Earth Sciences
Sample test

Module 1. Choose one correct answer (each question is worth 2 points)

1.1 Which of the isotope-geochemical methods for determining rock age is employed in Quaternary geology?

A) the Uranium-thorium-lead method;
B) the Potassium-argon method;
C) the radiocarbon method;
D) the Argon method.
Answer: C.

1.2 Which subduction zones have no island arcs or marginal seas?

A) the Andean subduction zone;
B) the Sunda subduction zone;
C) the Mariana subduction zone;
D) the Japanese subduction zone.
Answer: A.

1.3 Which areas of continental lithosphere have NOT undergone considerable changes since the Precambrian?

A) rifts;
B) allochthons;
C) cratons;
D) drumlins.
Answer: C.

1.4 The formation of which geological feature is associated with substantial temperature differences?

A) salt diapir;
B) solifluction;
C) salt deposit;
D) salt dome.
Answer: B.

1.5 The main purpose of the spontaneous potential (SP) logging method is:

A) reservoir oil-saturation estimation;

B) cased-hole formation evaluation;

C) the lithologic differentiation of a geological section;

D) an assessment of fracturing in carbonate rocks.

Answer: C.

1.6 Which of the following is NOT used to describe the earth's magnetic field?

A) isodynamic line;

B) isogon;

C) isocline;

D) isobar.

Answer: D.

1.7 What is pleochroism?

A) the ability of a mineral to change its group when the table rotates;

B) the ability of a mineral to change its color depending on the lighting;

C) the ability of a mineral to change its interference color when rotated in polarized light;

D) the ability of a mineral to change its color when the polarizer rotates.

Answer: D.

1.8 The collision of which two plates formed the Andes?

A) Nazca and South American;

B) Juan de Fuca and Pacific;

C) Caribbean and North American;

D) Eurasian and Philippine.

Answer: A.

1.9 What is the term for a cylindrical rock sample taken from a drilling well to study its properties?

A) a core sample;

B) a lump;

C) a sludge;

D) a piece.

Answer: A.

1.10 Which of the following gases is NOT a greenhouse gas?

A) carbon dioxide;

B) methane;

C) water vapor;

D) nitrogen.

Answer: D.

1.11 What is the term for restoring the quality of lands disturbed by mining operations?

A) renovation;

B) recultivation;

C) dumping;

D) reconstruction.

Answer: B.

1.12 Which of the following can be done with Inverse Distance Weighted (IDW)?

A) a dip test;

B) grade estimation in block models;

C) determining the position of a wireframe model in space;

D) determining the ore body volume.

Answer: B.

Module 2. There is more than one correct answer to each question.

2.1 Which THREE geological features form without participation of water?

A) kames;

B) dunes;

C) bars;

D) loesses;

E) eskers;

F) barchans;

G) sandurs.

Answer: B, D, F.

Assessment criteria:

1 point for one correct answer;

2 points for two correct answers;

4 points for all correct answers.

2.2 Which THREE fauna groups belong to so-called orthostratigraphic groups determining zonal subdivisions (these subdivisions define GSSPs for the lower boundaries of stages in the International Chronostratigraphic Chart)?

A) gastropods;
B) graptolites;
C) rugose corals;
D) atromatolites;
E) conodonts;
F) tabulate corals;
G) ammonites;
H) vertebrates;
I) chitinozoans.

Answer: B, E, G

Assessment criteria:

1 point for one correct answer;
3 points for two correct answers;
5 points for all correct answers.

2.3 Which THREE minerals are diamagnets?

A) dolomite;
B) olivine;
C) halite;
D) fluorite;
E) chlorite;
F) barite;
G) siderite.

Answer: C, D, F.

Assessment criteria:

1 point for one correct answer;
2 points for two correct answers;
4 points for all correct answers.

2.4 Which TWO minerals are diamond indicators?

A) spessartine;

B) pyrope;
C) picroilmenite;
D) orthopyroxene;
E) staurolite;
F) calcite;
G) gold.
Answer: B, C.
Assessment criteria:
3 points for one correct answer;
5 points for all correct answers.

2.5 Select the THREE deepest trenches:
A) the Puerto Rico Trench;
B) the Aleutian Trench;
C) the Tonga Trench;
D) the Izu-Bonin Trench;
E) the Philippine Trench;
F) the Kuril-Kamchatka Trench;
G) the Kermadec Trench;
H) the Japan Trench;
I) the Mariana Trench.
Answer: C, E, I.
Assessment criteria:
1 point for one correct answer;
3 points for two correct answers;
5 points for all correct answers.

2.6 Which THREE minerals are NOT zinc minerals?
A) sphalerite;
B) zincite;
C) pentlandite;
D) smithsonite;
E) calamine;
F) mackinawite;
G) mooihoekite.
Answer: C, F, G.

Assessment criteria:
1 point for one correct answer;
2 points for two correct answers;
4 points for all correct answers.

2.7 Which THREE characteristics of clayey rocks are used to assess the stability of the slope structure (slope, open-pit, etc.)?

A) density;
B) granulometric composition;
C) mineral composition;
D) internal friction angle;
E) compressive strength;
F) Young's modulus;
G) soil adhesion;
H) the content of dust particles.

Answer: A, D, G.
Assessment criteria:
1 point for 1 correct answer;
3 points for 2 correct answers;
5 points for all correct answers.

Module 3. Give a detailed answer (the correct answer is worth 11 points).

3.1 Task: Describe the structure of the East European Platform.
Points are awarded for each element of the answer. You may change the order of the elements.
a) What shields are part of the East European Platform? (**1 point**)
b) What rocks make up the East European Platform basement? (**1 point**)
c) What are the occurrence depths of the East European Platform basement? (**2 points**)
d) What is the age of marine sedimentary formations of the East European Platform cover? (**2 points**)
e) What is the age of the continental sedimentary formations of the East European Platform cover? (**1 point**)
f) What are the largest syneclises in the East European Platform? (**2 points**)
g) What are the largest aulacogens in the East European Platform? (**2 points**)

Solution
a) the Baltic Shield, the Ukrainian Shield and the Russian Plate (**1 point**),
b) crystalline schists and granites (**1 point**),

c) 1-2 km in the Moscow Syneclise and over 5 km in the Dnieper-Donets and Caspian (Pricaspian/Peri-Caspian) Depressions (**2 points**),
d) The marine sediments of the cover: Cambrian, Ordovician, Silurian, Upper Devonian, Middle-Upper Carboniferous, Lower Permian, Jurassic (center of the platform) and Cretaceous (south of the platform) (**2 points**),
e) Lower-Middle Devonian, Lower Carboniferous, Upper Permian, Mesozoic (**1 point**),
f) the Mezen, Moscow, Baltic, Ukrainian, Caspian (Pricaspian/Peri-Caspian), Ulyanovsk-Saratov Syneclises (**2 points**),
g) the Moscow, Pachelmsky, Dnieper-Donets, Kama-Belsky Aulacogens (**2 points**),
TOTAL: 11 points

3.2 A gravity station is located on land at an altitude h = 500 m above sea level. The average rock density in the area of the station is ρ = 2.67 g/cm³. The theoretical value of gravity is g_t= 980,900.00 mGal, the observed gravity is g = 980,700.50 mGal.
1. Calculate the free air correction.
2. Calculate the Bouguer correction.
3. Calculate the free-air gravity anomaly.
4. Calculate the Bouguer gravity anomaly.
Round the results to two decimal places.
Useful information
Universal gravitational constant $G = 6.67 \cdot 10^{-11}$ N·m²/kg²;
1 mGal = 10^{-5} m/s²;
1 N = 1 kg · 1 m/s²;
π = 3.14.
Solution
1. The free air correction (FAC) is calculated using the formula:
FAC = h · 0.308 [mGal/m] = 500.0 [m] · 0.308 [mGal/m] = 154.00 mGal.
2. The Bouguer correction (BC) is computed as follows:
$BC = 2 \cdot \pi \cdot G \cdot \rho \cdot h = 2 \cdot \pi \cdot 6.67 \cdot 10^{-11}$ [N·m²/kg²] · ρ [g/cm³] · h [m] = $41.9 \cdot 10^{-11}$ [N·m²/kg²] · 2.67 · 10^3 [kg/m³] · 500.0 [m] = $41.9 \cdot 10^{-8} \cdot 2.67 \cdot 500.0$ [N/kg] = $55936.5 \cdot 10^{-8}$ [m/s²] = $55936.5 \cdot 10^{-3} \cdot 10^{-5}$ [m/s²] = $55.94 \cdot 10^{-5}$ [m/s²] = 55.94 mGal.
3. The free air gravity anomaly (Δg_{FA}) is:
$\Delta g_{FA} = g - g_t + FAC$ = 980 700.50 [mGal] - 980 900.00 [mGal] + 154.00 [mGal] = -45.50 mGal.
4. The Bouguer gravity anomaly (Δg_B) is:
$\Delta g_B = \Delta g_{FA} - BC$ = -45.50 [mGal] - 55.94 [mGal] = -101.44 mGal.
Assessment criteria:

1. A correctly calculated free air correction (FAC) is worth 2 points.
2. A correctly determined Bouguer correction (BC) is worth 3 points.
3. A correctly found free-air gravity anomaly (Δg_{FA}) is worth 3 points.
4. A correctly estimated Bouguer gravity anomaly (Δg_B) is 3 points.

TOTAL: 11 points.

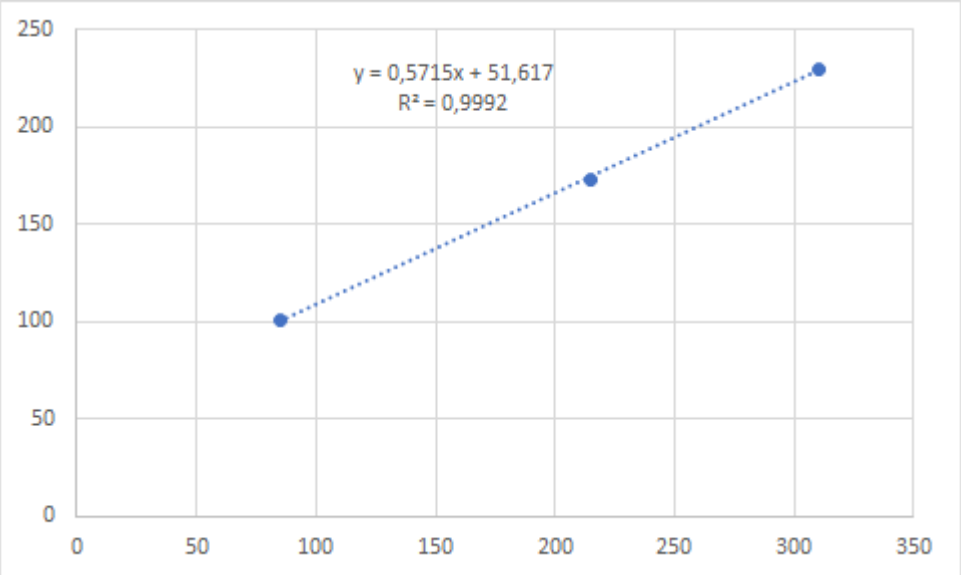
3.3 Determine the angle of internal friction of the rock based on the results of a shear test. Seven measurements were carried out for each of the normal stress. Round the results to two decimal places.

Normal stress, kPa	Ultimate shear stress, kPa						
85	102.07	102.07	98.07	103.07	96.07	108.07	98.07
215	177.13	179.13	165.13	168.13	167.13	184.13	166.13
310	231.98	222.98	235.98	218.98	235.98	225.98	237.98

Solution:

1. A calculation of the average shear stress for each normal stress gives 101.07 kPa, 172.42 kPa and 229.98 kPa.
2. Then, a least squares linear approximation is performed:

Normal stress, kPa	Ultimate shear stress, kPa
85	101.07
215	172.42
310	229.98



3. The angle of internal friction is determined as the arctangent of the proportionality coefficient in the resulting straight line. It equals arctan (0.5715) = 29.75 degrees

Answer: 29.75
3 points for correctly calculated average values of shear stress for each normal stress;
6 points for the data approximation;
2 points for the correct answer in the correct format.

3.4 Calculate the indicators of the completeness and quality of ore extraction, using the following data.
These data were obtained by stoping and surveying measurements during the extraction of ore reserves in a producing block:

- the commercially viable reserves in the block (B) = 3300 thousand tons;
- the ore mined from the block at the end of stoping (D) = 2990.8 thousand tons;
- the actual total loss of ore in the block (P) = 350.3 thousand tons;
- the diluting rock mass (B) = 40.3 thousand tons;
- the average of the ore in commercial reserves in the block (c) = 48.3%;
- the average grade of produced ore in the block (a) = 46.9%;
- the average grade of ore mixed with dradge rock in the block (b) = 0%

Answer:
The loss factor is 10.6 %; the dilution factor is 1.3 %; the recovery factor is 0.97; the extraction ratio is 0.88.

Assessment criteria:
2 points for a correctly determined loss factor;
3 points for a correctly determined dilution factor;
3 points for a correctly determined recovery factor;
3 points for a correctly determined extraction ratio.
Total: 11 points.