Geology · Biology and Earth Sciences

Minerals

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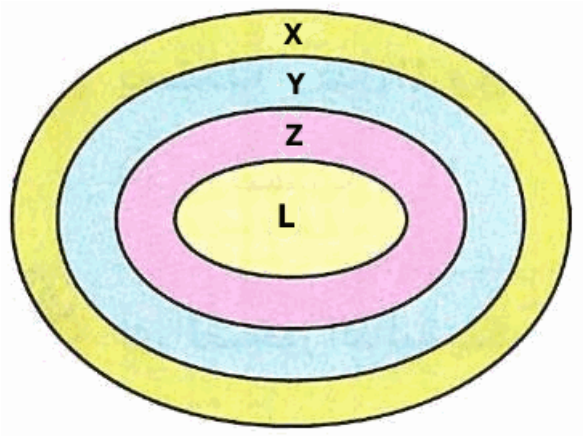
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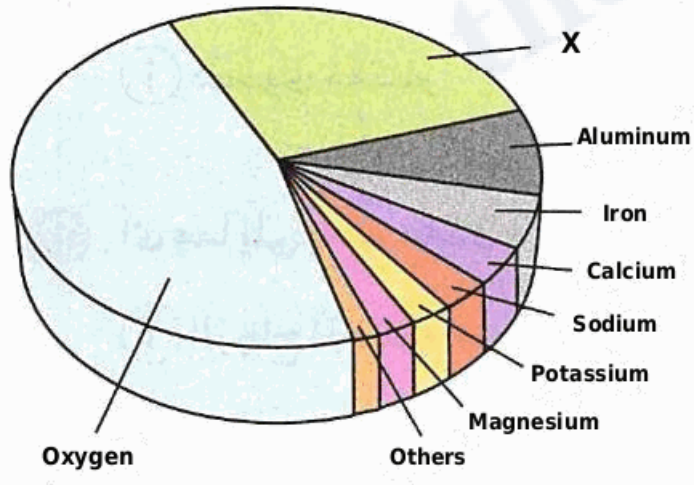
Multiple choice questions — 55 questions

1 In the opposite figure, if (L) represents chemical elements, then (Z) and (X) respectively may represent .....



(A) (Z) minerals / (X) rocks
(B) (Z) rocks / (X) minerals
(C) (Z) minerals / (X) the Earth's crust
(D) (Z) the Earth's crust / (X) minerals

2 In the opposite figure, the letter (X) represents an element that is part of the mineral .....



(A) hematite
(B) malachite
(C) calcite
(D) flint

3 Carbon is a main component of a mineral substance and of a non-mineral substance, which are respectively .....

(A) diamond / coal
(B) graphite / glass
(C) calcite / graphite
(D) coal / malachite

4 The element that forms two different native (elemental) minerals is .....

(A) carbon
(B) sulfur
(C) iron
(D) silicon

5 All the following minerals share at least one element in their chemical composition except .....

(A) malachite (B) sulfur (C) diamond (D) calcite

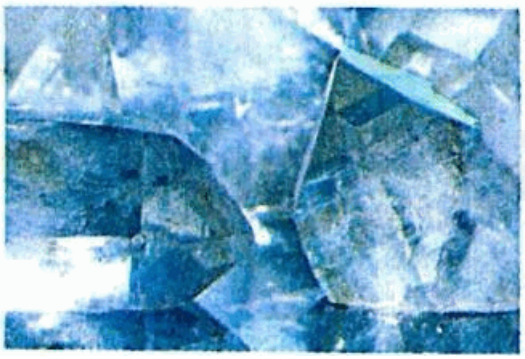
6 The least abundant of the following elements in the rocks of the Earth's crust is .....

(A) oxygen (B) nitrogen (C) silicon (D) iron

7 The most common element in the Earth's crust, when combined with the element whose percentage is about 5 %, forms a mineral used in the manufacture of .....

(A) pottery (B) cement (C) car glass (D) railways

8 The opposite mineral is made of the two most abundant elements in the Earth's crust. This mineral is used in the manufacture of .....



(A) aircraft bodies (B) cement (C) eyeglasses (D) iron and steel

9 Quartz (silica) is used in the manufacture of .....

(A) cement (B) cars (C) ceramics (D) glass cups

10 Which of the following rocks is made of a mineral used in producing cement?

(A) Granite (B) Limestone (C) Sandstone (D) Quartzite

11 Petroleum is not classified as a mineral because it is .....

(A) organic and crystalline (B) liquid and organic
(C) inorganic and liquid (D) non-crystalline and inorganic

12 Which of the following is a mineral?

(A) Glass made from quartz
(B) Pottery made from clay
(C) Petroleum used in making medicines
(D) Calcite used in making cement

13 You have two substances (A) and (B) with the properties shown in the opposite table. Based on the definition of a mineral, we find that .....

Substance (B)	Substance (A)
Solid - natural - organic - its chemical composition (C) - non-crystalline	Solid - natural - inorganic - its chemical composition (Fe_2O_3) - triclinic crystals
	

(A) substance (A) is a mineral belonging to the oxides group
(B) substance (A) is not a mineral because it is inorganic
(C) substance (B) is a mineral belonging to the carbonates group
(D) substance (B) is not a mineral because it is natural

14 "Any natural substance with a definite chemical composition is a mineral." Which of the following substances proves this statement wrong?

(A) Coal
(B) Diamond
(C) Glass
(D) Rock salt

15 The opposite mineral is a compound carbonate mineral and is the main component of two different rocks. This mineral is .....



(A) quartz (B) calcite (C) graphite (D) malachite

16 Quartz and calcite are alike in that both minerals are .....

(A) silicates (B) carbonates
(C) compound minerals (D) native (elemental) minerals

17 What is the opposite carbonate mineral that was used in ornaments in the past?



(A) Calcite (B) Barite (C) Malachite (D) Galena

18 The two elements whose total is the lowest percentage in the rocks of the Earth's crust, of the following elements, are .....

(A) iron and calcium (B) calcium and magnesium
(C) magnesium and sodium (D) iron and potassium

19 The mineral whose elements together make up about 50 % of the weight of the rocks of the Earth's crust is .....

(A) quartz (B) calcite (C) mica (D) galena

20 The mineral anhydrite is formed by the combination of oxygen and calcium with the element .....

(A) sulfur (B) carbon (C) hydrogen (D) silicon

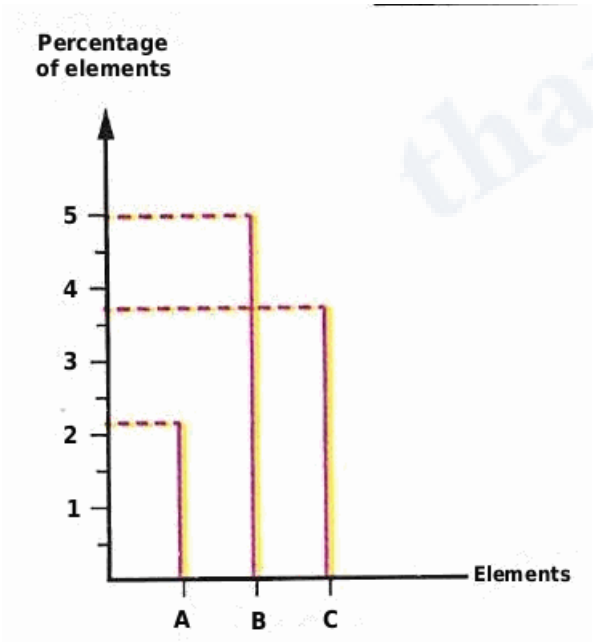
21 What is the correct descending order of the following minerals according to how widespread their mineral groups are in the Earth's crust?

(A) Flint, then gypsum, then copper
(B) Feldspar, then barite, then hematite
(C) Dolomite, then quartz, then gold
(D) Copper, then galena, then gypsum

22 The mineral that forms marble belongs to the group of .....

(A) silicates (B) carbonates (C) oxides (D) sulfates

23 In the opposite graph, the vertical axis represents the percentage of some elements that form the rocks of the Earth's crust. What do the letters (A), (B) and (C) represent respectively?



(A) (A) sodium / (B) iron / (C) potassium
(B) (A) magnesium / (B) iron / (C) calcium
(C) (A) magnesium / (B) aluminum / (C) sodium
(D) (A) calcium / (B) aluminum / (C) sodium

24 The correct ascending order of the following elements according to their percentage by weight in the Earth's crust is .....

(A) aluminum, then iron, then calcium

(B) aluminum, then silicon, then magnesium

(C) magnesium, then iron, then aluminum

(D) magnesium, then silicon, then calcium

---

25 Which of the following statements is not correct?

(A) Some rocks are made of one mineral

(B) The minerals forming one rock usually share some properties

(C) Pyroxene is one of the main minerals forming granite

(D) The silicates group is the most common in the rocks of the Earth's crust

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26 Which minerals have calcium sulfate as their main component?

(A) Quartz and barite

(B) Calcite and anhydrite

(C) Galena and pyrite

(D) Gypsum and anhydrite

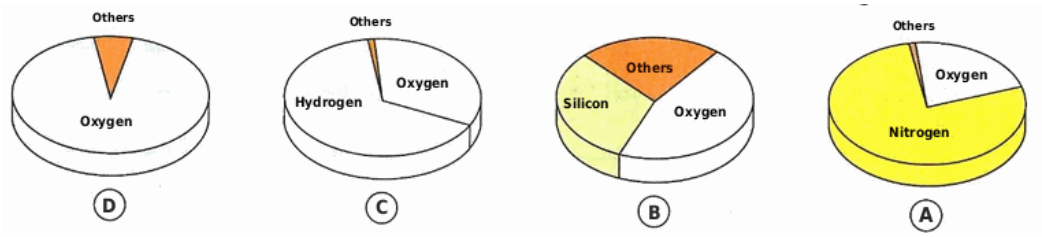
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27 One of the oxide minerals used in the past and today is .....

(A) flint (B) feldspar (C) hematite (D) quartz

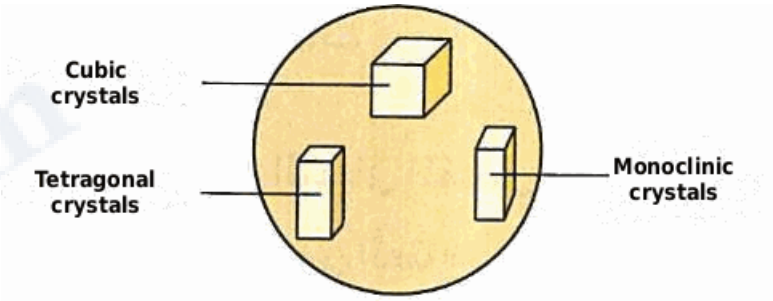
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28 The figure that shows the percentages of the elements forming the rocks of the Earth's crust is .....



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29 The opposite figure represents .....

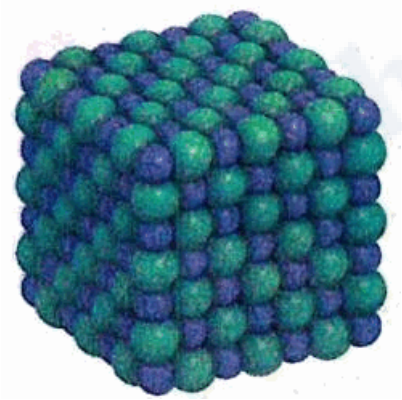


(A) a rock made of several minerals
(B) a rock made of one mineral
(C) a mineral made of several elements
(D) a mineral made of one element

30 The number of crystal systems that have two or more equal crystal axes is .....

(A) 2 (B) 3 (C) 4 (D) 5

31 A gaseous element and a solid element combine to form a mineral with cubic crystals as in the figure. These two elements are .....



(A) oxygen and potassium
(B) nitrogen and calcium
(C) chlorine and silicon
(D) chlorine and sodium

32 The bonding of zinc with sulfur to form the mineral sphalerite is expressed by .....

(A) the vertical axis of symmetry
(B) the plane of crystal symmetry
(C) the crystal form
(D) the colour of the resulting mineral

33 One mineral cannot occur in more than one crystal system because each mineral .....

(A) has a variable chemical composition
(B) crystallizes in a different environment
(C) has a fixed atomic structure
(D) is made of a definite number of crystals

34 The crystal system in which only the two axes (a1) and (a2) are equal in length has .....

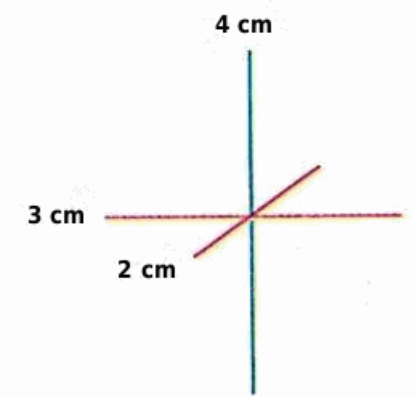
(A) vertical and inclined planes of symmetry

(B) a vertical axis of six-fold symmetry

(C) horizontal and vertical planes of symmetry

(D) a vertical axis of three-fold symmetry

35 If the lengths of the crystal axes in a model of a crystal are as shown in the opposite drawing, the relation between the angles of these axes is one of the following choices except .....



(A) $\alpha = \beta = \gamma$ (B) $\alpha = \gamma \neq \beta$ (C) $\alpha \neq \beta \neq \gamma$ (D) $\alpha = \beta \neq \gamma$

36 A crystal of the hexagonal system can be divided into two identical halves by .....

(A) the axis of symmetry (B) the plane of symmetry

(C) the axial plane (D) the crystal axis

37 The crystal system in which the angles between the axes are equal, only two axes are equal in length and the third axis is different from them is the ..... system.

(A) orthorhombic (B) cubic (C) monoclinic (D) tetragonal

38 The angle between every two crystal axes is 90° in all the crystals that belong to the following systems except .....

(A) cubic (B) tetragonal (C) trigonal (D) orthorhombic

39 The crystal of the opposite shape is characterized by having .....

(A) one plane of symmetry (B) 4 perpendicular crystal axes

(C) 6 crystal axes (D) a vertical axis of six-fold symmetry

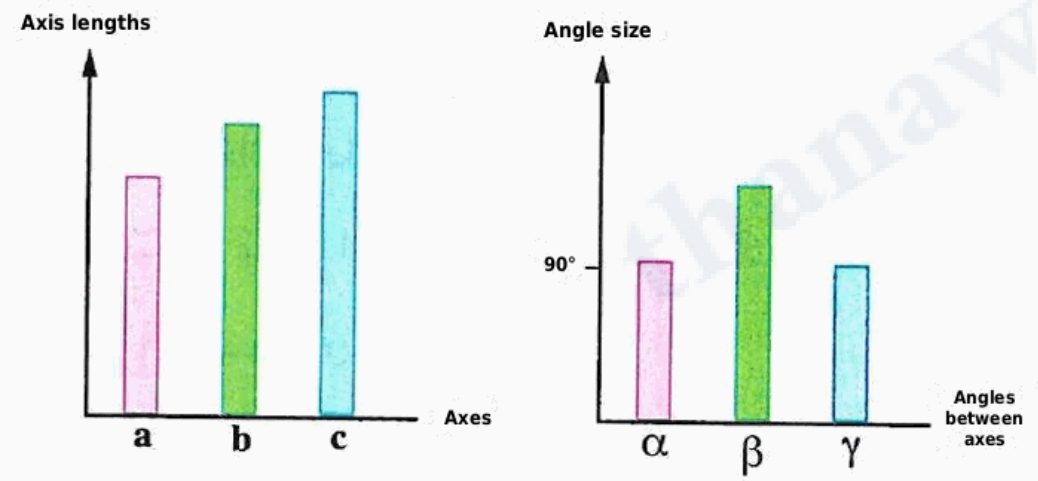
40 Which of the following crystal systems have only horizontal and vertical planes of symmetry?

(A) Tetragonal and hexagonal
(B) Cubic and tetragonal
(C) Trigonal and orthorhombic
(D) Hexagonal and trigonal

41 Halite crystals have the greatest degree of crystal symmetry because .....

(A) the crystal axes are equal in length and the angles between them are different
(B) the crystal axes are equal in length and the angles between them are equal
(C) the crystal axes are different in length and the angles between them are equal
(D) the crystal axes are different in length and the angles between them are different

42 Here are two graphs showing the axis lengths and the angles between them for one of the crystal systems. This system is characterized by .....



(A) the greatest degree of crystal symmetry
(B) having square faces only
(C) being the least symmetrical crystal system
(D) being the most common crystal system

43 The similarity between crystals of the orthorhombic and the monoclinic systems is .....

(A) the size of the angles between the axes
(B) the inclination of the vertical axis to the horizontal axes
(C) the number of minerals in each system
(D) the relation between the lengths of the axes

44 The crystal system in which all the crystal axes differ in length and which has horizontal and vertical planes of symmetry is characterized by .....

(A) none of its crystal axes being perpendicular

(B) all its crystal axes being perpendicular

(C) being the most symmetrical

(D) being the least symmetrical

---

45 If one axis of a cubic crystal model becomes longer than the other two axes, which of the following relations describes the new shape of the crystal model?

(A) $a_1 = a_2 = a_3$ (B) $a \neq b \neq c$ (C) $\alpha = \beta = \gamma$ (D) $\alpha = \beta \neq \gamma$

---

46 The following table shows the axis lengths of four crystal models of different shapes. When the angles between the axes were measured, they were right angles in all the crystal models:
Which of these models represents a crystal that may form the mineral halite?

Crystal (Z)	Crystal (Y)	Crystal (X)	Crystal (W)	Crystals / Axis lengths
3 cm	3 cm	4 cm	3 cm	Length of axis (a)
4 cm	4 cm	4 cm	3 cm	Length of axis (b)
5 cm	6 cm	6 cm	3 cm	Length of axis (c)

(A) W (B) X (C) Y (D) Z

---

47 The following table shows the axis lengths of four crystal models of different shapes. When the angles between the axes were measured, they were right angles in all the crystal models:
If the length of axis (a) in crystal model (Z) is increased by 1 cm, the model represents a crystal that belongs to the ..... system.

Crystal (Z)	Crystal (Y)	Crystal (X)	Crystal (W)	Crystals / Axis lengths
3 cm	3 cm	4 cm	3 cm	Length of axis (a)
4 cm	4 cm	4 cm	3 cm	Length of axis (b)
5 cm	6 cm	6 cm	3 cm	Length of axis (c)

(A) cubic (B) tetragonal (C) orthorhombic (D) monoclinic

---

48 The cubic and hexagonal crystal systems are alike in that .....

(A) the number of crystal axes is equal

(B) the lengths of all the crystal axes are equal

(C) the horizontal crystal axes are perpendicular

(D) the vertical axis is perpendicular to the horizontal axes

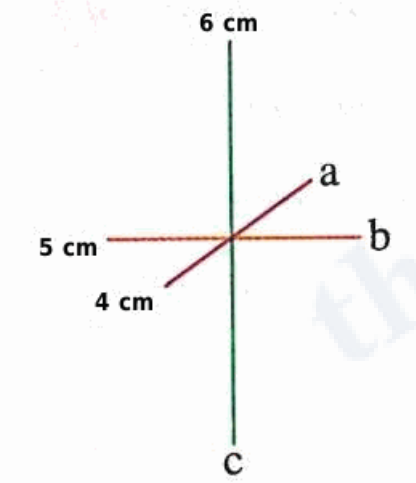
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49 The relation (a ≠ b ≠ c) does not represent crystals of the ..... system.

(A) orthorhombic (B) monoclinic (C) tetragonal (D) triclinic

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50 We have a crystal model whose axis lengths are as shown in the opposite drawing, and all its axes are perpendicular. Which of the following is correct about this model?



(A) If the length of axis (a) becomes 5 cm, it changes to the tetragonal system

(B) If the length of axis (b) becomes 4 cm, it changes to the orthorhombic system

(C) If the length of axis (c) becomes 8 cm, it changes to the trigonal system

(D) If the length of axis (a) becomes 7 cm, it changes to the hexagonal system

---

51 When three crystal axes are horizontal, the fourth is a vertical axis and there is a horizontal plane of symmetry, the crystal belongs to the ..... crystal system.

(A) trigonal (B) orthorhombic (C) hexagonal (D) tetragonal

---

52 In a crystal, if the relation between the axis lengths is (a ≠ b ≠ c), the angle between (a , b) = 90°, the angle between (c , b) = 90° and the angle between (c , a) = 100°, then the crystal system of this crystal is the ..... system.

(A) cubic (B) orthorhombic (C) tetragonal (D) monoclinic

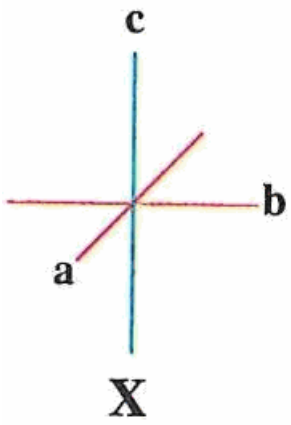
53 One crystal system that has horizontal and vertical planes of symmetry, and in which the length of axis (a3) differs from the length of axis (c), is the ..... system.

(A) tetragonal (B) cubic (C) trigonal (D) hexagonal

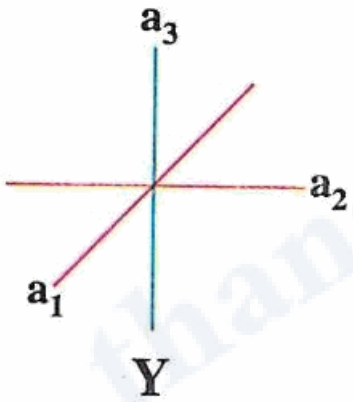
54 The cubic and orthorhombic systems are alike in .....

(A) the crystal axes being perpendicular
(B) the crystal axes being equal in length
(C) the crystal axes being unequal in length
(D) the crystal angles being unequal

55 If you know that the angles between the crystal axes are equal in the two opposite crystal shapes, then each of them may belong to the system .....



X



Y

(A) (X) cubic - (Y) tetragonal
(B) (X) triclinic - (Y) cubic
(C) (X) orthorhombic - (Y) cubic
(D) (X) cubic - (Y) hexagonal

Essay questions — 8 questions

1 Crystal systems differ according to the lengths of the crystal axes and the angles between them. Using this, explain:

(1) one similarity between a cubic crystal and a tetragonal crystal.

(2) why the triclinic system is the least symmetrical.

(3) which crystal systems have three crystal axes of equal length?

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2 Which of the following substances are minerals and which are not? Give the reason:

(1) Coal.

(2) Natural ice.

(3) Diamond.

(4) Graphite.

---

3 Crystal shapes differ from one mineral to another. In light of this, explain what results from:

(1) one axis of a model of a cubic crystal becoming longer than the other two axes, while the angles stay the same.

(2) angle (β) becoming equal to angle (γ) in a model of a monoclinic crystal.

(3) all the axes of a model of an orthorhombic crystal becoming equal in length.

(4) the length of axis (c) becoming equal to the length of axis (a) in a model of a tetragonal crystal.

---

4 A crystal may have 3 or 4 crystal axes. Using this, deduce:

(1) Which crystal has 4 crystal axes and no similarity between its upper half and its lower half?

(2) How many crystal axes does the crystal of the mineral formed by the combination of sodium ions and chlorine ions have?

(3) What relation links the angles between the crystal axes of the crystal system to which most minerals belong?

(4) Why does petroleum not have a definite crystal form?

---

5 "The presence of oxygen in the chemical composition of a mineral does not necessarily mean that the mineral belongs to the oxides group." How correct is this statement? Explain.

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6 Many industries depended on minerals in the past. In light of this, answer:

(1) Which industry depended on the discovery of fire? And what type of minerals was used?

(2) Which carbonate mineral did the ancient Egyptians use in ornaments?

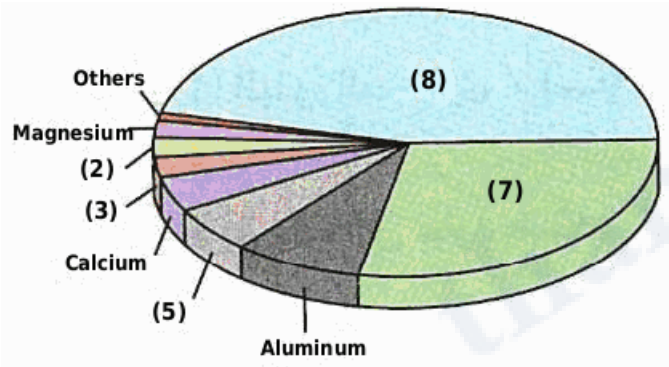
7 The opposite figure shows the percentages by weight of some chemical elements in the Earth's crust. Study it, then answer:

(1) Give the number of one of the elements that form the mineral halite.

(2) Name a mineral formed by the combination of elements (7) and (8).

(3) What is the total percentage of elements (5) and (7) of the weight of the rocks of the Earth's crust?

(4) Which numbers represent the elements that form a mineral used in the past for painting on cave walls?



8 Give one difference between each of the following:

(1) A tetragonal crystal and an orthorhombic crystal.

(2) The mineral anhydrite and the mineral sulfur.

Past exam questions — 26 questions

1 One of the minerals humans use in making building materials is ..... (Trial exam / June 2021, Sample exam 2025)

(A) olivine (B) calcite (C) granite (D) sphalerite

2 A solid inorganic substance was formed during a laboratory experiment. The substance is not considered a mineral because it ..... (Trial exam / June 2021, Sample exam 2025)

(A) is inorganic (B) is crystalline
(C) was not formed naturally (D) is a solid substance

3 Two minerals: one is used in making glass and is given the letter (A), and the other is used in making ceramics and is given the letter (B). The two minerals are respectively ..... (1st session 2021)

(A) (A) mica / (B) quartz (B) (A) quartz / (B) feldspar
(C) (A) rock crystal / (B) mica (D) (A) feldspar / (B) quartz

4 Which of the following has the characteristics of a mineral? (1st session 2021)

(A) Coal (B) Sugar (C) Ice (D) Wax

5 One of the rocks that are mostly made of one mineral and used in building is ..... (2nd session 2021)

(A) granite (B) limestone (C) basalt (D) calcite

6 Which property is not an essential part of the definition of a mineral? (1st session 2022)

(A) Having many colours (B) A definite chemical composition
(C) A distinctive crystal form (D) A fixed atomic structure

7 In a laboratory experiment, a crystalline solid of sodium chloride was formed. Is this substance considered a mineral? (2nd session 2022)

(A) Yes, because it has a definite chemical composition
(B) No, because it was prepared in the laboratory
(C) No, because it dissolves in water
(D) Yes, because it is a crystalline substance

8 Which of the following choices shows that coal is not considered a mineral? (Trial exam 2023)

(A) The chemical composition
(B) The physical state
(C) The economic importance
(D) The crystal system

9 The reason the porcelain streak plate is not considered a mineral is ..... (2nd session 2023)

(A) that its chemical composition is not definite
(B) that it was not formed in nature
(C) that it is of organic origin
(D) that its texture is glassy

10 Which of the following substances has natural solid geometric bodies? (1st session 2024)

(A) Porcelain
(B) Coal
(C) Glass
(D) Gypsum

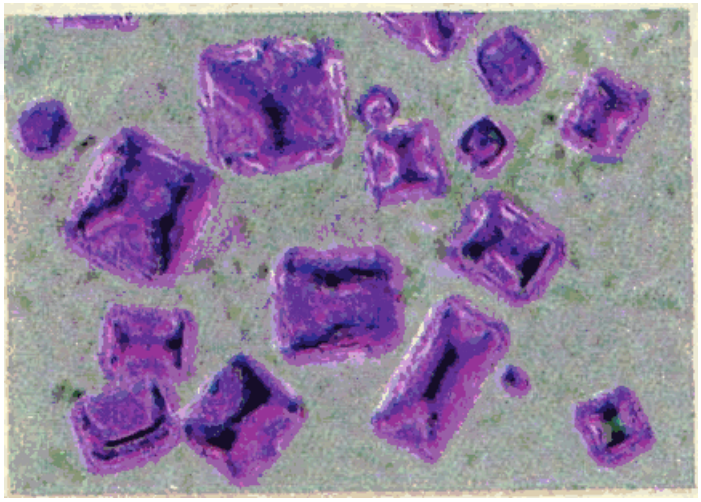
11 A mineral may be made of all of the following except ..... (2nd session 2024)

(A) a gaseous element and a solid element
(B) a gaseous element
(C) two non-metallic elements
(D) a solid element

12 Which of the following describes sugar crystals? (Sample exam 2025)

(A) They are a mineral because they have a distinctive crystal form
(B) They are a mineral because they have a definite chemical composition
(C) They are not a mineral because they are manufactured
(D) They are not a mineral because they are solid

13 The opposite picture shows kidney stones made of calcium oxalate crystals. Are these stones considered a mineral? (Sample exam / 2nd session 2025)



(A) They are a mineral because they have a distinctive crystal form

(B) They are a mineral because they have a definite chemical composition

(C) They are not a mineral because they are manufactured

(D) They are not a mineral because they are organic

---

14 Which of the following minerals is classified as a native (elemental) mineral? (Sample exam 2026)

(A) Calcite (B) Graphite (C) Coal (D) Quartz

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15 When all the angles of a model of the orthorhombic system become different, the system becomes ..... (Trial exam / June 2021)

(A) cubic (B) tetragonal (C) monoclinic (D) triclinic

---

16 The crystal system of quartz differs from that of halite. This is due to ..... (1st session 2021)

(A) the percentages of the elements in each of them

(B) the internal arrangement of the atoms and ions

(C) the type of rock each of them is found in

(D) the percentage of impurities in each of them

---

17 How many crystal systems have a vertical axis whose length differs from the other axes? (2nd session 2021)

(A) 3 systems (B) 4 systems (C) 5 systems (D) 6 systems

18 Which property distinguishes the orthorhombic system from the tetragonal system? (1st session 2022)

(A) Some faces are rectangular
(B) All the axes are equal in length
(C) All the faces are rectangular
(D) Some axes are equal in length

19 In what are a tetragonal crystal and a monoclinic crystal alike? (2nd session 2022)

(A) The lengths of the crystal axes
(B) The size of angle (β)
(C) All the angles being right angles
(D) The number of crystal axes

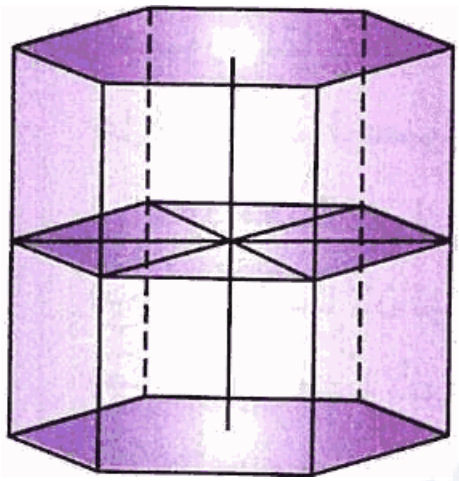
20 Which of the following crystal systems differs from the cubic system in the number of axes? (Trial exam 2023)

(A) Trigonal (B) Monoclinic (C) Tetragonal (D) Orthorhombic

21 If the length of axis (c) is twice the length of each of axes (a) and (b), and all the axes are perpendicular, to which crystal system does this crystal belong? (1st session 2023, Sample exam 2025)

(A) Hexagonal (B) Cubic (C) Tetragonal (D) Monoclinic

22 What does not characterize the opposite crystal? (2nd session 2023)



(A) It has a horizontal plane of symmetry
(B) It has 6 horizontal crystal axes
(C) The vertical axis has six-fold symmetry
(D) It has 4 crystal axes

23 Arrange the following crystal systems in descending order of degree of crystal symmetry (orthorhombic - triclinic - monoclinic - cubic) ..... (1st session 2024)

(A) Cubic → orthorhombic → monoclinic → triclinic

(B) Cubic → monoclinic → orthorhombic → triclinic

(C) Monoclinic → triclinic → cubic → orthorhombic

(D) Triclinic → orthorhombic → monoclinic → cubic

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24 To which of the following crystal systems does a crystal belong that has a horizontal plane of symmetry and the largest number of crystal axes? (2nd session 2024)

(A) The trigonal crystal system

(B) The hexagonal crystal system

(C) The cubic crystal system

(D) The triclinic crystal system

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25 A crystal that has three axes of different lengths that are not perpendicular, and has no planes of symmetry, represents the ..... system. (Sample exam 2025)

(A) triclinic (B) monoclinic (C) tetragonal (D) cubic

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26 In which of the following crystal systems is angle (β) not equal to angle (α)? (Sample exam 2026)

(A) Monoclinic and triclinic

(B) Cubic and tetragonal

(C) Orthorhombic and tetragonal

(D) Cubic and orthorhombic

Answer key and solutions

Multiple choice questions

1 C	2 D	3 A	4 A	5 B	6 B	7 D	8 C	9 D	10 B
11 B	12 D	13 A	14 A	15 B	16 C	17 C	18 C	19 B	20 A
21 A	22 B	23 B	24 C	25 C	26 D	27 C	28 B	29 A	30 C
31 D	32 C	33 C	34 C	35 D	36 B	37 D	38 C	39 D	40 A
41 B	42 D	43 D	44 B	45 C	46 A	47 B	48 D	49 C	50 A
51 C	52 D	53 D	54 A	55 C					

1 **Answer (C)**

(L) are elements that combine to form minerals (Z); minerals form rocks, and rocks form the Earth's crust (X).

2 **Answer (D)**

The letter (X) represents silicon, and flint is a silicate mineral.

3 **Answer (A)**

Diamond is a mineral, but coal is not a mineral because it is organic and not crystalline.

4 **Answer (A)**

Carbon forms the two minerals diamond and graphite.

5 **Answer (B)**

Malachite, diamond and calcite all contain carbon, but sulfur does not contain it.

6 **Answer (B)**

Oxygen, silicon and iron are among the most abundant elements, but nitrogen is rare in the crust.

7 **Answer (D)**

Oxygen combined with iron (5 %) forms the mineral hematite, which is used in the iron and steel industry.

8 **Answer (C)**

The two elements are oxygen and silicon, which form the mineral quartz, used in making lenses and eyeglasses.

9 **Answer (D)**

Quartz is used in the manufacture of glass.

10 **Answer (B)**

Cement is made from the mineral calcite, which forms limestone.

11 **Answer (B)**

A mineral is a solid, inorganic, crystalline substance, but petroleum is liquid and organic.

12 **Answer (D)**

Calcite is a natural, solid, inorganic, crystalline substance, so it is a mineral.

13 **Answer (A)**

Substance (A) is natural, solid and inorganic with a definite chemical composition and crystals, so it is a mineral of the oxides group.

14 **Answer (A)**

Coal is a natural substance with a definite chemical composition, but it is not a mineral because it is organic and has no distinctive crystal form.

15 **Answer (B)**

Calcite is a carbonate mineral, and it is the main component of limestone and marble.

16 **Answer (C)**

Both are made of more than one element, so they are compound minerals.

17 **Answer (C)**

Malachite is a green copper carbonate mineral, and it was used in ornaments in the past.

18 **Answer (C)**

19 **Answer (B)**

Calcite (calcium carbonate) is made of oxygen (46.6 %), calcium (3.6 %) and carbon (less than 1.5 %).

So the total percentage of its elements is about 50 %.

20 **Answer (A)**

Anhydrite is calcium sulfate, so it contains sulfur.

21 **Answer (A)**

Silicates (flint) are the most widespread, then sulfates (gypsum), then native elements (copper).

22 **Answer (B)**

Marble is made of the mineral calcite, which belongs to the carbonates group.

23 **Answer (B)**

Iron is 5 %, calcium 3.6 % and magnesium about 2 % of the rocks of the crust.

24 **Answer (C)**

Magnesium 2.1 %, then iron 5 %, then aluminum 8.1 %.

25 **Answer (C)**

Granite is made of quartz, feldspar and mica; pyroxene is not one of its main minerals.

26 **Answer (D)**

Gypsum and anhydrite are both calcium sulfate.

27 **Answer (C)**

Hematite is an oxide mineral, and it has been used in the past and today.

28 **Answer (B)**

Oxygen and silicon are the elements with the highest percentages in the rocks of the Earth's crust.

29 **Answer (A)**

The figure contains crystals of different systems, that is, different minerals, so it is a rock.

30 **Answer (C)**

The systems with two or more equal axes are: cubic, tetragonal, hexagonal and trigonal.

31 **Answer (D)**

The gaseous element is chlorine and the solid one is sodium; they form the mineral halite, which has cubic crystals.

32 **Answer (C)**

33 **Answer (C)**

Each mineral has a fixed atomic structure, which determines its crystal system.

34 **Answer (C)**

The system in which only two axes are equal is the tetragonal system, and it has horizontal and vertical planes of symmetry.

35 **Answer (D)**

The axis lengths are all different, so the system is orthorhombic, monoclinic or triclinic.
None of them matches the relation in (D).

36 **Answer (B)**

The plane of symmetry is the plane that divides the crystal into two identical halves.

37 **Answer (D)**

In the tetragonal system the angles are 90°, two axes are equal in length and the third is different.

38 **Answer (C)**

In the trigonal system the angles between the axes are not 90°.

39 **Answer (D)**

The shape is a hexagonal crystal, which has a vertical axis of six-fold symmetry.

40 **Answer (A)**

41 **Answer (B)**

Halite is cubic: its axes are equal in length and its angles are equal.

42 **Answer (D)**

The lengths are different, two angles are 90° and the third is different: the system is monoclinic.
It is the most common system.

43 **Answer (D)**

In both, the lengths of the three axes are different ($a \neq b \neq c$).

44 **Answer (B)**

In the orthorhombic system the axes differ in length and are all perpendicular.

45 **Answer (C)**

The shape becomes tetragonal, and its axes stay perpendicular, so the angles stay equal (90°).

46 **Answer (A)**

Halite has cubic crystals whose axes are equal in length, which matches model (W).

47 **Answer (B)**

When axis (a) is increased its length becomes 4 cm, so the axes are 4, 4 and 5 cm.
This is the tetragonal system (two equal axes and the third different).

48 **Answer (D)**

In both, the vertical axis is perpendicular to the horizontal axes.

49 **Answer (C)**

In the tetragonal system two axes are equal in length.

50 **Answer (A)**

When (a) becomes 5 cm it equals (b), so the axes become 5, 5 and 6 cm and perpendicular.
This is the tetragonal system.

51 **Answer (C)**

The hexagonal system has four axes: three horizontal and a fourth vertical one.

52 **Answer (D)**

The lengths are different, two angles are 90° and the third is 100°, which is the monoclinic system.

53 **Answer (D)**

The hexagonal system has four axes: three equal horizontal axes (a1, a2 and a3) and a different vertical axis (c).

54 **Answer (A)**

In both, the crystal axes are perpendicular.

55 **Answer (C)**

(X) has axes of different lengths and equal angles: orthorhombic.

(Y) has axes of equal lengths: cubic.

Essay questions

1 **Model answer**

(1) All the crystal axes are perpendicular, $\alpha = \beta = \gamma = 90°$; both have 3 crystal axes; both have horizontal and vertical planes of symmetry.

(2) Because the lengths of the axes and the angles between them are all different.

(3) Cubic - trigonal - hexagonal.

2 **Model answer**

(2) Natural ice, (3) diamond, (4) graphite: minerals, because they are solid inorganic substances formed in nature, with a definite chemical composition and a distinctive crystal form.

(1) Coal: not a mineral, because it is of organic origin and has no distinctive crystal form.

3 **Model answer**

(1) It changes to the tetragonal system.

(2) It changes to the orthorhombic system.

(3) It changes to the cubic system.

(4) It changes to the cubic system.

4 **Model answer**

(1) The crystal of the trigonal system.

(2) Three crystal axes.

(3) $\alpha = \gamma \neq \beta$

(4) Because it is not a mineral, as it is a liquid organic substance.

5 **Model answer**

The statement is correct, because oxygen is part of the chemical composition of most mineral groups, such as quartz (silicon dioxide), which belongs to the silicates group.

6 **Model answer**

(1) The pottery industry; clay minerals.

(2) Malachite.

7 **Model answer**

(1) (3).

(2) Quartz.

(3) 32.7 %

(4) (5) and (8).

8 **Model answer**

(1) Tetragonal: $a_1 = a_2 \neq c$, two axes are equal in length and the third is different; orthorhombic: $a \neq b \neq c$, all its axes are different in length.

(2) Anhydrite: a compound mineral; sulfur: a native (elemental) mineral.

Past exam questions

1	2	3	4	5	6	7	8	9	10
B	C	B	C	B	A	B	D	B	D
11	12	13	14	15	16	17	18	19	20
B	C	D	B	D	B	D	C	D	A
21	22	23	24	25	26				
C	B	A	B	A	A				

1 **Answer (B)**

Calcite is the main component of limestone and is used in making cement and building materials.

Granite is a rock, not a mineral.

2 **Answer (C)**

One of the conditions of a mineral is that it forms naturally, and this substance was prepared in the laboratory.

3 **Answer (B)**

Quartz is used in making glass, and feldspar in making ceramics.

4 **Answer (C)**

Ice is a solid inorganic substance formed naturally, with a definite chemical composition and a distinctive crystal form.

Coal, sugar and wax are of organic origin.

5 **Answer (B)**

Limestone is mostly made of the mineral calcite and is used in building.

6 **Answer (A)**

Having many colours is not part of the definition of a mineral; the same mineral may occur in different colours.

7 **Answer (B)**

A mineral forms naturally, so a substance prepared in the laboratory is not a mineral.

8 **Answer (D)**

Coal has no distinctive crystal form (crystal system), and it is of organic origin.

9 **Answer (B)**

The porcelain streak plate is manufactured, that is, it was not formed in nature.

10 **Answer (D)**

Gypsum is a mineral with a crystal form (a natural solid geometric body).
Porcelain and glass are manufactured, and coal is of organic origin.

11 **Answer (B)**

A mineral is a solid substance, so it cannot be made of a gaseous element alone.

12 **Answer (C)**

Sugar is a manufactured substance (of organic origin), so it is not a mineral.

13 **Answer (D)**

Kidney stones form inside the body of a living organism, so they are organic, and a mineral must be inorganic.

14 **Answer (B)**

A native mineral is made of one element, and graphite is made of carbon only.

15 **Answer (D)**

All the angles different with axes of different lengths: the triclinic system.

16 **Answer (B)**

The crystal form expresses the regular internal arrangement of the atoms and ions.

17 **Answer (D)**

In all the crystal systems except the cubic one, the length of the vertical axis differs from the other axes, so there are 6.

18 **Answer (C)**

In the orthorhombic system all the axes are different in length and perpendicular, so all the faces are rectangular.

In the tetragonal system the base is square and only some faces are rectangular.

19 **Answer (D)**

The tetragonal crystal and the monoclinic crystal each have 3 crystal axes.

20 **Answer (A)**

The trigonal system has 4 crystal axes, while the cubic system has 3 axes.

21 **Answer (C)**

The axes are perpendicular, a = b and axis c is different: the tetragonal system.

22 **Answer (B)**

The crystal is hexagonal: it has 4 axes (3 horizontal and a vertical axis), a horizontal plane of symmetry and a vertical axis of six-fold symmetry.

It does not have 6 horizontal axes.

23 **Answer (A)**

The degree of symmetry decreases as the axis lengths and angles become different: cubic → orthorhombic → monoclinic → triclinic.

24 **Answer (B)**

The hexagonal system has 4 crystal axes and a horizontal plane of symmetry.

25 **Answer (A)**

Three axes of different lengths, not perpendicular, and no planes of symmetry: triclinic.

26 **Answer (A)**

In the monoclinic system $\beta \neq \alpha = \gamma = 90°$, and in the triclinic system all the angles are different.

In the cubic, tetragonal and orthorhombic systems all the angles are 90°.