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 $Al^{3+} + 3e^- \rightarrow Al$.

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 → calcium oxide + carbon dioxide

B calcium oxide + silicon(IV) oxide → calcium silicate

C carbon + oxygen → carbon dioxide

D carbon dioxide + carbon → carbon monoxide

Solution 28

Answer: **C**

Why

- The heat comes from burning the coke in the blast of hot air.
- $C + O_2 \rightarrow CO_2$ is strongly exothermic and raises the furnace above $1500\,^{\circ}C$.
- 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	$2O^{2-} \rightarrow O_2 + 4e^-$	$Al^{3+} + 3e^- \rightarrow Al$	cathode replaced as it gets coated with aluminium
B	$2O^{2-} \rightarrow O_2 + 4e^-$	$Al^{3+} + 3e^- \rightarrow Al$	anode replaced as it burns away in oxygen
C	$Al^{3+} + 3e^- \rightarrow Al$	$2O^{2-} \rightarrow O_2 + 4e^-$	cathode replaced as it burns away in oxygen
D	$Al^{3+} + 3e^- \rightarrow Al$	$2O^{2-} \rightarrow O_2 + 4e^-$	anode replaced as it gets

Question 29

Solution 29

Answer: **B**

Why

- At the anode oxide ions lose electrons: $2O^{2-} \rightarrow O_2 + 4e^-$.
- At the cathode aluminium ions gain electrons: $Al^{3+} + 3e^- \rightarrow Al$.
- 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 $1 \rightarrow 2 \rightarrow 3$ **B** $1 \rightarrow 3 \rightarrow 2$ **C** $2 \rightarrow 1 \rightarrow 3$ **D** $3 \rightarrow 1 \rightarrow 2$

Solution 32

Answer: **B**

Why

- The coke burns first in the hot air blast: $C + O_2 \rightarrow CO_2$.
- 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.

1 $Al^{3+} + 3e^- \rightarrow Al$

2 $C + O_2 \rightarrow CO_2$

3 $2O^{2-} \rightarrow O_2 + 4e^-$

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

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

[2]

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

- $3CO + Fe2O3 \rightarrow 2Fe + 3CO2$ M1
- species M2
- correct equation
- 2

Solution 2

(a)(v)

Mark scheme

- M1 $CaCO3 \rightarrow CaO + CO2$ M2
- $CaO + SiO2 \rightarrow CaSiO3$
- 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?

A $Ca + CO_2 \rightarrow CaO + CO$

B $Fe_2O_3 + 3Ca \rightarrow 2Fe + 3CaO$

C $Ca(OH)_2 \rightarrow CaO + H_2O$

D $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

Solution 28

Answer: **D**

Why

- Hematite is iron(III) oxide, and it is reduced by carbon monoxide.
- $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$ – 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	$2C + O_2 \rightarrow 2CO$	$FeO + CO \rightarrow Fe + CO_2$
B	$CO_2 + C \rightarrow 2CO$	$FeO + CO \rightarrow Fe + CO_2$
C	$C + O_2 \rightarrow CO_2$	$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$
D	$CO_2 + C \rightarrow 2CO$	$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

Solution 30

Answer: **D**

Why

- Carbon monoxide forms when hot coke reduces carbon dioxide: $C + CO_2 \rightarrow 2CO$.
- That carbon monoxide then reduces the ore: $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$.
- Check the balancing – iron(III) oxide needs three CO, not one.