PHYSICAL SCIENCES

Grade 11

TERM 4

RESOURCE PACK

Contents

WORKSHEETS

Topic 14: Exploiting the Lithosphere

WORKSHEET

MULTIPLE CHOICE

1. Which metal is commonly used to coat iron to prevent rusting?

A Cobalt

B Zinc

C Copper

D Magnesium (2)

2. Gold is an unreactive metal. Which of the following is **true**?

A It is usually found in nature as pure nuggets.

B It forms an amalgam with mercury.

C It rusts to form an attractive gold oxide compound.

D It is almost impossible to extract and refine. (2)

3. Which of the following is the main greenhouse gas that comes from the burning of fossil fuels?

A CO_2

B CH_4

C N_2O

D CO (2)

4. Which of the following correctly calculated the mass of iron in 10 g of Fe_2O_3?

A $\frac{10}{2(56) + 3(16)} \times 2(56)$

B $\frac{10}{(56) + (16)} \times (56)$

C $\frac{10}{2(56) \times 3(16)} \times \frac{2(56)}{} = \frac{10}{3(16)}$

D $\frac{10}{2(26) \times 3(8)} \times 2(26)$ (2)

LONG QUESTIONS

5. Extraction of iron and rusting are in some ways opposite reactions.

$Fe_2O_3 + CO \rightarrow Fe + CO_2$

$Fe + O_2 + H_2O \rightarrow Fe_2O_3 \cdot nH_2O$

5.1 What is the name of Fe_2O_3? (1)

5.2 In the formula $Fe_2O_3 \cdot nH_2O$ what is meaning of nH_2O? (2)

5.3 What is the oxidation number of the iron in Fe_2O_3 ? (2)

5.4 What is the oxidation number of the iron in Fe? (2)

5.5 Thus is $Fe_2O_3 \rightarrow Fe$ an oxidation or reduction half reaction? (2)

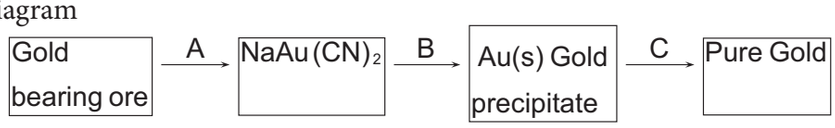
5.6 Why does iron rust faster at the sea-side than at dry interior parts of the country? (2)

5.7 What would some advantages and disadvantages be of recycling rusted iron instead of mining it? Mention four factors. (4)

CONSOLIDATION QUESTIONS

TOTAL: 32 MARKS

1. Gold is mined and then extracted from its ore, according to the following simplified flow diagram



1.1 There is evidence that in South Africa gold was worked as early gold as 1200 (at Mapungubwe.) Those early pioneers in gold products did not use a similar process to the one on the flow diagram. Explain why they did not need to use this type of process. (2)

1.2 Name the process indicated by arrow A. (1)

1.3 During process A, gold is extracted from its ore. Is the gold oxidised or reduced in this process? (1)

1.4 Use oxidation numbers to explain your answer to 1.3 above. (3)

1.5 Explain a potential danger of using the cyanide process? (2)

1.6 **Name** the chemical used in process B. (1)

1.7 Process C illustrates smelting, which normally occurs in two stages.

1.7.1 What is meant by the term "smelting"? (2)

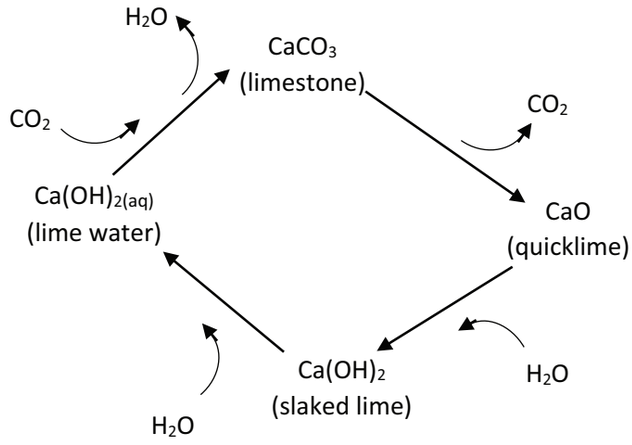
1.7.2 Why is flux added to the gold when it is smelted? (2)

1.7.3 After the first smelting, the gold is about 85% pure and is referred to as "bullion gold." This bullion gold is further refined by a second smelting or by electroplating.

What is the economic advantage of exporting only purer gold, which has been smelted twice? (3)

2. Limestone is a form of calcium carbonate and is a very useful mineral mined in South Africa.

It can also undergo chemical reactions, as indicated by the following cycle.



2.1 The chemical reaction for converting limestone to quicklime is:

$$CaCO_3 \rightarrow CaO + CO_2$$

2.1.1 What is the name of the second product in this reaction? (1)

2.1.2 What is done to the limestone to cause this reaction to occur? (1)

2.1.3 If 500 g of $CaCO_3$ reacts completely, what mass of CaO is produced? (5)

2.2 Quicklime (CaO) reacts with water to form slaked lime. Write down a balanced reaction equation for this reaction. (2)

2.3 Is slaked lime soluble in water? Explain your answer. (2)

2.4 Lime water is used as an important test for a gas?

2.4.1 What gas can it be used to test for? (1)

2.4.2 Give the balanced equation for the reaction that takes place when this gas reacts with the lime water. (3)

WORKSHEET MEMORANDUM

1. B✓ This process is known as galvanising and is very important way of preventing the rusting of iron. (2)

2. B✓✓ Although gold is unreactive, and does not rust easily, it can form amalgams (which is why mercury was used to extract it at one stage.) However, most gold is found in gold bearing ores where the gold is scattered in large amounts of rock – often about 5 g of gold per ton of rock. (2)

3. A✓✓ While A, B and C are all greenhouse gases, CO_2 is a product of the combustion of fossil fuels. (2)

4. A✓✓ This is a quantitative question, which is looking for the correct method of essentially calculating the percentage composition. The atomic mass of each element must be used and the formula mass worked out correctly. (2)

5.1 Iron oxide✓ (1)

5.2 nH_2O refers to waters✓ of crystallisation.✓ There is a varying (or unknown) number of water molecules trapped in the crystal structure, with *n* water molecules for every two Fe_2O_3 formula units. (2)

5.3 +3✓✓ (Each oxygen has an oxidation number of –2.) (2)

5.4 0 ✓✓ (Fe is in its elemental state.) (2)

5.5 It is a reduction half reaction. (However the half reaction equation is incomplete. The complete reaction would show the iron III ion gaining 3 electrons.) (2)

5.6 Better at the sea-side because rust requires waters of crystallisation✓, which requires moisture/water✓ to be available. (2)

5.7 Advantages of recycling – should be cheaper, requires no extraction from an ore, only chemical processing; environmentally helpful as landfill will not be filled with rusted objects (any acceptable answer.)

Disadvantages – loss of jobs in the mining sector; difficulty in obtaining commercially viable quantities (any acceptable answer.)

1 ✓each – max 4 (4)

CONSOLIDATION QUESTIONS MEMORANDUM

TOTAL: 32 MARKS

1. They used alluvial gold✓/gold nuggets, which did not need✓ to be extracted via this process. (Also that technology was not available.) (2)

1.2. Leaching✓ (Also called cyanidation.) (1)

1.3 Oxidised✓ 1)

1.4 Au – oxidation number is 0✓; in $NaAu(CN)_2$ Au has an oxidation number of +1. ✓
The oxidation number of Au has increased, therefore Au has been oxidised. ✓ (3)

1.5 Cyanide is a poisonous substance✓ and any leakage would poison the environment.✓ HCN is a very toxic gas, and NaCN is a very soluble salt that can poison water ways. (2)

1.6 Zinc ✓ (Activated carbon can also be used.) (1)

1.7.1 Smelting is to extract a metal from an ore by heating and melting.✓✓ (2)

1.7.2 Flux is added to reduce the melting point✓ and to react with other impure metals. ✓ (2)

1.7.3 The purer gold is sold for a much higher price✓: we are able to recover more money for our gold✓: we don't pay for the transport cost of a less pure substance.✓(Any acceptable answers.) (3)

2.1.1 Carbon dioxide✓ (1)

2.1.2 It is heated.✓ (1)

2.1.3 $n(CaCO_3) = \frac{m}{M}$

$= \frac{500}{(40 + 12 + 3(16))}$ ✓

$= 5,0 \text{ mol}$ ✓

Therefore n (CaO) = 5,0 mol ✓

$m = nM$

$=5,0 \times (40 + 16)$ ✓

$=280\text{g}$ ✓ (5)

2.2 $CaO + H_2O$✓→ $Ca(OH)_2$✓ (2)

2.3 Yes,✓ according to the diagram it can dissolve to form lime water.✓ (2)

2.4.1 CO_2 (carbon dioxide)✓ (1)

2.4.2 $Ca(OH)_2 + CO_2$✓→ $CaCO_3$✓+ H_2O✓ (3)

ASSESSMENTS

Topic 14: Exploiting the Lithosphere

QUESTIONS

MULTIPLE CHOICE QUESTIONS

1. In which layer(s) of the Earth are most of our minerals found?
   A Crust
   B Inner mantle
   C Upper mantle
   D Crust and outer part of the upper mantle (2)

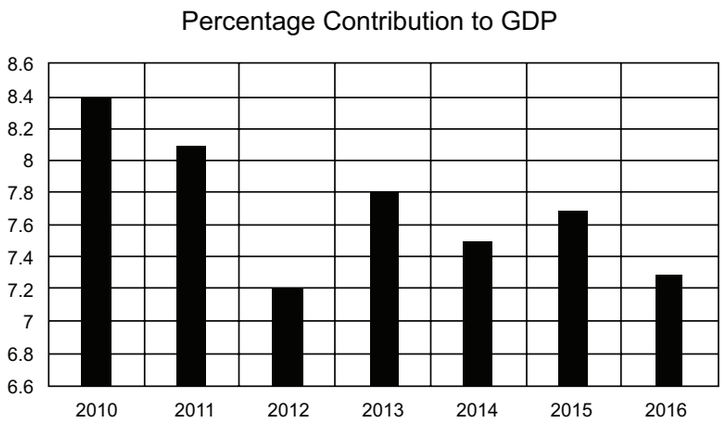
2. During the extraction of gold, zinc powder is added to gold cyanide solution, according to the following equation:
   $$2Au(CN)_2^- + Zn \rightarrow 2Au + Zn^{2+} + 2CN^-$$
   Which of the following substances is the reducing agent in this reaction?
   A Au^+
   B Zn
   C CN^-
   D Au (2)

3. Carbon dioxide (CO_2) is a common product of the combustion of fossil fuels. Which of the following gives the best reason why excessive CO_2 is considered harmful to our environment.?
   A CO_2 damages the ozone layer.
   B CO_2 causes trees to grow as they photosynthesize.
   C CO_2 is a greenhouse gas and can increase the temperaure of the Earth.
   D Solid CO_2 is dry ice which can burn people if they hold it. (2)

4. Consider the balanced reaction equation which represents the reduction of iron oxide to iron:
   $$2Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2$$
   Which of the following can be correctly inferred from the equation?
   A 2 kilograms of iron oxide will produce 4 kilograms of iron.
   B 2 moles of iron oxide will produce 3 moles of carbon dioxide.
   C The production of iron is exothermic.
   D The reaction of iron oxide and carbon is spontaneous. (2)

LONG QUESTIONS

1. Mining is a very important contributor to the economy of South Africa. The graph below (Graph 1) shows the percetnage contribution from mining to South Africa's GDP (which is a meaure of the economy.) [Information sourced from *Chamber of mines: facts and figures 2016*]



Graph 1: Graph to show the percentage contribution from mining to South Africa's GDP

1.1 Copy the table below, and complete it with reference to Graph 1.

Year	% composition from mining to the GDP
2010	8,4
	8,1
2012	
2014	
2015	
2016	7,3

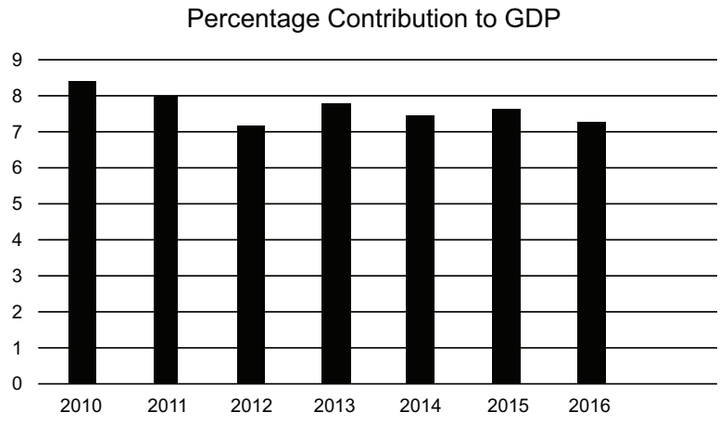
(5)

1.2 Describe the trend of mining's contribution to the economy over this period. (2)

1.3 What impact could this trend have on South Africa? (2)

ASSESSMENTS

1.4. A second representation of the same data is given below.



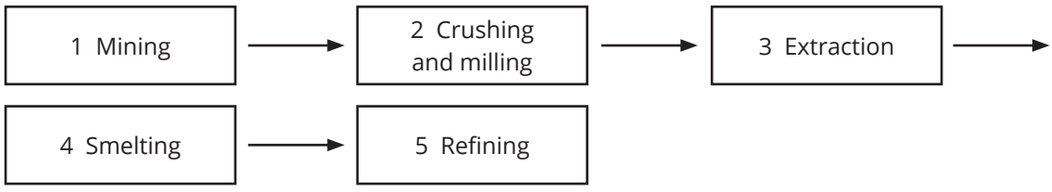
Graph 2: Graph to show the percentage contribution from mining to South Africa's GDP

1.4.1 Why do the graphs look differrent? (2)

1.4.2 Which graph show the change in percentage contribution more clearly? (1)

1.4.3 Which graph is a better representation of the data? Explain your answer. (3)

2. The stages of mining and extracting gold are given in the flow diagram shown below.



2.1 What are the two major types of mining used in South Africa? (2)

2.2. The extraction process often uses the following chemical reaction:

$$4Au + 8\,CN^- + O_2 + 2H_2O \rightarrow 4[Au(CN)_2^-] + 4\,OH^-$$

2.2.1 The cyanide ion (CN^-) is very useful for extracting gold. However, there are significant dangers in using the cyanide ion. Explain what some of these are. (2)

2.2.2 What mass of cyanide ion would be needed to react with 2 kg of gold? (4)

2.2.3 The cyanide ion is often added as sodium cyanide.

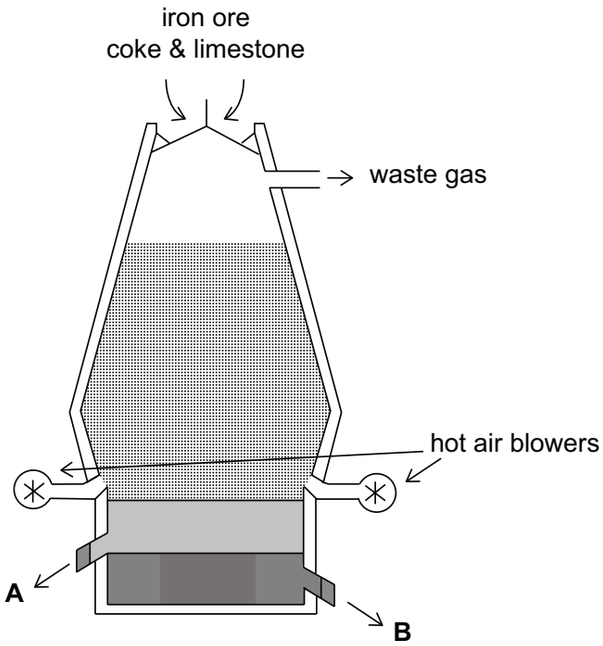
a) Give the formula for sodium cyanide. (1)

b) What mass of sodium cyanide is needed fto react with 2 kg of gold? Use your answer in 2.2.2 to calculate the mass required. (2)

2.3 Give 2 benefits of mining. (2)

2.4 Give 2 potential disadvantages of mining. (2)

3. Iron is produced in a blast furnace by reacting iron oxide with coke (carbon) and limestone at very high temperatures. Several reactions take place in the blast furnace.



Source: https://www.mrcorfe.com/KS4/Applied/Unit2/CountrysideEnvironment/ManEnvrion/BlastFurnace.php

3.1 Where does the molten iron escape from the furnace? (A or B.) (1)

3.2 The reaction that occurs in this furnace is often given as:

$$Fe_2O_3 + CO \rightarrow Fe + CO_2$$

3.2.1 Balance this reaction equation. (2)

3.2.2 Which of the materials added the furnace produce the CO that reacts with the iron oxide? (2)

3.2.3 What is the name of CO? (1)

3.2.4 What is the function of the CO is this reaction? (2)

3.2.5 Give the name of one waste gas. (1)

3.2.6 Limestone is added to the blast furnace.

a) What is the chemical formula for limestone? (1)

b) What is the function of limestone? (1)

c) What product does the reacted limestone form and where does this product escape? (2)

3.2.7 What volume of carbon dioxide at STP would be produced in the making of 1 ton (1 000 kg) of iron? (4)

MARKING GUIDELINES

MULTIPLE CHOICE

1. D ✓✓ Minerals are found in two layers. This is a rote question. [CL1] (2)
2. B ✓✓ Zn is oxidised to Zn^{2+}. [CL2] (2)
3. C ✓✓ A is a common misconception. Both B and D are true but not relevant to the question. [CL2] (2)
4. B ✓✓ This is very important, as learners need to understand that the balancing of an equation gives the mole ratios. Neither C nor D can be deduced from the equation. [CL2] (2)

LONG QUESTIONS

1.1

Year	% composition from mining to the GDP
2010	8,4
2011	8,1
2012	7.2 ✓
2013 ✓ (for both years correct)	7.8 ✓
2014	7.5 ✓
2015	7.7 ✓
2016	7,3

[CL1] (5)

1.2 Mining's contribution to the economy is generally decreasing ✓ but not uniformly.✓ [CL3] (2)

1.3 The decline could have a negative impact✓ as there will be less money✓ in the economy. [CL3] (2)

1.4.1 The 2nd graph is plotted from zero.✓✓ [CL2] (2)

1.4.2 The change is seen easier in the 1st graph.✓ [CL3] (1)

1.4.3 The learners can say Graph 1, because it shows the change✓ from year to year ✓clearly. (2 max)
OR they can say Graph 2, because it gives all the data and it shows the real effect✓of the change ✓from year to year by showing the 0. ✓ (3 max) [CL4] (3)

2.1 Open cast✓ and underground/deep level✓ [CL1] (2)

2.2. 2.2.1 The cyandide ion is toxic ✓ and must not be allowed to escape/pollute any of the waste, including the waste water. ✓ [CL2] (2)

2.2.2 Given: m (Au)=2 000 g

M (Au)= 197 g·mol^{-1}

$$n = \frac{m}{M} = \frac{2\,000}{197} = 10,15 \text{ mol}✓$$

From the balanced equation:

$$4Au + 8CN^- + O^2 + 2H_2O \rightarrow 4Au(CN)_2^- + 4OH^-$$

the mole ratio Au : CN^- = 4 : 8 = 1 : 2

therefore 10,15 mol Au requires 20,30 mol CN- ions.✓

m (CN^-)= nM=20,30 × (12 + 14)✓ = 527 g ✓ [CL3] (4)

2.2.3 a) NaCN ✓ [CL1] (1)

b) n (NaCN) = 20,30 mol

M (NaCN) = 23 + 12 + 14 = 49 g·mol^{-1}✓

$m = nM$ = 20,30 × 49 = 995 g✓

[CL2] (2)

2.3 Mining is a major employer, it gives us export products; it buys machinery etc. from suppliers and supports the economy, it provides valuable products (Any two acceptable answers.) ✓✓ [CL2] (2)

2.4 Mining often uses unskilled labour. Mining is often dangerous can lead to the workers being injured or killed; it can harm the environment directly or indirectly. (Other reasonable answers accepted.) [CL2] (2)

3.1 B ✓ [CL1] (1)

3.2 3.2.1 $Fe_2O_3 + 3CO$ ✓→ $2Fe + 3CO_2$ ✓ [CL2] (2)

3.2.2 The coke ✓ (the carbon); oxygen ✓ (from the air/hot air blowers). [CL2] (2)

3.2.3 Carbon monoxide [CL1] (1)

3.2.4 The CO is a reducing agent. ✓✓ [CL3] (2)

3.2.5 Carbon dioxide ✓ [CL1] (1)

ASSESSMENTS

3.2.6 a) $CaCO_3$ ✓ [CL2] (1)

b) It reacts with impurities. ✓ [CL2] (1)

c) It forms the slag ✓ and escapes through A. ✓ [CL2] (2)

3.2.7 Given: m (Fe)=1 000 000 g

M (Fe) = 56 g·mol^{-1}

$$n = \frac{m}{M} = \frac{1\,000\,000}{56} = 17\,857 \text{ mol}✓$$

From the balanced equation the mole ratio Fe : CO_2^- = 2 : 3

therefore n (CO_2) = 26 786 mol ✓

$V = n \times 22{,}4 = 26\,786 \times 22{,}4✓ = 600\,006$ dm^3 ✓

[CL3] (4)