K19 Metals, Reactivity and the Rock Cycle

Calculator allowed · about 75 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Name three physical properties of metals that distinguish them from non-metals.

(1)

2 Complete the sentence: The reactivity series is a list of metals arranged from most reactive to least reactive. Place these metals in order from most reactive to least reactive: copper, potassium, iron.

(2)

3 Sodium is more reactive than magnesium. A student puts a small piece of sodium into water and, in a separate test, a small piece of magnesium into water. Describe the differences the student should see between the two tests.

(3)

4 Explain why a piece of iron will displace copper from copper(II) sulfate solution, but copper will not displace iron from iron(II) sulfate solution.

(4)

5 A student places a strip of zinc into a blue copper(II) sulfate solution. Predict the colour change of the solution and explain why.

(2)

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6 State one method used to extract iron from its ore in a blast furnace and name one reactant used in the process.

(3)

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7 What is rust chemically called and what two things are needed for iron to rust?

(2)

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8 A student investigates how quickly different metals corrode in salty water. Suggest two variables they must keep the same to make the test fair and explain why.

(4)

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9 Give one reason why aluminium is often used to make the bodies of aeroplanes instead of iron.

(1)

10 The simple word equation for the reaction of zinc with hydrochloric acid is: zinc + hydrochloric acid -> zinc chloride + hydrogen. A student reacts 13 g of zinc with excess hydrochloric acid. Calculate the mass of hydrogen gas produced. (Relative atomic masses: H = 1, Zn = 65).

(3)

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11 Match the rock type to its formation process: igneous, sedimentary, metamorphic. Processes: formed from cooled molten rock; formed by layers of sediment being compacted and cemented; formed when existing rocks are changed by heat and pressure. Provide the three pairings.

(2)

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12 Describe one difference in appearance you would expect between an igneous rock and a sedimentary rock, and give a short reason for each observation.

(4)

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13 Which rock type would likely contain fossil shells and why?

(2)

14 A sample of rock is heated and squeezed deep inside the Earth and becomes more compact with new mineral bands. Identify the rock type and explain two changes that occur during this process.

(3)

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15 Explain why recycling metals saves energy compared with extracting metals from ores.

(2)

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16 A piece of granite (an igneous rock) has a mass of 2.7 kg and a volume of 1.0 L. Calculate its density in g/cm^3. (1 L = 1000 cm^3).

(4)

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17 State one environmental problem caused by mining metal ores.

(1)

18 Extended response: A local council is deciding whether to support a new small metal recycling plant near a town. Using your knowledge of metal extraction, corrosion and the rock cycle, evaluate the advantages and disadvantages for people and the environment. Write a balanced answer and give a reasoned conclusion.

(6)

Mark scheme · K19 Metals, Reactivity and the Rock Cycle

Question 1

- **B1** one correct property named (shiny, malleable, good conductor of heat or electricity, ductile, high density, sonorous) cao
- Answer: **Examples: shiny; malleable; good conductor of electricity (any one of these for 1 mark).**

Question 2

- **M1** correct order: potassium, iron, copper
- **A1** Potassium, iron, copper cao
- Answer: **Potassium, iron, copper**

Question 3

- **M1** sodium: reacts vigorously, moves on surface, may fizz and melt into a ball
- **M1** magnesium: reacts slowly or very little with cold water, maybe slight fizzing or no visible reaction
- **A1** comparison statement referencing faster/stronger reaction for sodium than magnesium cao
- Answer: **Sodium reacts vigorously with water, fizzes, may move and form a small ball; magnesium reacts slowly or hardly at all with cold water, showing little or no fizzing. Sodium reacts much faster than magnesium.**

Question 4

- **M1** state that iron is higher than copper in the reactivity series (more reactive)
- **M1** displacement idea: a more reactive metal will displace a less reactive metal from its compound
- **A1** apply to iron and copper: iron displaces copper ions to form iron(II) sulfate and copper metal
- **A1** therefore copper cannot displace iron because copper is less reactive cao
- Answer: **Iron is more reactive than copper so iron atoms displace copper ions from copper(II) sulfate, forming iron(II) sulfate and copper metal; copper cannot displace iron because it is less reactive.**

Question 5

- **M1** prediction that the blue colour fades or the solution becomes colourless/less blue
- **A1** zinc displaces copper ions to form colourless zinc sulfate and copper metal precipitates, causing blue to fade cao
- Answer: **The blue colour will fade as copper metal forms and the solution becomes less blue (zinc ions replace copper ions).**

Question 6

- **M1** method named: heating in a blast furnace or smelting
- **M1** reactant named: coke (carbon) or limestone or hot air (oxygen as part of hot air) - one required
- **A1** brief link: coke is used to reduce the iron oxide to iron (or limestone removes impurities) cao
- Answer: **Method: heating in a blast furnace (smelting). Reactant: coke (carbon) used to reduce iron oxide to iron.**

Question 7

- **M1** chemical name: iron oxide (or hydrated iron oxide)
- **A1** two factors: oxygen and water (moisture) cao
- Answer: **Rust is iron oxide (hydrated iron oxide). Iron needs oxygen and water to rust.**

Question 8

- **M1** variable: concentration of salt (same) with brief reason: affects corrosion rate
- **M1** variable: temperature (same) with brief reason: affects reaction speed
- **A1** variable: surface area of metal samples (same) with brief reason: more area gives more corrosion
- **A1** variable: time exposed (same) with brief reason: ensures fair comparison
- Answer: **Keep salt concentration and temperature the same so corrosion conditions do not vary; also use the same surface area and exposure time so results are comparable.**

Question 9

- **B1** correct reason: aluminium is lighter than iron (low density) or resists corrosion better, oe
- Answer: **Aluminium is much lighter than iron (lower density).**

Question 10

- **M1** use ratio from equation: 1 mol Zn produces 1 mol H2
- **M1** calculate moles Zn = 13 / 65 = 0.2 mol
- **A1** mass H2 = moles H2 x Mr H2 = 0.2 x 2 = 0.4 g cao
- Answer: **0.4 g**

Question 11

- **B1** igneous = formed from cooled molten rock
- **B1** sedimentary = formed by compacting and cementing layers of sediment; metamorphic = formed when existing rocks change by heat and pressure (either point scored as second mark)
- Answer: **Igneous = formed from cooled molten rock. Sedimentary = formed by sediment being compacted and cemented. Metamorphic = formed when existing rocks are changed by heat and pressure.**

Question 12

- **M1** appearance of igneous: often has interlocking crystals or a glassy texture
- **A1** reason: cooled from molten rock so crystals grew and interlocked
- **M1** appearance of sedimentary: often has visible layers or contains fossils and grainy texture
- **A1** reason: formed from deposited sediments or remains cemented together cao
- Answer: **Igneous rock: interlocking crystals or glassy texture because it cooled from molten rock. Sedimentary rock: visible layers or fossils and grainy texture because sediments were deposited and cemented together.**

Question 13

- **M1** answer: sedimentary
- **A1** reason: formed from deposited sediments that can include and preserve remains such as shells cao
- Answer: **Sedimentary rock, because sediments can bury and preserve shells and other remains.**

Question 14

- **M1** identify rock as metamorphic
- **M1** change 1: minerals recrystallise, forming new crystals or mineral bands
- **A1** change 2: rock becomes more compact and harder due to heat and pressure altering structure cao
- Answer: **Metamorphic rock. Minerals recrystallise forming new mineral bands, and the rock becomes more compact and harder from heat and pressure.**

Question 15

- **M1** state that extracting from ore requires heating, smelting and chemical processes that use lots of energy
- **A1** recycling uses less processing and lower temperatures so less energy is needed cao
- Answer: **Extracting from ores needs high-temperature smelting and chemical processing which uses lots of energy; recycling uses lower temperature processes and less processing, so it saves energy.**

Question 16

- **M1** convert mass to grams: 2.7 kg = 2700 g and volume to cm^3: 1.0 L = 1000 cm^3
- **M1** substitute into density = mass / volume: 2700 / 1000
- **A1** answer 2.7 g/cm^3 cao
- **A1** correct unit g/cm^3
- Answer: **2.7 g/cm^3**

Question 17

- **B1** one correct problem: habitat destruction, soil and water pollution, acid mine drainage, landscape scarring, CO2 emissions from processing, oe
- Answer: **Mining can cause water pollution, for example acid mine drainage contaminating streams.**

Question 18

- **Level 3** (5-6): Detailed evaluation with several advantages and disadvantages linked to science. Clear, justified conclusion that weighs environmental and social factors and refers to energy savings and pollution control.
- **Level 2** (3-4): Some relevant advantages and disadvantages with some linked reasons. A conclusion is given but it may be partially supported.
- **Level 1** (0-2): Simple statements of advantage or disadvantage with little or no scientific explanation. No supported conclusion.
- **Indicative content:**
  - Advantages: recycling reduces need to extract metal from ores, saving energy and lowering CO2 emissions; reduces mining damage to landscapes and habitats; can reduce landfill; creates local jobs.
  - Disadvantages: recycling plant may produce noise, dust or local air pollution; risk of contamination of water if not managed; increased traffic for collection and processing; energy still needed for melting.
  - Scientific links: extraction from ores uses smelting and high heat whereas recycling requires lower temperatures; corrosion issues mean recycled metals may need treatment; recycled metal supply reduces pressure on rock mining and quarrying.
  - Conclusion: a supported judgement weighing local environmental controls and benefits of energy saving and reduced mining; e.g. support if strict pollution controls, noise limits and community benefits are in place, otherwise recommend further mitigation.