Chemistry · Transition Elements

Iron Metal

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Multiple choice questions — 54 questions

1 Which of the following statements is NOT correct?

(A) Natural iron compounds are mixed with impurities.

(B) The suitability of an iron ore is determined by its iron percentage and the composition of its impurities.

(C) The percentage of iron in the Earth's crust is less than that of aluminium.

(D) Iron is not found in the free state in meteorites.

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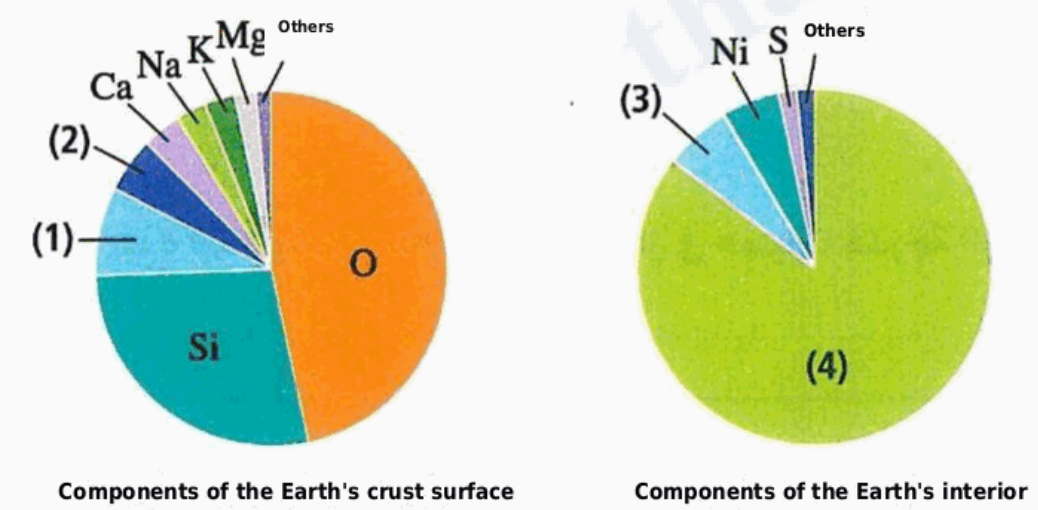
2 What is the approximate mass of iron in a meteorite of mass (14150 kg)?

(A) 545.72 kg (B) 721.65 kg (C) 12735 kg (D) 1400 kg

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3 The following two figures show the percentages of the components of the Earth's interior and of the Earth's crust surface:

The numbers that show the percentage of iron in the Earth's interior and in the Earth's crust surface, respectively, are .....



(A) (3) , (2) (B) (4) , (1) (C) (4) , (2) (D) (1) , (3)

---

4 The following are ores of the metal used in electricity pylons, except .....

(A) magnetite. (B) magnesite. (C) siderite. (D) limonite.

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5 The opposite figure shows one of the stones known as .....



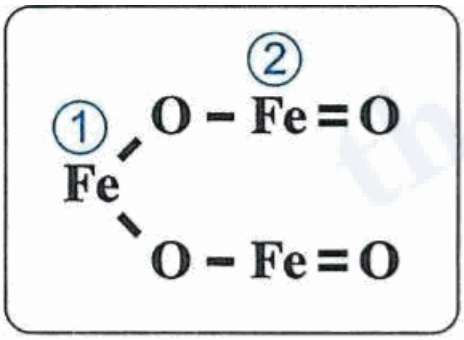
(A) haematite. (B) limonite. (C) magnetite. (D) siderite.

---

6 From the opposite chemical formula:

What is the electron configuration of each of the ions (1) and (2)?

And from which ore is this compound extracted?



(A) Ion (1): [Ar], $3d^6$, ion (2): [Ar], $3d^5$, ore: magnetite

(B) Ion (1): [Ar], $3d^5$, ion (2): [Ar], $3d^6$, ore: magnetite

(C) Ion (1): [Ar], $3d^6$, ion (2): [Ar], $3d^5$, ore: haematite

(D) Ion (1): [Ar], $3d^5$, ion (2): [Ar], $3d^6$, ore: haematite

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7 Haematite ore becomes worthless if it contains a large percentage of element (X), while its value increases greatly if it contains 5 : 15% of element (Y).

Which of the following is correct?

(A) (X): sodium , (Y): manganese. (B) (X): sodium , (Y): sulphur.

(C) (X): phosphorus , (Y): sulphur. (D) (X): phosphorus , (Y): manganese.

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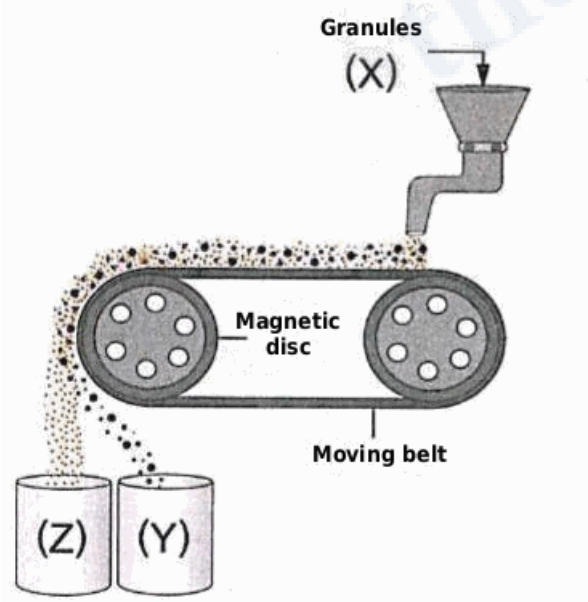
8 The opposite figure shows a rock of the Earth's crust that contains one of the iron ores.
Which of the following describes this ore?



(A) Iron is mostly extracted from it by electrolysis.
(B) The percentage of iron in it is greater than in the other iron ores.
(C) It has diamagnetic properties.
(D) The iron ion in it cannot be oxidized.

---

9 The opposite figure shows one of the processes of preparing iron ores.
Which of the following is correct?



(A) (X): the iron ore before crushing.
(B) (X): the iron ore before sintering.
(C) (Y): the iron ore granules.
(D) (Z): the iron granules.

---

10 Separating impurities from iron ores without any chemical change is the process of .....

(A) roasting.
(B) sintering.
(C) reduction.
(D) electric separation.

11 Each of the following improves the physical and mechanical properties of iron ores, except .....

(A) increasing their surface area.
(B) decreasing their surface area.
(C) magnetic separation.
(D) oxidizing some impurities.

12 Each of the following happens when hydrated iron(III) oxide is heated, except .....

(A) a colour change.
(B) a decrease in mass.
(C) an increase in the percentage of iron.
(D) a change in the oxidation number of the cation.

13 The process that changes the percentage of iron in its ores is .....

(A) cutting the ores into equal sizes.
(B) crushing.
(C) using surface tension to purify the ore.
(D) sintering.

14 When siderite ore is roasted, ... is formed.

(A) FeO
(B) Fe_3O_4
(C) Fe_2O_3
(D) $Fe(OH)_2$

15 Which of the following is correct when a certain mass of limonite ore is heated?

(A) The mass of iron increases and the mass of the sample decreases.
(B) The mass of iron increases and the mass of the sample increases.
(C) The percentage of iron increases and the mass of the sample decreases.
(D) The percentage of iron increases and the mass of the sample increases.

16 Which of the following shows the decrease and the increase that happen in an iron ore as a result of roasting?

(A) Decrease in: the mass of iron , increase in: the concentration of iron in the ore
(B) Decrease in: the mass of the ore , increase in: the concentration of iron in the ore
(C) Decrease in: the impurities of the ore , increase in: the mass of iron
(D) Decrease in: the concentration of iron in the ore , increase in: the mass of iron

17 Each of the following is correct for strongly heating iron ores in air, except .....

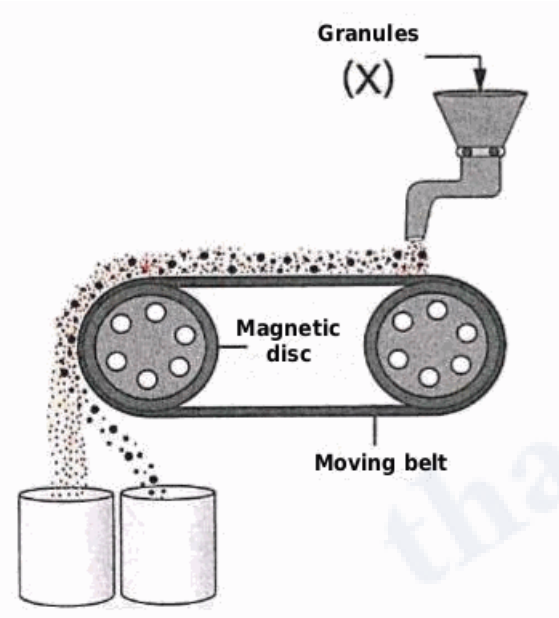
(A) improving the chemical properties of the ores.

(B) forming a dark red substance.

(C) separating some impurities as compounds.

(D) increasing the mass of iron in the ores.

18 Which of the following shows the importance of the process shown in the opposite figure?



(A) Raising the iron percentage in the ore: false , improving the physical properties of the ore: false , crushing process: false

(B) Raising the iron percentage in the ore: true , improving the physical properties of the ore: false , crushing process: true

(C) Raising the iron percentage in the ore: true , improving the physical properties of the ore: true , crushing process: false

(D) Raising the iron percentage in the ore: true , improving the physical properties of the ore: true , crushing process: true

19 Improving the chemical properties of iron ores before reduction produces .....

(A) Fe_2O_3 , CO_2 only.

(B) FeO , CO_2 , SO_2 , P_2O_5 only.

(C) Fe_2O_3 , CO_2 , SO_2 , P_2O_5 , H_2O

(D) FeO , CO_2 , H_2O only.

20 Iron is extracted from haematite ore. Which of the following is correct?

(A) Coke is used as a catalyst.

(B) Haematite contains iron(II) oxide.

(C) The purity of the haematite used reaches 90%.

(D) Haematite ore is roasted outside the blast furnace.

---

21 Among the reactions that take place in the blast furnace is .....

(A) the reaction of CO with SO_2 to remove the ore impurities.

(B) oxidation and reduction of carbon and carbon dioxide.

(C) oxidation of haematite to iron.

(D) the use of methane gas to reduce iron(III) oxide to iron.

---

22 In the middle zone of the blast furnace the temperature is 1000°C. There, compound (1) changes into compound (2), which reacts with substance (3), changing it into substance (4). Which of the following is correct?

(A) (1): CO_2 , (2): CO , (3): Fe_3O_4 , (4): Fe_2O_3

(B) (1): CO_2 , (2): CO , (3): Fe_2O_3 , (4): Fe

(C) (1): CO , (2): CO_2 , (3): FeO , (4): Fe

(D) (1): CO , (2): CO_2 , (3): Fe_2O_3 , (4): FeO

---

23 Which of the following pairs of substances is oxidized in the blast furnace?

(A) Carbon and oxygen.

(B) Coke and carbon monoxide.

(C) Carbon monoxide and carbon dioxide.

(D) Carbon dioxide and oxygen.

---

24 All the following reactions take place in the furnaces for extracting iron from its ores, except .....

(A) $C + O_2 \xrightarrow{(\Delta)} CO_2$

(B) $3Fe + 2O_2 \xrightarrow{(\Delta)} Fe_3O_4$

(C) $Fe^{3+} + 3e^- \longrightarrow Fe$

(D) $C + CO_2 \xrightarrow{(\Delta)} 2CO$

---

25 The following equations show reactions that take place inside the blast furnace:

(1) $C + O_2 \longrightarrow CO_2$

(2) $CO_2 + C \longrightarrow 2CO$

(3) $Fe_3O_4 + CO \longrightarrow 3FeO + CO_2$

(4) $Fe_2O_3 + 3CO \longrightarrow 2Fe + 3CO_2$

Which of the previous reactions raises the temperature of the furnace?

(A) (1). (B) (2). (C) (3). (D) (4).

26 The following substances are used in the processes of extracting iron from haematite ore, except .....

(A) coke.
(B) carbon monoxide gas.
(C) methane gas.
(D) sulphur trioxide gas.

27 When the iron oxide in haematite reacts with carbon monoxide gas, the oxidation number of iron changes from .....

(A) +3 to 0, and CO acts as the reducing agent.
(B) +6 to 0, and CO acts as the reducing agent.
(C) +3 to 0, and CO acts as the oxidizing agent.
(D) +6 to 0, and CO acts as the oxidizing agent.

28 All the following reactions are oxidation-reduction reactions, except .....

(A) $C + O_2 \longrightarrow CO_2$
(B) $C + CO_2 \longrightarrow 2CO$
(C) $CaO + SiO_2 \longrightarrow CaSiO_3$
(D) $Fe_2O_3 + 3CO \longrightarrow 2Fe + 3CO_2$

29 Which of the following are the oxidizing agents in the reactions that take place in the blast furnace?

(A) O_2 only. (B) O_2 , Fe_2O_3 only. (C) O_2 , CO_2 only. (D) O_2 , CO_2 , Fe_2O_3

30 Which of the following is the reducing agent in the reactions that take place in the blast furnace?

(A) CO_2 , H_2 (B) CO only. (C) CO , C (D) H_2 , CO

31 Which of the following gives the correct order of the processes of preparing the iron ores used in the blast furnace?

(A) Surface tension → sintering → roasting.

(B) Crushing → magnetic separation → roasting.

(C) Roasting → crushing → sintering.

(D) Crushing → roasting → electric separation.

---

32 Among the processes carried out after gathering the fine granules of iron ore, to obtain an alloy used in making railway lines, are .....

(A) magnetic separation – reduction – roasting.

(B) roasting – reduction – improving properties.

(C) crushing – roasting – reduction.

(D) surface tension – crushing – improving properties.

---

33 The following equations show four chemical reactions:

(1) $2CO + O_2 \longrightarrow 2CO_2$

(2) $Fe_2O_3 + 3H_2 \longrightarrow 2Fe + 3H_2O$

(3) $2C + O_2 \longrightarrow 2CO$

(4) $Fe_2O_3 + 3CO \longrightarrow 2Fe + 3CO_2$

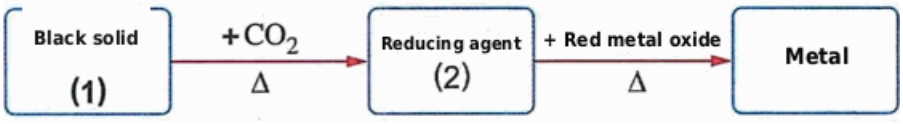
Which of the following shows the reactions that take place in the blast furnace?

(A) (2) , (3). (B) (1) , (2). (C) (1) , (4). (D) (3) , (4).

---

34 From the following chart:

Which of the following is correct?



(A) (1): C , (2): CO

(B) (1): CO , (2): C

(C) (1): C , (2): CO_2

(D) (1): CO , (2): CO

---

35 Each of the following describes the gas mixture used in the Fischer–Tropsch method, except that it .....

(A) reduces the ion whose electron configuration is [Ar], $3d^5$ to its atom.

(B) can be obtained from natural gas.

(C) is used in the Midrex furnace.

(D) is a strong oxidizing agent.

---

36 In which of the following processes is pig iron obtained?

(A) The second stage of extracting iron from its ores.

(B) Roasting iron ores.

(C) The third stage of extracting iron from its ores.

(D) Reducing iron(III) oxide with water gas.

---

37 The following processes show the steps of making steel «not in order»:

(1): reducing the ore.

(2): strongly heating the ore in air.

(3): adding carbon to iron.

(4): reducing carbon dioxide gas.

What is the correct order of these steps?

(A) (2) → (1) → (4) → (3).

(B) (1) → (2) → (3) → (4).

(C) (2) → (4) → (1) → (3).

(D) (1) → (3) → (2) → (4).

---

38 From the following statements:

(1): the iron produced in it contains some impurities.

(2): iron ores are reduced in it by electrolysis.

(3): the iron produced in it is known as pig iron or steel.

Which of the previous describes the blast furnace?

(A) (1): true , (2): false , (3): false

(B) (1): false , (2): true , (3): true

(C) (1): false , (2): true , (3): false

(D) (1): true , (2): false , (3): true

---

39 Adding some carbon to iron metal to form the steel alloy changes each of the following, except .....

(A) electrical conductivity.

(B) magnetic properties.

(C) melting point.

(D) the atomic size of the components of steel.

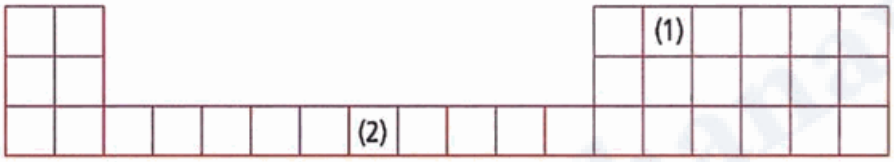
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40 The elements that can be added to iron to form an alloy that is harder than steel and does not rust are .....

(A) Mn , Al (B) Mn , Cr (C) C , Al (D) Cr , C

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41 The opposite figure shows a part of the periodic table. Elements (1) and (2) together can form a(n) ..... alloy.



(A) interstitial or substitutional

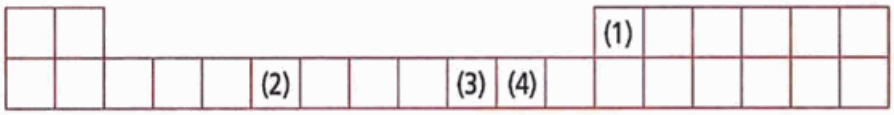
(B) interstitial or intermetallic

(C) substitutional or intermetallic

(D) interstitial, substitutional or intermetallic

---

42 The opposite figure shows a part of the periodic table. The two elements that together form one of the duralumin alloys are .....



(A) (1) , (2). (B) (2) , (3). (C) (3) , (4). (D) (1) , (4).

---

43 The following pairs of elements have similar crystal lattices, except .....

(A) iron and chromium. (B) gold and copper.

(C) iron and nickel. (D) titanium and copper.

---

44 Coating iron door handles with brass requires using .....

(A) the blast furnace.

(B) electroplating from a solution containing (Cu^{2+} , Sn^{2+}).

(C) the Midrex furnace.

(D) electroplating from a solution containing (Cu^{2+} , Zn^{2+}).

45 Which of the following pairs of elements does not form alloys with aluminium?

(A) Sc , Ti (B) Mn , Cu (C) Ni , Cu (D) K , Na

46 Two elements (X) and (Y):

• (X): a source for preparing the reducing agent in the blast furnace.

• (Y): a catalyst for converting water gas into liquid fuel.

Which of the following is NOT correct?

(A) Their radii can be r(X) = 2 Å , r(Y) = 1 Å

(B) The compound (Y_3X) does not obey the laws of valency.

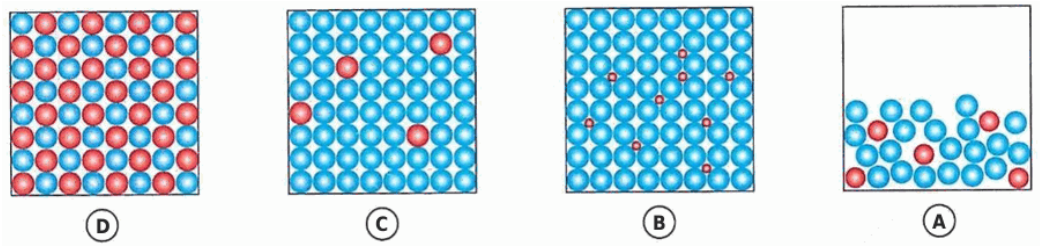
(C) When the crystal lattice of (Y) is hammered, the layers of its atoms move.

(D) Their radii can be r(X) = 0.67 Å and r(Y) = 1.16 Å

47 Each of the following pairs of elements together forms an alloy, except .....

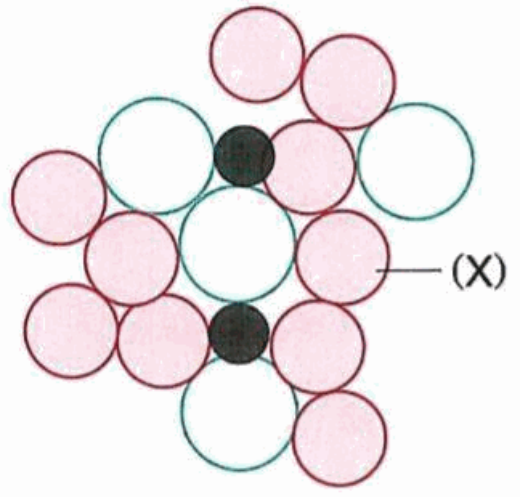
(A) Zn , Cu (B) Fe , Hg (C) Fe , C (D) Au , Cu

48 Which of the following shows an alloy in which the atoms of the original metal do not slide?



(A) Figure (A) (B) Figure (B) (C) Figure (C) (D) Figure (D)

49 Which of the following describes the substance shown in the opposite figure?



(A) A chemical compound whose formula obeys the laws of valency.

(B) Its melting point differs from the melting point of metal (X).

(C) The physical properties of its elements are similar.

(D) The chemical properties of its elements are similar.

---

50 Brass is a mixture of copper and a metal whose electron configuration is .....

(A) [Ar], $4s^1$, $3d^{10}$ (B) [Ar], $4s^2$, $3d^{10}$ (C) [Ar], $4s^2$, $3d^9$ (D) [Ar], $4s^2$, $3d^8$

---

51 Metal (M) is in the fourth period of the periodic table:

• It has the same crystal shape as gold.

• With tin it forms alloy (X), which is strong and hard.

Which of the following is correct?

(A) (M): iron , (X): cementite.

(B) (M): copper , (X): duralumin.

(C) (M): iron , (X): stainless steel.

(D) (M): copper , (X): bronze.

---

52 One of the duralumin alloys consists of 95% of element (X), 4.5% of element (Y) and 0.5% of other elements.

What are elements (X) and (Y), and what is one use of this alloy?

(A) (X): Sc , (Y): Al / making aircraft bodies because it is light.

(B) (X): Fe , (Y): Cr / making cutlery because it does not rust.

(C) (X): Al , (Y): Cu / making ship parts because it resists sea water.

(D) (X): Fe , (Y): C / making oil tankers because of its hardness.

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53 Alloys of metal (1) with metal (2) are used in making the bodies of spacecraft.
What are metals (1) and (2), and what are metals (3) and (4) that form an intermetallic alloy with metal (1)?

(A) (1): titanium / (2): aluminium / (3) , (4): aluminium and copper.

(B) (1): aluminium / (2): titanium / (3) , (4): nickel and copper.

(C) (1): aluminium / (2): titanium / (3) , (4): cobalt and iron.

(D) (1): titanium / (2): aluminium / (3) , (4): nickel and aluminium.

---

54 Pure iron is a soft metal, so it is mixed with a small amount of tungsten to make tungsten steel, which is known for its hardness. From the following statements:
(1): the particles of pure iron are arranged in layers.
(2): tungsten steel is an iron compound.
(3): iron forms interstitial, substitutional and intermetallic alloys.
Which of the previous statements are scientific facts?

(A) (1) , (2) only. (B) (2) , (3) only. (C) (1) , (3) only. (D) (1) , (2) , (3).

Essay questions — 7 questions

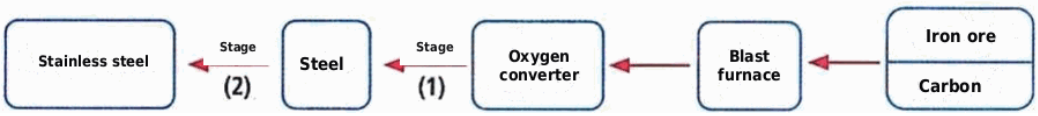
1 The following chart shows the steps of making stainless steel:

(1) Why is carbon added to:

(a) the blast furnace?

(b) iron in stage (1)?

(2) What is the name of the element added to iron in stage (2)?



2 The following chart shows the steps of extracting iron from haematite ore:

(1) What is the aim of:

(a) stage (1)?

(b) stage (2)?

(2) What is the name of the molten metal into which the iron produced in stage (3) is dipped to protect it from rusting? And what is the name of this process?



3 Metal (M): the electron configuration of its ion M^{3+} ends with the sublevel $3d^7$:

(1) What is the importance of this element in the food industry?

(2) What type of alloy does this element form with each of the following? Explain.

(a) Iron.

(b) Aluminium.

4 The oxide of metal (X) is used in making rubber and cosmetics, while the oxide of metal (Y) is used in making sunscreen products:

(1) What is the difference between the numbers of electrons in the 3d sublevel of the atoms of metals (X) and (Y)?

(2) Give one use of the alloy of each of:

(a) metal (X) with copper.

(b) metal (Y) with aluminium.

5 Nickel is part of many alloys:

(1) Name two alloys that contain nickel, and state their types.

(2) Name another nickel alloy and explain its importance.

---

6 Transition metal (1) is added to representative metal (2) to make an alloy used in making the bodies of aircraft and spacecraft, and metal (2) forms an intermetallic alloy with either of metals (3) and (4):

(1) Write the chemical formula of the chloride of:

(a) metal (1), the most stable one.

(b) metal (2).

(2) What type of alloy is formed when metal (3) is added to iron? Explain.

---

7 In alloy (W), the atoms of non-metal (X) occupy the interstitial spaces of the crystal lattice of iron. When a very small amount of metal (Y) is added to alloy (W), another alloy (Z) is formed, which is used in making car springs:

(1) What is the name of:

(a) non-metal (X)?

(b) metal (Y)?

(2) What change happens in the physical properties of:

(a) iron when non-metal (X) is added to it?

(b) alloy (W) when metal (Y) is added to it?

Past exam questions — 46 questions

1 Which of the following shows the change that happens to siderite ore when it is heated in air?
(Sample exam 2026)

(A) Its mass increases and its iron percentage increases.
(B) Its mass decreases and its iron percentage increases.
(C) Its mass decreases and its iron percentage decreases.
(D) Its mass increases and its iron percentage decreases.

---

2 Which of the following shows the result of the chemical processes of preparing iron ore before reduction?
(Sample exam 2026)

(A) A decrease in the mass of the ore and a decrease in the iron percentage.
(B) A decrease in the mass of the ore and an increase in the volume of the ore.
(C) A decrease in the percentage of impurities and a decrease in the iron percentage.
(D) A decrease in the percentage of impurities and an increase in the iron percentage.

---

3 Which of the following shows a reaction for preparing the reducing agent for iron ore in one of the furnaces?
(Sample exam 2026)

(A) Steam with coke.
(B) Hydrogen gas with coke.
(C) Carbon dioxide with methane gas.
(D) Steam and carbon dioxide with methane gas.

---

4 Which of the following gives the correct order of the processes carried out on limonite ore to obtain steel?
(Sample exam 2026)

(A) Roasting – adding carbon – reduction.
(B) Reduction – adding manganese – roasting.
(C) Roasting – reduction – adding carbon.
(D) Purifying the ore – sintering – reduction.

---

5 The representative element (X) forms the following alloys:

- an intermetallic alloy with element (Y).
- an alloy used in making MiG aircraft with element (Z).
- an alloy used in making spacecraft with element (L).

Which of the following gives elements (X), (Y), (Z) and (L)?

(Sample exam 2026)

(A) (X): Al , (Y): Ni , (Z): Sc , (L): Ti
(B) (X): C , (Y): Fe , (Z): Ni , (L): Cr
(C) (X): Pb , (Y): Au , (Z): Ni , (L): Ti
(D) (X): Al , (Y): Ni , (Z): Fe , (L): Sc

---

6 Study the opposite table:

Mass of the ore: 4 kg before preparation , 3.85 kg after preparation

Iron percentage: 45% before preparation , 69% after preparation

Which process was carried out to prepare the ore?

(Sample exam 2026)

(A) Crushing.
(B) Roasting.
(C) Sintering.
(D) Reduction.

---

7 Each of the following is a property of transition elements that leads them to form substitutional alloys with each other, except .....

(Sample exam 2026)

(A) their radii are close.
(B) their chemical properties are similar.
(C) they have the same crystal shape.
(D) they react with each other easily.

---

8 Everything that happens to iron ores during roasting, except .....

(Sample exam 2026)

(A) some gases and vapours are given off from the ore.
(B) all iron ores are oxidized.
(C) the colour of limonite and siderite changes.
(D) most of the impurities in the ore are oxidized.

---

9 Which of the following processes are needed to produce steel from a sample of siderite?
(Sample exam 2026)

(A) Roasting – oxidation – removing impurities – adding carbon.

(B) Roasting – reduction – removing impurities – adding carbon.

(C) Removing impurities – roasting – adding carbon – reduction.

(D) Removing impurities – reduction – adding carbon – roasting.

---

10 (X) and (Y) are two consecutive transition elements in the first series; each of them has a compound in its highest oxidation state that is an oxidizing agent.
Which of the following is correct?
(Sample exam 2026)

(A) (X): used as a catalyst in the manufacture of ammonia.

(B) (Y): used in making car springs.

(C) The alloy formed of element (Y), the element after it and a non-metal is known for resisting acids.

(D) The alloy formed of the element between (X) and (Y) and carbon is known for its hardness.

---

11 (X) and (Y) are processes carried out while preparing one of the iron ores:
(X): it decreases the size of the iron ore granules while its mass stays constant.
(Y): it increases the number of unpaired electrons in the iron ion.
Which of the following gives processes (X) and (Y)?
(Sample exam 2026)

(A) (X): crushing , (Y): roasting siderite

(B) (X): sintering , (Y): surface tension

(C) (X): crushing , (Y): roasting haematite

(D) (X): sintering , (Y): magnetic separation

---

12 Each of the following is a group of transition and non-transition elements that form different types of alloys.

(X): a non-transition element of period 3, group (IIIA)

(Y): a non-transition element of period 2, group (IVA)

(A): a transition element used as a catalyst in the hydrogenation of oils.

(B): a transition element used as a catalyst in the Fischer–Tropsch method.

Which of the following gives the types of alloys formed from some of the previous elements? (Sample exam 2026)

(A) An alloy of (Y) and (B) whose components can be separated by a dilute acid: intermetallic , an alloy of (Y) and (B) whose components cannot be separated by a dilute acid: interstitial , an alloy of (X) and (A): substitutional , an alloy of (Y), (A) and (B): interstitial – intermetallic

(B) An alloy of (Y) and (B) whose components can be separated by a dilute acid: interstitial , an alloy of (Y) and (B) whose components cannot be separated by a dilute acid: substitutional , an alloy of (X) and (A): intermetallic , an alloy of (Y), (A) and (B): substitutional – interstitial

(C) An alloy of (Y) and (B) whose components can be separated by a dilute acid: interstitial , an alloy of (Y) and (B) whose components cannot be separated by a dilute acid: intermetallic , an alloy of (X) and (A): intermetallic , an alloy of (Y), (A) and (B): interstitial – substitutional

(D) An alloy of (Y) and (B) whose components can be separated by a dilute acid: substitutional , an alloy of (Y) and (B) whose components cannot be separated by a dilute acid: intermetallic , an alloy of (X) and (A): interstitial , an alloy of (Y), (A) and (B): interstitial – substitutional

13 A sample of a yellow iron ore (X) went through the following processes:

(1): a physical process that decreased the mass of the ore and increased the iron percentage.

(2): a chemical process that decreased the mass of the ore and increased the iron percentage.

(3): a process that changed neither the mass of the ore nor its iron percentage.

Which of the following gives ore (X) and processes (1), (2) and (3)?

(Sample exam 2026)

(A) Ore: siderite , process (1): magnetic separation , process (2): roasting , process (3): electric separation

(B) Ore: haematite ore , process (1): roasting , process (2): electric separation , process (3): sintering

(C) Ore: hydrated iron(III) oxide , process (1): surface tension , process (2): roasting , process (3): crushing

(D) Ore: limonite ore , process (1): roasting , process (2): magnetic separation , process (3): surface tension

---

14 Which of the following gives the correct order of the processes needed to obtain stainless steel from the products of cleaning the reduction furnaces?

(Sample exam 2026)

(A) Concentration – roasting – reduction – adding chromium metal.

(B) Concentration – reduction – roasting – adding manganese metal.

(C) Sintering – roasting – adding carbon and chromium – reduction.

(D) Sintering – roasting – reduction – adding carbon and chromium.

---

15 A transition element (X) of the first series, with the lowest oxidation state in its series, combines chemically with another metal to form an alloy.

Which of the following is correct for the type of alloy and the use of element (X)?

(Sample exam 2026)

(A) Substitutional, and (X) is used in making soft-drink cans.

(B) Substitutional, and (X) is used in making railway lines.

(C) Intermetallic, and (X) is used in making MiG fighter aircraft.

(D) Intermetallic, and (X) is used in making coins.

---

16 Each of the following is an intermetallic alloy, except .....
(Sample exam 2026)

(A) cementite. (B) brass. (C) duralumin. (D) lead and gold.

---

17 Coke has a role in extracting zinc from its ores according to the following equation:
$2ZnO + C \longrightarrow 2Zn + CO_2$
Which of the following substances has the same role as coke when iron is extracted?
(Sample exam 2026)

(A) A mixture of $(CO + H_2)$
(B) Methane gas.
(C) Coke.
(D) A mixture of $(CO_2 + H_2O)$

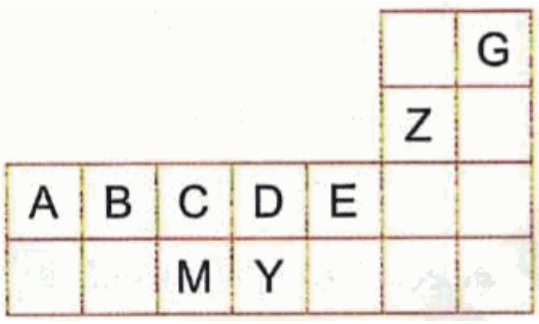
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18 What is the correct order of the processes and furnaces that haematite ore goes through to obtain steel?
(Sample exam 2026)

(A) Roasting – Midrex furnace – blast furnace.
(B) Roasting – Midrex furnace – oxygen converter.
(C) Electric furnace – Midrex furnace – open hearth furnace.
(D) Open hearth furnace – blast furnace – oxygen converter.

---

19 The opposite figure shows a part of the periodic table with hypothetical symbols for some elements.
Which of the following is NOT correct?
(Sample exam 2026)



(A) Element (Z) forms with each of (D , C) separately two alloys known by the same name.
(B) Elements (G , A) form two types of alloys.
(C) Elements (D , E) form the brass alloy.
(D) Elements (M , C) form an intermetallic alloy.

20 Which of the following gives the correct order of some of the processes needed to obtain an alloy used in making car springs from iron ore?
(1st session 2025)

(A) Roasting – removing impurities – reduction – adding manganese.
(B) Concentration – reduction – removing impurities – adding vanadium.
(C) Crushing – reduction – removing impurities – reacting with manganese.
(D) Sintering – removing impurities – reduction – reacting with vanadium.

---

21 An alloy is made of a non-transition element and a transition element, both from the first transition series; the highest-energy sublevel of each of them is completely filled with electrons.
Which of the following gives a use of this alloy?
(1st session 2025)

(A) Containers for storing acids.
(B) Railway rails.
(C) Coating iron handles.
(D) Car springs.

---

22 A transition element in the fourth period whose ion X^{2+} contains five unpaired electrons.
Which of the following is correct?
(1st session 2025)

(A) XO_2 is used as an oxidizing agent.
(B) Element (X) is used in making the bronze alloy.
(C) Element (X) is used in making car springs.
(D) XSO_4 is used in purifying drinking water.

---

23 All the compounds of element (X) are diamagnetic, and element (Y) comes directly before it in the first transition series.
Which of the following applies to an alloy formed of elements (X) and (Y)?
(Sample exam 2025)

(A) It is used in making military aircraft (MiG).
(B) It is used in making railway rails.
(C) It has high hardness and the ability to resist corrosion.
(D) It can be prepared by electroplating.

---

24 Some impurities of iron ore are removed by .....
(2nd session 2024)

(A) electric separation – sintering.
(B) surface tension – roasting.
(C) roasting – sintering.
(D) magnetic separation – crushing.

25 The gases used in the Fischer–Tropsch method can be used to reduce iron ore in the .....
(2nd session 2024)

(A) blast furnace.
(B) Midrex furnace.
(C) electric furnace.
(D) open hearth furnace.

26 Which of the following processes are used to remove the sulphur in iron ore?
(1st session 2024)

(A) Electric separation – sintering.
(B) Magnetic separation – roasting.
(C) Magnetic separation – sintering.
(D) Crushing – roasting.

27 Among the chemical processes that must be carried out on limonite ore to obtain iron are .....
(2nd session 2023)

(A) sintering and reduction.
(B) roasting and reduction.
(C) sintering and roasting.
(D) roasting and producing steel.

28 Each of the following can be done to iron ore before its reduction, except .....
(2nd session 2021)

(A) changing sizes that are not suitable for reduction into suitable sizes.
(B) reacting with CO gas at a high temperature.
(C) using magnetic separation to reduce the impurities.
(D) removing moisture and heating it strongly in air.

29 Among the physical processes that iron ores go through and that decrease the mass of the ore is .....
(1st session 2021)

(A) roasting.
(B) sintering.
(C) crushing.
(D) surface tension.

30 A piece of iron ore of mass 2 kg went through a physical process, and its mass became 1.8 kg. Which of these processes was carried out on it?
(2nd session 2022)

(A) Crushing. (B) Sintering. (C) Concentration. (D) Roasting.

---

31 Each of the following aims at improving the physical properties of iron ore before reduction, except .....
(Trial exam / June 2021)

(A) oxidizing some impurities.
(B) binding and gathering the granules.
(C) increasing the iron percentage in the ore.
(D) crushing and grinding the ore rocks.

---

32 Each of the following can be done to iron ore before the furnace stage, except .....
(1st session 2022)

(A) changing the grey ore into another one that is red.
(B) raising the iron percentage in the ore.
(C) reacting with a mixture of the gases ($CO + H_2$).
(D) separating some impurities by surface tension.

---

33 The process that raises the iron percentage in the ore by turning some impurities into gases is .....
(Trial exam / March 2023)

(A) sintering. (B) crushing. (C) concentration. (D) roasting.

---

34 Which of the following has the same role in both the blast furnace and the Midrex furnace?
(1st session 2022)

(A) $CO(g)$ (B) $H_2O(v)$ (C) $H_2(g)$ (D) $CH_4(g)$

---

35 A solid element is changed into a reducing gas for iron ore in the .....
(1st session 2024)

(A) Midrex furnace. (B) blast furnace.
(C) open hearth furnace. (D) electric furnace.

36 The furnaces in which iron(III) oxide is changed into iron and then into an alloy of iron and carbon, respectively, are .....

(Trial exam / March 2023)

(A) the open hearth furnace, then the Midrex furnace.

(B) the oxygen converter, then the blast furnace.

(C) the blast furnace, then the Midrex furnace.

(D) the blast furnace, then the open hearth furnace.

---

37 • Element (X): a representative element in period 2 whose outer level contains 4 electrons.

• Element (Y): a main transition element in the first transition series whose atom contains four unpaired electrons.

When the two elements are mixed, ... is formed.

(2nd session 2021)

(A) an intermetallic alloy

(B) an interstitial alloy

(C) a substitutional and interstitial alloy

(D) an intermetallic and substitutional alloy

---

38 The processes carried out on the products of cleaning the blast furnaces to obtain an interstitial alloy, in order,

are:

(1st session 2023)

(A) concentration – oxidation – reduction.

(B) crushing – reduction – producing steel.

(C) sintering – reduction – producing steel.

(D) crushing – roasting – reduction.

---

39 An alloy made of iron and carbon.

The correct order of the furnaces used to obtain this alloy from haematite ore is .....

(2nd session 2023)

(A) the Midrex furnace, then the oxygen converters.

(B) the blast furnace, then the Midrex furnace.

(C) the open hearth furnace, then the oxygen converters.

(D) the electric furnace, then the blast furnace.

---

40 You have two elements (X) and (Y):

• (X): one of the coinage elements.

• (Y): an element that forms with manganese the alloy of soft-drink cans.

The alloy formed of (X) and (Y) is characterized by .....

(2nd session 2023)

(A) its elements having the same crystal shape.

(B) element (Y) preventing the layers of element (X) from sliding.

(C) a chemical combination between elements (X) and (Y).

(D) element (Y) being in the interstitial spaces of element (X).

---

41 The opposite table shows the radii of four transition elements of the first transition series (A), (B), (C) and (D).

Element (A): radius 1.15 Å

Element (B): radius 1.16 Å

Element (C): radius 1.62 Å

Element (D): radius 1.17 Å

Each of the following can form a substitutional alloy, except .....

(Trial exam / June 2021)

(A) (C) , (A). (B) (B) , (A). (C) (D) , (A). (D) (D) , (B).

---

42 Which of the following gives the alloy used in electric heaters and its type?

(2nd session 2022)

(A) Nickel and chromium / substitutional. (B) Copper and gold / substitutional.

(C) Duralumin / intermetallic. (D) Nickel and chromium / interstitial.

---

43 An alloy is made of two elements (X) and (Y) in the same period;

metal (X) is one of the coinage metals and metal (Y) is a representative element in group (4A).

The type of the alloy is .....

(Trial exam / March 2023)

(A) substitutional only. (B) interstitial – substitutional.

(C) intermetallic only. (D) interstitial – intermetallic.

---

44 Four elements (A), (B), (C) and (D) have the following properties:

- Element (A): in group 3A
- Element (B): forms the bronze alloy with tin.
- Element (C): used as a catalyst in the manufacture of ammonia.
- Element (D): a non-transition element in the d-block

To coat a metal object with brass, we use the two elements .....

(1st session 2021)

(A) (B) , (D). (B) (A) , (C). (C) (A) , (B). (D) (C) , (D).

---

45 (A), (B) and (C) are examples of alloys described in the following table:

- (A): harder than its elements
- (B): its elements have the same crystal shape
- (C): its elements are chemically combined

These alloys are .....

(1st session 2022)

(A) (A) interstitial , (B) substitutional , (C) intermetallic.

(B) (A) substitutional , (B) interstitial , (C) intermetallic.

(C) (A) intermetallic , (B) substitutional , (C) interstitial.

(D) (A) interstitial , (B) intermetallic , (C) substitutional.

---

46 Silicon steel is obtained by mixing silicon, chromium and steel, so it is considered .....

(1st session 2023)

(A) a substitutional alloy only.

(B) an interstitial alloy and an intermetallic alloy.

(C) an intermetallic alloy only.

(D) an interstitial alloy and a substitutional alloy.

Answer key and solutions

Multiple choice questions

1 D	2 C	3 C	4 B	5 C	6 A	7 D	8 D	9 C	10 D
11 D	12 D	13 C	14 C	15 C	16 B	17 D	18 C	19 C	20 D
21 B	22 B	23 B	24 B	25 A	26 D	27 A	28 C	29 D	30 C
31 B	32 B	33 D	34 A	35 D	36 C	37 C	38 A	39 D	40 B
41 B	42 D	43 D	44 D	45 D	46 A	47 B	48 B	49 B	50 B
51 D	52 C	53 B	54 C						

1 **Answer (D)**

Meteorites contain iron in the free (metallic) state, not only as compounds

So statement (D) is not correct

2 **Answer (C)**

Iron in meteorites is about 90% of the mass

$14150 \times 0.9 = 12735$ kg

3 **Answer (C)**

Iron is the largest component of the Earth's interior (4)

In the Earth's crust it comes after oxygen, silicon and aluminium, so it is (2)

4 **Answer (B)**

The metal of electricity pylons is iron

Magnetite, siderite and limonite are iron ores, while magnesite $MgCO_3$ is a magnesium ore

5 **Answer (C)**

The stone attracts the paper clip magnetically, which is a property of magnetite Fe_3O_4

6 **Answer (A)**

The formula $Fe_3O_4 = FeO \cdot Fe_2O_3$, which is the ore magnetite

Ion (1) is Fe^{2+} with configuration [Ar] $3d^6$, and ion (2) is Fe^{3+} with configuration [Ar] $3d^5$

7 **Answer (D)**

Phosphorus is a harmful impurity; it makes iron brittle and the ore loses its value

Manganese at 5 – 15% improves the hardness of iron, so it increases the value of the ore

8 **Answer (D)**

The red ore is haematite Fe_2O_3, in which iron is in the +3 state

So Fe^{3+} cannot easily be oxidized to a higher state

It is extracted by reduction, not by electrolysis, and its iron percentage is less than that of magnetite

9 **Answer (C)**

The figure shows magnetic separation: the ore granules are attracted to the magnetic disc and fall far away in (Y)

The non-magnetic impurities fall near, in (Z)

10 **Answer (D)**

Separating impurities (such as electric or magnetic separation) is a physical process with no chemical change

Roasting and reduction are chemical changes, and sintering does not separate impurities

11 **Answer (D)**

Oxidizing some impurities (in roasting) improves the chemical properties, not the physical and mechanical properties

12 **Answer (D)**

Heating $Fe_2O_3 \cdot nH_2O$ drives off the water, so the colour changes, the mass decreases and the percentage of iron increases

The oxidation number of iron stays +3 without change

13 **Answer (C)**

Using surface tension separates the impurities, so the percentage of iron in the ore changes

Cutting, crushing and sintering the ore do not change the percentage

14 **Answer (C)**

Roasting siderite $FeCO_3$ in air gives Fe_2O_3 and CO_2

$4FeCO_3 + O_2 \longrightarrow 2Fe_2O_3 + 4CO_2$

15 **Answer (C)**

When hydrated limonite is heated, it loses water

So the mass of the sample decreases; the mass of iron stays constant, so the percentage of iron increases

16 **Answer (B)**

Roasting drives off water, CO_2 and some impurities

So the mass of the ore decreases and the percentage (concentration) of iron rises, while the mass of iron itself stays constant

17 **Answer (D)**

Strongly heating the ore in air (roasting) improves the chemical properties and forms dark red Fe_2O_3

It separates impurities such as sulphur and phosphorus as oxides

But the mass of iron does not increase

18 **Answer (C)**

The figure shows magnetic separation: it raises the iron percentage and improves the physical properties

It is not a crushing process

19 **Answer (C)**

Roasting produces Fe_2O_3, CO_2, SO_2, P_2O_5 and H_2O

20 **Answer (D)**

Haematite is roasted outside the blast furnace before it is fed in

Coke is a source of the reducing agent, not a catalyst, and haematite Fe_2O_3 contains iron(III)

21 **Answer (B)**

In the blast furnace carbon is oxidized to CO_2, then CO_2 is reduced by carbon to CO

So oxidation and reduction of carbon and carbon dioxide take place

22 **Answer (B)**

In the middle zone (1000°C) CO_2 is reduced by carbon to CO

Then CO reduces iron oxide Fe_2O_3 to iron Fe

23 **Answer (B)**

The substances oxidized are coke (C to CO_2 or CO) and carbon monoxide (CO to CO_2)

Oxygen and CO_2 are reduced

24 **Answer (B)**

Forming Fe_3O_4 from iron and oxygen does not happen in the furnace (the furnace reduces the oxide to iron)

25 **Answer (A)**

The combustion of carbon $C + O_2 \longrightarrow CO_2$ is exothermic, so it raises the temperature of the furnace

26 **Answer (D)**

In extracting iron, coke, CO gas and methane (in the Midrex furnace) are used

SO_3 gas is not used

27 **Answer (A)**

In Fe_2O_3 iron is +3 and it is reduced to Fe (zero)

CO is oxidized to CO_2, so it is the reducing agent

28 **Answer (C)**

$CaO + SiO_2 \longrightarrow CaSiO_3$ is a combination of two oxides with no change in oxidation numbers

So it is not an oxidation-reduction reaction

29 **Answer (D)**

The oxidizing agents are O_2 (oxidizes carbon), CO_2 (oxidizes C to CO) and Fe_2O_3 (oxidizes CO to CO_2)

30 **Answer (C)**

The reducing agents in the blast furnace are carbon C and carbon monoxide CO

31 **Answer (B)**

The order is: crushing the ore, then magnetic separation, then roasting

32 **Answer (B)**

After gathering the fine granules: roasting, then reduction, then improving the properties (to obtain steel)

33 **Answer (D)**

In the blast furnace C burns partly to CO (3), then CO reduces Fe_2O_3 to Fe (4)

34 **Answer (A)**

The black solid (1) is carbon (coke C)

$C + CO_2 \longrightarrow 2CO$, so substance (2) is CO, which is the reducing agent

35 **Answer (D)**

The gas mixture (water gas, CO and H_2) is a reducing agent, not an oxidizing agent

36 **Answer (C)**

37 **Answer (C)**

The order is: roasting the ore (2) → reducing CO_2 with carbon to CO (4) → reducing the ore with CO (1) → adding carbon (3)

38 **Answer (A)**

The blast furnace produces impure iron containing impurities, so statement (1) is true

Reduction in it is chemical, by CO, not by electrolysis

And the product is pig iron only, not steel

39 **Answer (D)**

Adding carbon changes the electrical conductivity, the magnetic properties and the melting point

But the atomic size of the components of steel does not change

40 **Answer (B)**

Mn increases hardness and Cr prevents rusting

So the alloy that is harder than steel and does not rust is formed with Mn and Cr

41 **Answer (B)**

(1) is carbon (period 2, group 14) and (2) is iron

Carbon is a small atom that enters between the iron atoms (interstitial alloy) or forms Fe_3C (intermetallic)

It does not form a substitutional alloy because carbon is a non-metal

42 **Answer (D)**

(1) is aluminium (period 3) and (4) is copper

Duralumin is an alloy of aluminium and copper (with a little Mg and Mn)

43 **Answer (D)**

Ti has a hexagonal close-packed lattice, while Cu has a face-centred cubic lattice, so they differ

The pairs iron and chromium and gold and copper have similar lattices, as in the book

44 **Answer (D)**

Brass is an alloy of Cu and Zn

So iron is coated by electroplating from a solution containing Cu^{2+} and Zn^{2+}

45 **Answer (D)**

Transition metals and aluminium form alloys

Na and K are alkali metals that do not form alloys with aluminium

46 **Answer (A)**

(X) is carbon (CO from coke) and (Y) is cobalt (the Fischer–Tropsch catalyst)

The carbon atom is much smaller than the cobalt atom, so r(X) = 2 Å cannot be larger than r(Y) = 1 Å

47 **Answer (B)**

Fe and Hg do not form an alloy (iron does not dissolve in mercury)

Zn–Cu (brass), Fe–C (steel) and Au–Cu are alloys

48 **Answer (B)**

The interstitial alloy (B): small atoms fill the spaces between the atoms of the original metal

So they prevent its layers from sliding

49 **Answer (B)**

The substance is an alloy, not a compound, so its formula does not obey the laws of valency

Its melting point differs from the melting point of the original metal (X)

50 **Answer (B)**

Brass is an alloy of copper with zinc Zn

Its configuration is [Ar] $4s^2$ $3d^{10}$

51 **Answer (D)**

The metal (M) that has the same crystal shape as gold and forms a hard alloy with tin is copper
The alloy of copper and tin is bronze

52 **Answer (C)**

Duralumin is an alloy of aluminium (95%) and copper (4.5%) with a little of other elements
So the two elements are Al and Cu

53 **Answer (B)**

Alloys of aluminium with titanium are used in spacecraft bodies
Aluminium forms intermetallic alloys with nickel and copper

54 **Answer (C)**

(1) is correct: the particles of pure iron are arranged in layers that slide over each other, so it is soft
(2) is wrong: tungsten steel is an alloy, not a compound
(3) is correct: iron forms interstitial, substitutional and intermetallic alloys

Essay questions

1 **Model answer**

(1) (a) It is used to obtain CO gas, which reduces haematite ore.
(b) To increase the hardness of iron, in addition to improving its other physical properties such as malleability, ductility and electrical conductivity.
(2) Chromium.

2 **Model answer**

(1) • Stage (1): improving the physical and chemical properties.
• Stage (2): reducing haematite ore.
(2) • Name of the molten metal: zinc.
• Name of the process: galvanization.

3 **Model answer**

Metal (M) is nickel.

M^{3+} : [Ar], $3d^7 \Rightarrow$ M : [Ar], $3d^8$, $4s^2$

(1) Finely divided nickel is used as a catalyst in the hydrogenation of oils.

(2) (a) The alloy of iron with nickel is a substitutional alloy, because iron and nickel atoms are close in atomic radius, crystal shape and chemical properties.

(b) The alloy of aluminium with nickel is an intermetallic alloy, because they combine chemically and the formula of the compound formed does not obey the laws of valency.

4 **Model answer**

Zinc oxide (the oxide of metal X) is used in making rubber and cosmetics, while titanium dioxide (the oxide of metal Y) is used in making sunscreen products.

$_{22}Ti$: [Ar], $3d^2$, $4s^2$, $_{30}Zn$: [Ar], $3d^{10}$, $4s^2$

(1) The difference between the numbers of 3d electrons in the two metals = 10 − 2 = $8e^-$

(2) (a) The alloy of copper with zinc is used to coat iron handles with brass.

(b) The alloy of aluminium with titanium is used in making aircraft and spacecraft.

5 **Model answer**

(1) • The alloy of aluminium with nickel is an intermetallic alloy.

• The alloy of iron with nickel is a substitutional alloy.

(2) The nickel-chromium alloy, which is used in making heating coils and electric ovens.

6 **Model answer**

Titanium (1) is added to aluminium (2) to make an alloy used in making the bodies of aircraft and spacecraft, and aluminium (2) forms an intermetallic alloy with either nickel (3) or copper (4).

(1) (a) $TiCl_4$

(b) $AlCl_3$

(2) A substitutional alloy, because iron and nickel (3) are close in radius, crystal shape and chemical properties.

7 **Model answer**

(1) (a) Non-metal (X): carbon.

(b) Metal (Y): vanadium.

(2) (a) The hardness of iron increases, and some of its other physical properties are affected, such as malleability, ductility, melting point, electrical conductivity and magnetic properties.

(b) It gains high hardness and a great ability to resist corrosion.

Past exam questions

1 B	2 D	3 D	4 C	5 A	6 B	7 D	8 B	9 B	10 D
11 A	12 C	13 C	14 D	15 D	16 B	17 A	18 B	19 D	20 B
21 C	22 A	23 D	24 B	25 B	26 B	27 B	28 B	29 D	30 C
31 A	32 C	33 D	34 A	35 B	36 D	37 B	38 C	39 A	40 C
41 A	42 A	43 C	44 A	45 A	46 D				

1 **Answer (B)**

Roasting siderite: $4FeCO_3 + O_2 \longrightarrow 2Fe_2O_3 + 4CO_2$

CO_2 escapes, so the mass decreases; the mass of iron stays constant, so its percentage increases

2 **Answer (D)**

The chemical processes (roasting) turn impurities into gases and drive off water

So the percentage of impurities decreases and the iron percentage increases

3 **Answer (D)**

The reducing agent in the Midrex furnace (CO and H_2) is prepared from methane, steam and carbon dioxide

4 **Answer (C)**

Limonite: roasting (it loses water), then reduction, then adding carbon to obtain steel

5 **Answer (A)**

(X) is aluminium: intermetallic with Ni, the MiG aircraft alloy with Sc and the spacecraft alloy with Ti

6 **Answer (B)**

7 **Answer (D)**

Substitutional alloys are formed when the radii are close and the chemical properties and crystal shape are similar

They do not form by a chemical reaction between the elements (that is for intermetallic alloys)

8 **Answer (B)**

Roasting does not oxidize all the ores (haematite, for example, is already an oxide)

9 **Answer (B)**

Siderite: roasting, then reduction, then removing the impurities (slag), then adding carbon to obtain steel

10 **Answer (D)**

11 **Answer (A)**

(X) Crushing makes the granules smaller without changing the mass

(Y) Roasting siderite changes Fe^{2+} ($3d^6$, with 4 unpaired electrons) into Fe^{3+} ($3d^5$, with 5 unpaired electrons)

12 **Answer (C)**

(Y) is C, (X) is Al, (A) is Ni and (B) is Co

C with Co is interstitial (a mixture separated by a dilute acid) or intermetallic (the compound Co_3C, which cannot be separated)

Al with Ni is intermetallic (Ni_3Al)

C with Ni and Co: Ni and Co are substitutional (close radii) and carbon is interstitial

13 **Answer (C)**

The yellow ore is the hydrated oxide (limonite)

(1) Surface tension is physical; it separates impurities, so the mass decreases and the iron percentage increases

(2) Roasting is chemical, by loss of water

(3) Crushing changes neither the mass nor the percentage

14 **Answer (D)**

The products of cleaning the furnaces are fine: sintering, then roasting, then reduction, then adding carbon and chromium to obtain stainless steel

15 **Answer (D)**

The element with the lowest oxidation state in the series is copper

Its chemical combination with another metal gives an intermetallic alloy, and copper is used in coins

16 **Answer (B)**

Brass (Cu + Zn) is a substitutional alloy, not intermetallic

Cementite Fe_3C, duralumin and lead with gold are intermetallic

17 **Answer (A)**

Coke is a reducing agent (it is oxidized)

For iron, the matching substance is the mixture of CO and H_2, both of which are reducing agents

18 **Answer (B)**

Haematite: roasting, then the Midrex furnace (sponge iron), then the oxygen converter for steel

19 **Answer (D)**

(M) and (C) are in the same group (10) and their radii are close

So they form a substitutional alloy, not an intermetallic one

20 **Answer (B)**

The steel used in springs is vanadium steel

Concentration, then reduction, then removing impurities, then adding vanadium

21 **Answer (C)**

The alloy of zinc with copper (brass) is used to coat iron handles

22 **Answer (A)**

X^{2+} with five unpaired electrons is Mn^{2+} $(3d^5)$

Manganese dioxide MnO_2 is an oxidizing agent

23 **Answer (D)**

X, whose compounds are all diamagnetic, is Zn, and Y is Cu

The alloy of copper and zinc (brass) is prepared by electroplating

24 **Answer (B)**

Surface tension and roasting remove some impurities

25 **Answer (B)**

The Fischer–Tropsch gases (CO and H_2) are used as reducing agents in the Midrex furnace

26 **Answer (B)**

Magnetic separation and roasting (which turns sulphur into SO_2 gas)

27 **Answer (B)**

Limonite needs two chemical processes: roasting, then reduction

28 **Answer (B)**

Reacting with CO at a high temperature is the reduction itself, and it is done in the furnace after preparing the ore

29 **Answer (D)**

Surface tension is a physical process that separates impurities, so the mass of the ore decreases
Roasting is chemical, and crushing and sintering do not change the mass

30 **Answer (C)**

A physical process that decreased the mass of the ore from 2 to 1.8 kg: concentration (separating impurities)

31 **Answer (A)**

Oxidizing some impurities is a chemical process (roasting), not for improving the physical properties

32 **Answer (C)**

Reacting with CO and H_2 is the reduction, and it takes place inside the furnace

33 **Answer (D)**

Roasting turns some impurities into gases, so the iron percentage rises

34 **Answer (A)**

CO is a reducing agent in the blast furnace and in the Midrex furnace
H_2 and CH_4 are used in the Midrex furnace only

35 **Answer (B)**

Solid carbon (coke) changes into CO in the blast furnace

36 **Answer (D)**

Fe_2O_3 is reduced to iron in the blast furnace, then carbon is added in the open hearth furnace

37 **Answer (B)**

(X) is carbon (period 2, 4 outer electrons) and (Y) is iron (4 unpaired electrons)
The carbon atom is small and enters between the iron atoms, so an interstitial alloy is formed

38 **Answer (C)**

The fine particles from the furnaces: sintering, then reduction, then producing steel (by adding carbon)

Steel is an interstitial alloy

39 **Answer (A)**

Haematite: the Midrex furnace, then the oxygen converters to obtain steel

40 **Answer (C)**

(X) is copper (coinage) and (Y) is aluminium (with Mn for drink cans)

Cu and Al combine chemically, so an intermetallic alloy is formed

41 **Answer (A)**

A substitutional alloy needs close radii

Element (C), of radius 1.62 Å, is very far from (A), 1.15 Å, so no substitutional alloy is formed

42 **Answer (A)**

Electric heaters use the nickel-chromium alloy (nichrome)

It is substitutional because the radii are close

43 **Answer (C)**

Cu (period 4) with the group 4A element (Ge) combine chemically

So an intermetallic alloy only is formed

44 **Answer (A)**

Brass is Cu + Zn

(B) is copper (it forms bronze with tin) and (D) is zinc (a non-transition element in the d-block)

45 **Answer (A)**

(A), harder than its elements: interstitial

(B), its elements have the same crystal shape: substitutional

(C), its elements are chemically combined: intermetallic

46 **Answer (D)**

Silicon steel: Si and carbon enter between the iron atoms (interstitial)

and Cr replaces some Fe atoms (substitutional)