

Earth & Environmental Sciences for Sustainability: second-round sample tasks

20 entry-level tasks

For each correct answer, the participant receives 1 point.
The maximum number of points is 20.

Section 1. Geology

1) What does a mineralogist study?

A) Mineral resources

B) Minerals

C) Fossils

D) Modern plants and animals

Answer: B

2) Which of the following is NOT a fossilized organism?

A) Trilobite

B) Rugosa

C) Obsidian

D) Articulata brachiopods

Answer: C

3) Which of the following is an optical property of minerals?

A) Structure

B) Hardness

C) Cleavage

D) Color

Answer: D

4) Which mineral is a native element mineral?

A) Gold

B) Lazurite

C) Charoite

D) Pyrite

Answer: A

Section 2. Geochemistry and geophysics

1) The hardest mineral on the Mohs scale:

A) Topaz

B) Corundum

C) Diamond

D) Quartz

Answer: C

2) Which of the following minerals is formed only by hypergene processes?

A) Calcite

B) Halite

C) Galenite

ONE CLICK TO OPEN ALL DOORS

D) Bauxite

Answer: D

3) What is the name of the process of changing the chemical composition of rocks while retaining the original volume?

- A) Isomorphism
- B) Polymorphism
- C) Metasomatism**
- D) Metamorphism

Answer: C

4) Which minerals are ores for aluminium?

- A) Corundum
- B) Biotite
- C) Bauxite**
- D) Haematite

Answer: C

Section 3. Environment

1) What is the name of the factors in the inorganic environment that affect the life and propagation of living organisms?

- A) Abiotic**
- B) Living
- C) Anthropogenic
- D) Biotic

Answer: A

2) Which of the following is an example of industrial symbiosis?

- A) Construction of a waste sorting complex
- B) Utilization of sewage sludge in an agro-industrial complex within one region**
- C) Combustion of hard coal with biofuel
- D) Production of biofertilizers from symbiotic fungi

Answer: B

3) What is the danger of human impact on the biosphere?

- A) The self-regulation processes that maintain its integrity are disrupted**
- B) The diversity of domestic animals increases excessively
- C) The biogeochemical cycle and energy become more complete
- D) Famine occurs

Answer: A

4) What value of the vertical temperature gradient will ensure the development of convection in the atmosphere (thermal instability):

- A) More than 1°/100 m**
- B) Less than 1°/100 m
- C) 1°/100 m
- D) More than 1°/1 km

Answer: A

Section 4. Cartography, geography, geodesy

1) Which of the following climate zones equatorial air masses predominate during summertime?

- A) Subtropical
- B) Tropical
- C) Temperate
- D) Subequatorial**

Answer: D

2) What is the name of the highest mountain in the world?

- A) Lhotse
- B) Mount Everest**
- C) Jengish Chokusu
- D) Masherbrum

Answer: B

3) What is the purpose of levelling in geodesy?

- A) Measuring distances between points
- B) Determining height differences between points**
- C) Calculating angular measurements
- D) Analyzing magnetic variations

Answer: B

4) Which geodetic method is commonly used to measure large-scale deformations of Earth's crust?

- A) Geopotential modeling
- B) Electromagnetic induction
- C) InSAR (Interferometric Synthetic Aperture Radar)**
- D) Gravitational lensing

Answer: C

Section 5. Applied Geology and Mining

1) Which of the following reservoir rocks has the highest porosity and permeability, making it an ideal storage space for hydrocarbons?

- A) Sandstone**
- B) Shale
- C) Quartzite
- D) Gneiss

Answer: A

2) Which drilling fluid is the most affordable and readily available for well drilling?

- A) Service water**
- B) Clay mud
- C) Hydrogel
- D) Polymer drilling mud

Answer: A

3) What is the first technological operation of ore preparation for mineral processing?

ONE CLICK TO OPEN ALL DOORS

- A) **Crushing**
 - B) Screening
 - C) Ore-dressing
 - D) Filtration
- Answer: A

4) Which of the following are three-dimensional geological models?

- A) Cross-section
 - B) Simulation model
 - C) Grid model
 - D) **Wire-frame model**
- Answer: D

10 intermediate-level tasks

For two correct answers, the participant receives 5 points.

For one correct answer, the participant receives 3 points.

For three selected answers, two of which are correct, the participant receives 3 points.

For two selected answers, one of which is correct, the participant receives 2 points.

For three selected answers, one of which is correct, the participant receives 1 point.

For four selected answers, two of which are correct, the participant receives 1 point.

0 point - other cases.

The maximum number of points is 50.

Section 1. Geology

1) Name TWO major mass extinctions that have occurred in Earth's history:

- A) **Permian-Triassic**
 - B) Paleogene-Neogene
 - C) **Cretaceous-Paleogene**
 - D) Cambrian-Ordovician
 - E) Paleogene-Quaternary
 - F) Serpukhovian-Bashkirian
- Answers: A, C

2) What TWO methods can be used to determine the absolute (radiometric) age of rocks?

- A) Biostratigraphic method
 - B) Geophysical methods
 - C) **Uranium–lead dating**
 - D) Gamma ray logging
 - E) **Potassium–argon dating**
 - F) Law of superposition
- Answers: C, E

Section 2. Geochemistry and geophysics

1) What TWO minerals dominate the composition of the mantle?

- A) Quartz
- B) Feldspars
- C) **Olivine**
- D) **Pyroxene**

- E) Calcite
 - F) Potassium salts
- Answers: C, D

2) What TWO geophysical methods of prospecting for mineral deposits can be applied from various flying objects?

- A) Radiometry**
 - B) Seismic survey
 - C) Magnetic survey**
 - D) Gravimetry
 - E) Well logging
 - F) Method of induced polarization
- Answers: A, C

Section 3. Environment

1) Which TWO colors have wavelengths longer than yellow rays:

- A) Dark blue
 - B) Orange**
 - C) Red**
 - D) Green
 - E) Violet
 - F) Blue
- Answers: B, C

2) The Amazon is one of the largest and longest rivers in the world. However, not a single bridge has been built along the entire length of the river. What is the reason? The width of the riverbed is not a limitation. Select TWO answers.

- A) High water rises during the rainy season and widespread flooding**
 - B) Presence of animals from the red book
 - C) Swampy and soft soil (weak soil) that makes it difficult to construct any engineering structures**
 - D) Dangerous animals
 - E) Economic hardship
 - F) Religious beliefs
- Answers: A, C

Section 4. Cartography, geography, geodesy

1) Which TWO countries have the smallest territories?

- A) Vatican City State**
 - B) Tongo
 - C) Egypt
 - D) Monaco**
 - E) Mali
 - F) UAE
- Answers: A, D

2) What are the TWO primary applications of bathymetric surveys?

- A) Seafloor mapping**
- B) Analysis of plate shear rate
- C) Navigation safety**

- D) Wind speed prediction
 - E) Atmospheric pressure study
 - F) Urban planning
- Answers: A, C

Section 5. Applied Geology and Mining

1) Choose TWO sources of geological data that are crucial for accurate mineral deposit modeling:

- A) Mineral commodity prices
 - B) Historical mining records
 - C) Core samples**
 - D) Drill logs**
 - E) Mining equipment specifications
 - F) Satellite images
- Answers: C, D

2) Select TWO minerals that can be most effectively enriched using magnetic methods:

- A) Magnetite**
 - B) Ilmenite**
 - C) Chromite
 - D) Molybdenite
 - E) Galena
 - F) Bornite
- Answer: A, B

3 tasks of a difficult level.

For each correct answer, the participant receives 10 points.

The maximum number of points is 30.

Section 2. Geochemistry and geophysics

1) Name the internal and external factors of chemical element migration.

Answer:

External factors: determined by environmental conditions:

- 1) T,P(degassing);
 - 2) pH(acidity)-Cl,F,complex anions, humic acids(organic).(alkalinity)-K,Na.
 - 3) eH- redox potential. Oxidising agent - O₂, reducing agent - S,C, hydrocarbons.
- The higher the temperature, the more active the migration.

Internal factors: Determined by the properties of atoms and compounds.

- 1) ratio of valence to ion radius
- 2) affinity for oxygen or sulphur
- 3) variable valence (depends on eH)
- 4) chemical activity
- 5) biophilicity
- 6) ability to be sorbed
- 7) molecular weight
- 8) melting point etc.
- 9) volatility (H₂, H₂S, Cl, B);
- 10) hardness of the substance.

Criteria for evaluation:

- Full and detailed answer - 10 points
- Only internal factors are listed - 5 points
- Only external factors are listed - 5 points
- Incomplete answer for both internal and external factors - 3 points
- Incomplete answer for internal factors only - 1 point
- Incomplete answer for external factors only - 1 point

Section 3. Environment

1) As a result of the prolonged use of pesticides in agricultural fields, the population of pests can significantly surge during a particular growing season. Give reasons behind this phenomenon and provide a rationale for the mechanisms that lead to an increase in the Colorado potato beetle population within a potato field following the application of pesticides.

Answer:

The increase in the Colorado potato beetle population after pesticide treatment can be attributed to several factors. Firstly, while most individuals die due to pesticide application, some may possess genes that give them resistance to these pesticides (First reason).

These resistance genes can develop through mutations in certain individuals, rendering the presence of pesticides ineffective. Consequently, resistant individuals continue to reproduce. Furthermore, the application of pesticides can inadvertently eliminate other organisms that serve as natural enemies of the Colorado potato beetle. With the absence of competitors and a reduced presence of natural predators, the surviving Colorado potato beetle individuals find themselves in an environment rich with food resources, which further stimulates their reproduction (Second reason).

Criteria for evaluation:

- Two reasons are given and explained - 10 points
- One reason is given and explained - 5 points
- No correct reasons are given - 0 points.

Section 5. Applied Geology and Mining

1) The mining enterprise for the extraction of iron ore is developing a deposit by an open-pit mining method. The deposit development system is longitudinal with a single open pit side; the mined ore is transported by trucks. Currently, the depth of the open pit is 100 m, the bench height is 20 m, the working bench face angle is 70°, and the width of the ramp is 45 m. A haulage berm of 20 m width is organized on each bench of the non-working slope of the pit; the face angle of the non-working bench is 64°.

Determine the overall angle of the working and non-working slopes of the open-pit sides. Give the solution in detail, and write the answer in the form XX.XX°.

Answer:

1. To determine the overall slope angles of the pit sides, it is necessary to determine the number of mining benches n first:

$$n = \frac{H_{pit}}{H_{bench}} = \frac{100}{20} = 5,$$

where H_{pit} – depth of the open pit, m
 H_{bench} – height of the bench, m.

2. The overall angle of the working slope γ_{work} can be found from the expression:

$$tg \gamma_{work} = \frac{H_{pit}}{(n-1) \cdot B_{ramp} + n \cdot H_{bench} \cdot ctg \alpha_{work}} = \frac{100}{(5-1) \cdot 45 + 5 \cdot 20 \cdot ctg 70} = 0.462$$

$$\gamma_{work} = 24.79^\circ,$$

B_{ramp} – the width of the ramp, m

α_{work} – the working bench face angle.

3. The overall angle of the non-working slope $\beta_{non.work}$ can be found from the expression:

$$tg \beta_{non.work} = \frac{H_{pit}}{(n-1) \cdot B_{haul.berm} + n \cdot H_{bench} \cdot ctg \alpha_{non.work}} = \frac{100}{(5-1) \cdot 20 + 5 \cdot 20 \cdot ctg 64} = 0.776$$

$$\beta_{non.work} = 37.81^\circ,$$

$B_{haul.berm}$ – the width of the haulage berm on the non-working slope of the pit, m

$\alpha_{non.work}$ – the non-working bench face angle.

Criteria for evaluation:

Correctly calculated number of mining benches n – 2 points

Correctly calculated angle of the working slope γ_{work} – 4 points

Correctly calculated overall angle of the non-working slope $\beta_{non.work}$ – 4 points