pollution
- Global Supply and Geopolitical Challenges
- Case Studies (Baotou, China & Mountain Pass, USA)
- Recycling and Urban Mining
- Alternative Materials and Innovation
- Sustainable Mining and Processing Practices
- Policy, Trade, and Resource Management
- Future of Rare Earth Supply and Technology

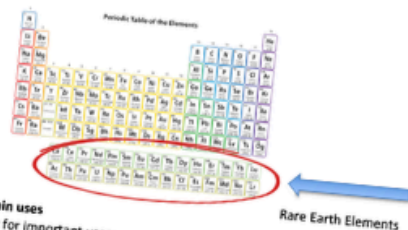
Comprehension Questions

1. What are rare earth elements and why are they important in technology?
2. Name two technologies that rely on neodymium or dysprosium.
3. What is a critical mineral and give an example involving an REE.
4. Describe one environmental problem caused by REE mining.
5. Why is China's role in the rare earth supply chain considered a risk?
6. What is meant by "urban mining" for rare earths?
7. Explain why recycling rare earths can be challenging.
8. Describe how rare earth elements are used in modern green and digital technologies.
9. Identify the rare earth elements that are most abundant in the Earth's crust.
10. Discuss the geopolitical challenges associated with the rare earth supply chain.

Extended Questions

1. Rare earth elements (REEs) are a group of 17 metals vital for modern devices, from smartphones to electric cars and wind turbines. As demand surges, concerns about limited supply, environmental damage from mining, and geopolitical control have grown, prompting efforts in recycling and diversification to build a more sustainable rare earth supply chain.

2. What are rare earth elements and why they matter
Rare earth elements are a set of 17 metallic elements (like neodymium, yttrium, lanthanum) that share similar chemical properties. Despite the name, most are not extremely rare in Earth's crust, but they rarely appear in concentrated deposits. These elements are critical in many high-tech applications: strong permanent magnets (neodymium, dysprosium) for motors in electric vehicles and wind turbines; battery technologies; catalysts in pollution control (cerium, lanthanum); and screens and lasers (yttrium, europium). Because these elements have unique magnetic, phosphorescent, and catalytic properties, modern green and digital technologies would not function without them.



Key REEs and their main uses

- Several REEs stand out for important uses:
- Neodymium (Nd): Used in NdFeB permanent magnets that power electric car motors, wind turbine generators, and earbuds.
 - Dysprosium (Dy): Added to magnets to maintain strength at high temperatures (crucial for EVs and turbine engines).
 - Lanthanum (La): Used in camera lenses (special glass), nickel-metal hydride batteries, and petroleum refining catalysts.
 - Cerium (Ce): Used in catalytic converters for cars and in catalytic converters for industrial processes.
 - Yttrium (Y): Used in lasers, superconductors, and in the production of high-strength alloys.

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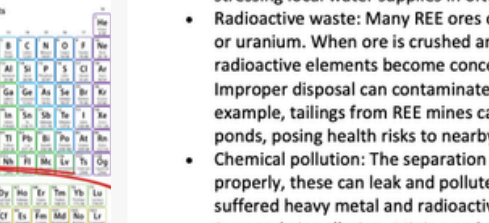


Rare Earth Elements and Technology: Uses, Supply Risks, and Sustainable Solutions

Rare earth elements (REEs) are a group of 17 metals vital for modern cars and wind turbines. As demand surges, concerns about limited mining, and geopolitical control have grown, prompting efforts in sustainable rare earth supply chain.

What are rare earth elements and why they matter

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Key REEs and their main uses

Several REEs stand out for important uses:

- Neodymium (Nd): Used in NdFeB permanent magnets that power generators, and earbuds.
- Dysprosium (Dy): Added to magnets to maintain strength at high temperatures (turbines).
- Lanthanum (La): Used in camera lenses (special glass), nickel refining catalysts.
- Cerium (Ce): Used in catalytic converters for cars and in glass polishing.
- Yttrium (Y): Used in red phosphors for LED screens and in lasers.

Each element's role is often in small quantities, but no substitute exists for these minerals (essential with no easy alternatives).

The supply chain: mining to product

The rare earth supply chain has several stages. First, ore containing rare earth elements (REE deposits) are often in hard rock or placer deposits, crushed and concentrated. Next comes separation, where individual elements are often (often by solvent extraction) and refined into pure oxides or salts. Finally, they are used in manufacturing of high-tech components (like magnets or electronics).

Case Study: Baotou, Inner Mongolia

Baotou, China, hosts one of the largest rare earth mining and processing areas in the world. Ore is mined and processed there, producing powerful magnets and materials for tech. The process generates huge amounts of waste. In Baotou's outskirts, tailings ponds are a major environmental concern. Reports indicate these ponds leak heavy metals and radioactive elements into the land and affecting locals' health.

It also shows the hidden environmental cost of rare earths. It underscores the need for cleaner processing methods. It also shows why many countries cannot easily shift to green processing methods. It also shows why many countries cannot easily shift to them without solving similar pollution challenges.

Mountain Pass, USA

This mine in California was once the leading global source of rare earths (1950s–1980s) but closed due to low prices and high pollution. In the 2010s, a U.S. company reopened it with a new operation using renewable solar power and enclosed facilities to reduce dust. The refined products are then shipped overseas, then import the refined products.

This demonstrates that domestic production can restart with better environmental safeguards. Local refining capacity in the U.S. is still limited, so finishing processes (notably in China). Building a full supply chain outside China requires investing in new technologies.

Challenges and trade-offs

Due to risks and damage, several approaches are used together:

- Recycling: Recovering REEs from old electronics, magnets, and batteries (circular economy approach) can provide some secondary supply. Though recycling is expensive, it can reduce the need for new mining. For example, magnets from electric vehicles or hybrid vehicle batteries are targets for recycling.
- Alternative materials: Researchers are seeking substitutes for certain REEs. For instance, iron-based magnets or batteries with fewer rare elements. Such alternatives are not yet widely available but often at some cost to efficiency or performance.
- Cleaner mining and processing: Cleaner chemical processes and better tailings management. Some new methods use lighter solvents or aim to capture radioactive elements. Some new methods use lighter solvents or aim to capture radioactive elements. Some new methods use lighter solvents or aim to capture radioactive elements.
- Stricter safety standards for tailings and waste are being adopted by mining companies. Countries are encouraging mining projects outside China. Australia, Canada, and other nations have REE deposits. However, developing these mines takes time and money. Tax incentives or strategic partnerships can speed this up.
- Stockpiles: Some governments maintain reserves of critical REEs to buffer against price volatility, but it provides a temporary safety net as new sources come online.
- International cooperation: Agreements like the EU's critical raw materials policy (e.g., the National Strategy for Critical and Emerging Materials) aim to coordinate policy and best practices internationally can help smaller countries develop their own REE sectors.

Trade-offs: Recycling can be expensive and energy-intensive for dilute materials. Opening new mines can still impact local environments. Policymakers must balance tech industries with funding environmental and safety measures. Public awareness and transparency (like disclosing ore origin) also play roles.

Element	Primary Uses	Concerns/Risks
Neodymium (Nd)	Strong magnets for EV motors, wind turbines	High demand, supply risk, mining pollution
Dysprosium (Dy)	Magnets that resist heat (EV, turbines)	Rarer element, critical for clean tech
Lanthanum (La)	Camera lenses, catalysts, NiMH batteries	Moderately abundant but still critical
Cerium (Ce)	Catalytic converters, glass polish	Most common REE; less critical
Yttrium (Y)	LEDs/phosphors, superconductors, lasers	Used in electronics; fewer alternatives in China

Monitoring and the future

Governments and companies are increasingly monitoring REE supply chains. This includes tracking production quantities, reserve estimates, and environmental impacts of known mines. Advances in geology and satellite imaging help find new deposits with less environmental guesswork.

Ultimately, a sustainable approach will likely involve a mix of mining, recycling, and innovation. Growing demand for green technologies ironically depends on reducing the environmental footprint of mining the very minerals these technologies need. Industry and policymakers must work together to promote transparency, fund research on new materials and methods, and ensure mining meets high environmental and social standards. Through these efforts, the goal is to secure critical materials without exhausting the planet's resources or harming communities.

Comprehension Questions - Answer Key

- Rare earth elements are 17 metals used in high-tech devices (like magnets, batteries, catalysts). They are important because they have special properties essential for electronics, magnets, and renewable energy technology.
- Neodymium and dysprosium are used in powerful permanent magnets, which are found in electric vehicle motors and wind turbine generators. (Also in computer hard drives and speakers.)
- A critical mineral is one that is vital for industry but has supply risk (few sources or geopolitical issues). Example: Neodymium is critical because it has no substitute in strong magnets and much of it comes from one country.
- Environmental problem example: REE mining produces radioactive waste and toxic tailings that can contaminate water, or large tailings ponds that pollute land (as seen in Baotou, China).
- China dominates global production and processing of REEs. This concentration is a risk because political decisions (like export limits) or trade disputes could cut off supply to other countries.
- "Urban mining" means recovering rare earths from electronic waste or old equipment (like recycling phones or magnets) rather than digging new ore from the ground.
- Recycling REEs is challenging because electronics contain only tiny amounts of them mixed with many other materials, so separating them is difficult and costly.
- The Mountain Pass mine was the main U.S. REE source decades ago, closed due to low prices and high pollution, and recently reopened with cleaner methods. It illustrates how environmental improvements and strategic needs can restart REE production in new ways.
- Other strategies include developing alternative materials (e.g., motors using less REE), diversifying mining locations (finding non-China sources), or building stockpiles of REEs.
- Trade-off example: Mining new REEs reduces import dependence but still causes environmental harm; stricter regulations improve safety but can make mines more expensive or slower to open.

Extension Questions – Answer Key

- Answers vary. A strong answer describes a specific country's REE project (like Australia's Lynas mine or the U.S. Mountain Pass) and mentions any processing partnerships or environmental practices.
- Answers vary. A good answer discusses one proposed alternative (like iron-nitride or aluminum-nickel-cobalt magnets) and notes challenges (cost, strength) and current development stage.
- Answers vary. Most sources say only a small fraction of REEs are recycled. Barriers include collection infrastructure, cost of recovery, and lack of recycling tech.
- Answers vary. Examples include investment tax credits for domestic mining, stockpile programs, or mandatory recycling. The answer should describe the policy goals, like ensuring supply or funding technology.
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- Why is China's role in the rare earth supply chain considered a risk?
- What is meant by "urban mining" for rare earths?
- Explain why recycling of REEs can be challenging.
- What happened at the Mountain Pass mine, and what does it illustrate?
- Name one strategy (other than recycling) that can reduce REE supply risks.
- Give one trade-off or difficulty in making rare earth supplies more sustainable.

Extension Questions

- Research one country outside China (e.g., Australia, USA, or Greenland) and explain its role in REE production or processing.
- Investigate a technological substitute for a rare earth magnet (such as an iron-nitrogen alloy). How close is it to commercial use?
- Look up the current status of recycling rare earths from used electronics. What percentage is recycled, and what are the barriers?
- Find an example of a government policy on critical minerals (e.g., US IRA incentives, materiality law). What does the policy aim to achieve?
- Explore one environmental impact study of a rare earth mine (e.g., Baotou or Mountain Pass). What methods were used to assess damage?

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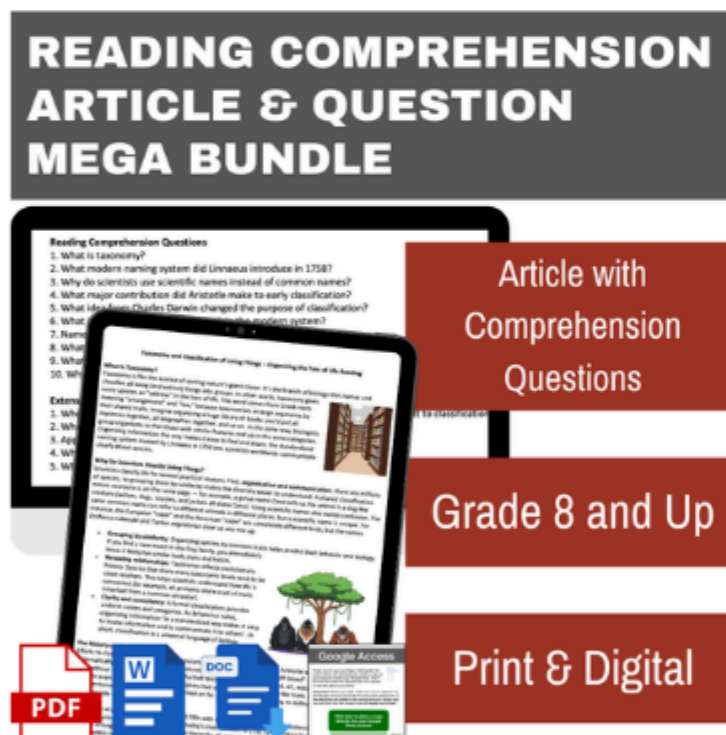
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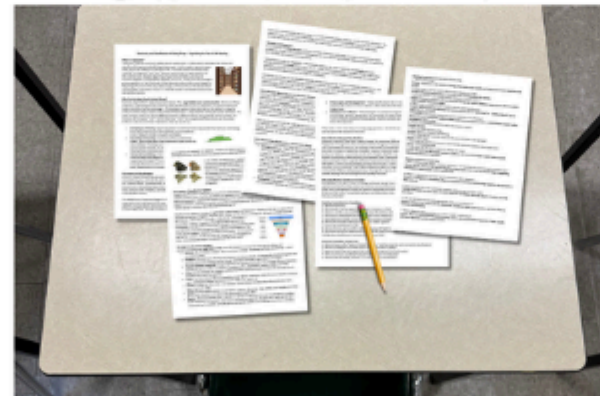
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★★★★★ Extremely satisfied - It is a good supplemental activity either for review and at the same time introducing some concept. I also use this for sub plan. It is well presented, organized and interesting.

★★★★★ Extremely satisfied - This a great resource. I used this for a sub plan. It was fun and engaging for my students.

Grade 8 and Up Scientific Reading Comprehension Article Mega Bundle

ALL my current and future grade 8 and up readings, covering the following subject areas:

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