

Past-paper walk-through

Extraction of metals ■ 9.6

eXercise

Questions in this set

- 0620/21 N25 Q29 ■ 1 mark
- 0620/22 N25 Q28 ■ 1 mark
- 0620/22 N25 Q29 ■ 1 mark
- 0620/23 N25 Q32 ■ 1 mark
- 0620/23 N25 Q33 ■ 1 mark
- 0620/42 N25 Q2 ■ 19 marks
- 0620/21 J25 Q28 ■ 1 mark
- 0620/22 J25 Q28 ■ 1 mark
- 0620/22 M25 Q30 ■ 1 mark

Reading the mark scheme

- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- **//** separates answers the examiner accepts equally.
- **ecf** = error carried forward: a later part is marked on your own earlier answer.
- **owtte** = “or words to that effect” – the wording need not match.

Question 29

0620/21 N25 ■ Q29 ■ 1 mark

- 29** Which statement about the extraction of aluminium by electrolysis is correct?
- A** Aluminium oxide is dissolved in molten cryolite to increase its melting point.
 - B** At the cathode, oxygen ions lose electrons to form oxygen gas.
 - C** The carbon in the graphite anode reacts with oxygen gas forming carbon dioxide.
 - D** The reaction at the anode is $\text{Al}^{3+} + 3\text{e}^{-} \rightarrow \text{Al}$.

Solution 29

Answer: **C**

Why

- Cryolite is added to *lower* the melting point, saving energy.
- Oxide ions are negative, so they travel to the *anode* and lose electrons there.
- Aluminium ions are positive, so they gain electrons at the cathode to form the metal.

Question 28

0620/22 N25 ■ Q28 ■ 1 mark

28 Iron is extracted from hematite in the blast furnace.

Which reaction increases the temperature in the blast furnace to over 1500 °C?

- A** calcium carbonate $\rightarrow$ calcium oxide + carbon dioxide
- B** calcium oxide + silicon(IV) oxide $\rightarrow$ calcium silicate
- C** carbon + oxygen $\rightarrow$ carbon dioxide
- D** carbon dioxide + carbon $\rightarrow$ carbon monoxide

Solution 28

Answer: **C**

Why

- The heat comes from burning the coke in the blast of hot air.
- $\text{C} + \text{O}_2 \rightarrow \text{CO}_2$ is strongly exothermic and raises the furnace above 1500°C .
- Decomposing the limestone absorbs energy, so it cools the furnace rather than heating it.

Question 29

0620/22 N25 ■ Q29 ■ 1 mark

29 Aluminium is extracted by the electrolysis of purified bauxite.

Which row shows the half-equations at the electrodes and explains why one of the electrodes has to be replaced regularly?

	half-equation at anode	half-equation at cathode	electrode replacement
A	$2\text{O}^{2-} \rightarrow \text{O}_2 + 4\text{e}^-$	$\text{Al}^{3+} + 3\text{e}^- \rightarrow \text{Al}$	cathode replaced as it gets coated with aluminium
B	$2\text{O}^{2-} \rightarrow \text{O}_2 + 4\text{e}^-$	$\text{Al}^{3+} + 3\text{e}^- \rightarrow \text{Al}$	anode replaced as it burns away in oxygen
C	$\text{Al}^{3+} + 3\text{e}^- \rightarrow \text{Al}$	$2\text{O}^{2-} \rightarrow \text{O}_2 + 4\text{e}^-$	cathode replaced as it burns away in oxygen
D	$\text{Al}^{3+} + 3\text{e}^- \rightarrow \text{Al}$	$2\text{O}^{2-} \rightarrow \text{O}_2 + 4\text{e}^-$	anode replaced as it gets

Question 29

			coated with aluminium
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Solution 29

Answer: **B**

Why

- At the anode oxide ions lose electrons: $2\text{O}^{2-} \rightarrow \text{O}_2 + 4\text{e}^-$.
- At the cathode aluminium ions gain electrons: $\text{Al}^{3+} + 3\text{e}^- \rightarrow \text{Al}$.
- The oxygen made at the anode burns the hot carbon away as CO_2 , which is why that electrode needs replacing.

Question 32

0620/23 N25 ■ Q32 ■ 1 mark

32 Iron is extracted from iron(III) oxide in the blast furnace.

Three steps in the process are listed.

- 1 Carbon (coke) is completely oxidised.
- 2 Iron(III) oxide is reduced.
- 3 Carbon dioxide is reduced to carbon monoxide.

What is the correct order of the steps in the extraction of iron?

- A** 1 → 2 → 3 **B** 1 → 3 → 2 **C** 2 → 1 → 3 **D** 3 → 1 → 2

Solution 32

Answer: **B**

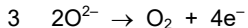
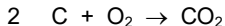
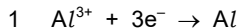
Why

- The coke burns first in the hot air blast: $\text{C} + \text{O}_2 \rightarrow \text{CO}_2$.
- That carbon dioxide is then reduced by more hot coke to carbon monoxide.
- The carbon monoxide finally reduces the iron(III) oxide, so the order is 1, 3, 2.

Question 33

0620/23 N25 ■ Q33 ■ 1 mark

33 Three different reactions that occur during the extraction of aluminium from purified bauxite are listed.



Which reactions occur at the anode?

A 1 and 2

B 1 only

C 2 and 3

D 3 only

Solution 33

Answer: **C**

Why

- Oxidation happens at the anode, so look for electrons being *lost*.
- Reaction 3 has oxide ions losing electrons, so it is at the anode.
- Reaction 2 is the oxygen made there attacking the carbon anode, so it happens at the anode too; reaction 1 is the cathode.

Question 2

0620/42 N25 ■ Q2 ■ 19 marks

- 2** Iron is extracted from iron ore in a blast furnace.
- (a)** The iron compound in the main iron ore used in the blast furnace is iron(III) oxide.
- (i)** State the name of the main iron ore used in the blast furnace.

Question 2

- (ii) State how the main source of heat is provided in the blast furnace.

Question 2

(iii) Name the gaseous reducing agent in the blast furnace.

Question 2

- (iv) Write a symbol equation for the reduction of iron(III) oxide by the gaseous reducing agent in (a)(iii).

Question 2

- (v) The main impurity in iron ore is silicon(IV) oxide.

Write **two** symbol equations to show the role of limestone in removing silicon(IV) oxide from iron ore.

Question 2

Question 2

[2]

(b) Table 2.1 shows four different isotopes of iron, **A**, **B**, **C** and **D**.

Table 2.1

A	B	C	D
^{54}Fe	^{56}Fe	^{57}Fe	^{58}Fe

Explain why **A**, **B**, **C** and **D** are isotopes of iron.

Question 2

(c) Iron can form two different ions, Fe^{2+} and Fe^{3+} .

(i) Complete Table 2.2 to show the number of protons, neutrons and electrons in the two iron ions shown.

Table 2.2

	$^{54}\text{Fe}^{2+}$	$^{58}\text{Fe}^{3+}$
protons		
neutrons		
electrons		

Question 2

[3]

Question 2

- (ii) Describe a test for aqueous Fe^{2+} ions.

Question 2

[2]

(d) An oxidising agent converts Fe^{2+} ions to Fe^{3+} ions.

(i) Define the term oxidising agent.

Question 2

- (ii) Explain why the conversion of Fe^{2+} ions to Fe^{3+} ions is described as oxidation.

Question 2

- (iii) The oxidising agent for the conversion of Fe^{2+} ions to Fe^{3+} ions is aqueous potassium manganate(VII).

State **one** condition needed for the oxidation to take place.

Question 2

(e) Iodide ions, I^- , reduce Fe^{3+} ions to Fe^{2+} ions in aqueous solution.

Suggest the identity of the other product formed in this reaction.

Question 2

[Total: 19]

Solution 2

(a)(i)

Mark scheme

- hematite
- 1

Solution 2

(a)(ii)

Mark scheme

- burning of carbon (coke)
- 1
- 0620/42
- October/November 2025

Solution 2

(a)(iii)

Mark scheme

- carbon monoxide
- 1

Solution 2

(a)(iv)

Mark scheme

- $3\text{CO} + \text{Fe}_2\text{O}_3 \rightarrow 2\text{Fe} + 3\text{CO}_2$ (M1)
- species (M2)
- correct equation
- 2

Solution 2

(a)(v)

Mark scheme

- M1 $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$ M2
- $\text{CaO} + \text{SiO}_2 \rightarrow \text{CaSiO}_3$
- 2

Solution 2

(b)

Mark scheme

- M1 atoms of the same element that have the same number of protons **M2**
- but different numbers of neutrons
- 2

Solution 2

(c)(i)

Mark scheme

- $p = 26$ and 26
- $n = 28$ and 32
- $e = 24$ and $23/3$

Solution 2

(c)(ii)

Mark scheme

- M1 NaOH(aq) OR NH₃(aq) (M2)
- green ppt.
- (insoluble in excess, ppt. turns brown near surface on standing)
- 2

Solution 2

(d)(i)

Mark scheme

- a substance that oxidises another substance and is itself reduced (M1)
- 'a substance' oxidises another substance (M2)
- is itself reduced
- 2

Solution 2

(d)(ii)

Mark scheme

- loss of (one) electron
- 1

(d)(iii)

Mark scheme

- acidified
- 1

Solution 2

(e)

Mark scheme

- iodine
- 1
- 0620/42
- October/November 2025

Question 28

0620/21 J25 ■ Q28 ■ 1 mark

28 Which process is used in the extraction of iron from hematite?

- A** electrolysis
- B** precipitation
- C** reduction
- D** fractional distillation

Solution 28

Answer: **C**

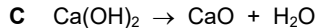
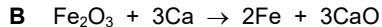
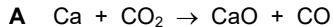
Why

- Hematite is iron(III) oxide, so the iron has to lose its oxygen.
- Loss of oxygen is reduction, done by carbon monoxide in the blast furnace.
- Electrolysis is reserved for more reactive metals such as aluminium.

Question 28

0620/22 J25 ■ Q28 ■ 1 mark

28 Which equation represents a reaction that occurs in a blast furnace during the extraction of iron from hematite?



Solution 28

Answer: **D**

Why

- Hematite is iron(III) oxide, and it is reduced by carbon monoxide.
- $\text{Fe}_2\text{O}_3 + 3\text{CO} \rightarrow 2\text{Fe} + 3\text{CO}_2$ – three CO per Fe_2O_3 .
- Calcium compounds are involved in removing the sandy impurities, not in reducing the ore.

Question 30

0620/22 M25 ■ Q30 ■ 1 mark

30 Which row gives the symbol equation for the formation of carbon monoxide and for the reduction of iron(III) oxide in a blast furnace?

	equation for the formation of carbon monoxide	equation for the reduction of iron(III) oxide
A	$2\text{C} + \text{O}_2 \rightarrow 2\text{CO}$	$\text{FeO} + \text{CO} \rightarrow \text{Fe} + \text{CO}_2$
B	$\text{CO}_2 + \text{C} \rightarrow 2\text{CO}$	$\text{FeO} + \text{CO} \rightarrow \text{Fe} + \text{CO}_2$
C	$\text{C} + \text{O}_2 \rightarrow \text{CO}_2$	$\text{Fe}_2\text{O}_3 + 3\text{CO} \rightarrow 2\text{Fe} + 3\text{CO}_2$
D	$\text{CO}_2 + \text{C} \rightarrow 2\text{CO}$	$\text{Fe}_2\text{O}_3 + 3\text{CO} \rightarrow 2\text{Fe} + 3\text{CO}_2$

Solution 30

Answer: **D**

Why

- Carbon monoxide forms when hot coke reduces carbon dioxide: $\text{C} + \text{CO}_2 \rightarrow 2\text{CO}$.
- That carbon monoxide then reduces the ore: $\text{Fe}_2\text{O}_3 + 3\text{CO} \rightarrow 2\text{Fe} + 3\text{CO}_2$.
- Check the balancing – iron(III) oxide needs three CO, not one.