Earth and Environmental Sciences: Second-round Sample Tasks for the Open Doors Bachelor's Track

This sample test comprises 30 tasks, including: 19 entry-level tasks, each correct answer assigned 2 points; 8 intermediate-level tasks, each correct answer assigned 4 points; 3 advanced-level tasks requiring a detailed answer, each correct answer assigned up to 10 points, depending on its correctness and completeness.
For advanced-level tasks requiring a detailed answer, assessment criteria, and a standard answer are provided.

Field of Science 1. Water Resources

Task 1
Entry level (2 points)

Which of the following water pollutants are generated exclusively through human activity?

a) Oil
b) Salts
c) **Dibenzofurans**
d) Hydrogen sulfide

Answer: c

Task 2
Entry level (2 points)

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Lakes are more susceptible to eutrophication than rivers because they typically have:

a) shallower depth.
b) **slower water flow.**
c) higher salinity.
d) less sediment.

Answer: b

Task 3
Intermediate level (4 points)

Select the two statements that most accurately capture the characteristics of Lake Victoria.

a) The third largest freshwater lake in the world, it is located within the territories of three African countries: Tanzania, Kenya, and Uganda.

b) **The second largest freshwater lake in the world by surface area, it is located within the territories of three African states: Tanzania, Kenya, and Uganda.**
c) It ranks as the third largest freshwater lake in the world by volume.
d) It is the largest freshwater lake in the world by volume.
e) **Fed primarily by precipitation and river inflow, the lake is subject to severe storms triggered by hurricane-force winds accompanying tropical thunderstorms.**
f) The lake basin generally experiences calm conditions and is primarily fed by groundwater.

Answer: b, e

Task 4
Advanced level (10 points)

It is known that approximately 3.8 billion years ago, the concentration of sodium chloride (NaCl) in the primordial ocean was 0.9% by mass—equivalent to the salt concentration in human blood. Today, the average salt concentration in the World Ocean has increased to 3.47%. Explain why the salt concentration in the World Ocean has changed over time. Calculate how much salt has entered the World Ocean during this period, assuming the total mass of seawater has remained constant at 1.34×10^{21} kg.

Note: A complete solution must include your method and reasoning. Providing the final answer alone will not suffice.

Solution:
1. The concentration of salts in the World Ocean has gradually increased due to neutralization reactions between acids formed in water during volcanic eruptions and alkaline elements—such as sodium, magnesium, potassium, and calcium—that entered the water as a result of rock weathering. Alkaline elements combined with chlorine, fluorine, and bromine, neutralizing the solution.
2. The concentration of salts in the World Ocean has increased by *3.47-0.9=2.57%*, i.e. 2.57 g/100 g sea water
3. Consequently, the mass of salts in the World Ocean has increased by $2.57\cdot1.34\cdot10^{21}$ = $\boldsymbol{3.44\cdot10^{21}}$ ***kg***.

Answer: 3.44·1021 kg of salt has entered the World Ocean

Assessment criteria
Criterion 1: 4 points.
Criterion 2: 3 points.
Criterion 3: 3 points.

Field of Science 2. Geology

Task 5
Entry level (2 points)

To which rock group does granite belong?

a) Sedimentary rocks
b) **Magmatic rocks**

c) Metamorphic rocks
d) It is not a rock

Answer: b.

Task 6
Entry level (2 points)

While planning a field trip, geologists drew straight lines on a map that lie in the same plane and do not intersect. What are these lines called?

a) Intersecting
b) Perpendicular
c) **Parallel**
d) Crossed

Answer: c.

Task 7
Intermediate level (4 points)

Select two countries from the list that have the largest uranium reserves in the Earth's subsoil.

a) **Australia**
b) Japan
c) **Namibia**
d) China
e) USA
f) Russia

Answer: a, c.

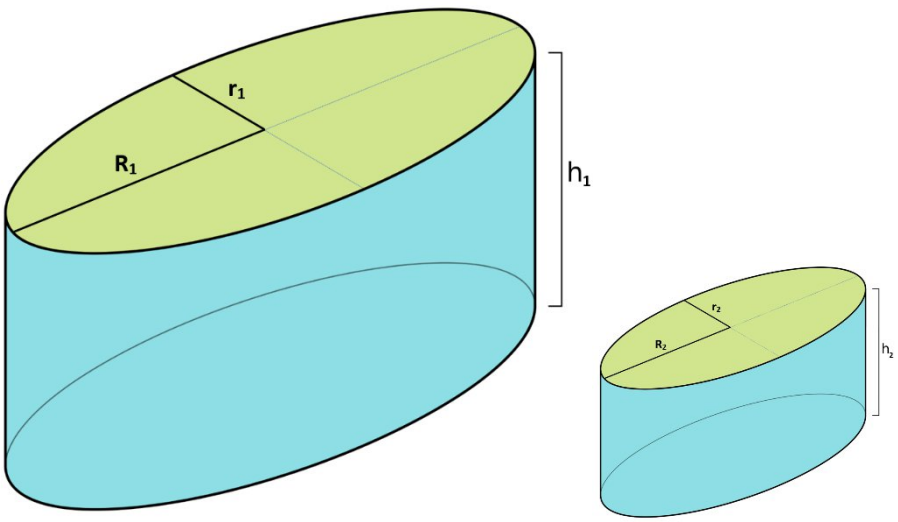
Task 8
Advanced level (10 points)

The majority of the continent lies in the southern and eastern hemispheres. It is partly bordered by the Atlantic and Indian Oceans, with a predominantly tropical climate and some subtropical areas. Several countries in this region possess vast reserves of a non-metallic mineral, accounting for a significant portion of the world's total. This mineral has substantial raw material value. Geologists have discovered and studied a new deposit of the mineral, which consists of two ore bodies of the same shape but different sizes. The ore bodies are elliptical (oval) cylinders, with the oval side exposed on the surface. The first ore body has a mineralization depth of 400 m and an oval shape on the surface, with a semi-major axis of 1000 m and a semi-minor axis of 500 m along the strike direction. The second ore body has a volume of 628,000 m^3. The geometric shape of both ore bodies is constant, with the radii and depths changing proportionally. The value of π is taken as 3.14.

1) Identify the continent and the specific region described above.
2) Name the mineral in question.
3) Determine the factor by which the surface exposure area of the second ore body is less than that of the first.

Note: A complete solution must include your method and reasoning. Providing the final answer alone will not suffice.

Solution: The two continents surrounded by the Atlantic and Indian Oceans are Africa and Antarctica. However, based on the described climate and the presence of countries, the continent in question is Africa. The southern region of Africa experiences a predominantly tropical climate, with subtropical conditions manifesting to a lesser degree. Two countries in this region—South Africa and Botswana—hold significant diamond reserves, together accounting for over 20% of the world's total. Diamonds belong to non-metallic minerals and are a valuable type of raw material.
Since the ore bodies have the shape of an elliptical (oval) cylinder, their volume should be calculated using the formula $V = \pi \cdot R \cdot r \cdot h$. Based on the dimensions of the first ore body specified in the task—mineralization depth (h) of 400 m, radius (R) of the long semi-major axis of 1000 m, and radius (r) of the short semi-major axis of 500 m—the volume is calculated as $V_1 = 3.14 \cdot 1000\ m \cdot 500\ m \cdot 400\ m = 628{,}000{,}000\ m^3$. The volume of the second ore body is 1000 times smaller than that of the first one ($V_1 / V_2 = 628{,}000{,}000\ m^3 / 628{,}000\ m^3 = 1000$).
The volume of the second ore body is 1000 times smaller than that of the first one ($V_1 / V_2 = 628{,}000{,}000\ m^3 / 628{,}000\ m^3 = 1000$). Given that the ore bodies share the same geometric shape, all linear dimensions (radii and height) change proportionally with the volume. By the scaling law, linear dimensions change relative to volumetric quantities by the cube root. This means the linear dimensions (R, r, h) of the second ore body are $\sqrt[3]{1000} = 10$ smaller than those of the first.
Accordingly, $R_2 = 100\ m$, $r_2 = 50\ m$, $h_2 = 40\ m$. Thus, the surface exposure area of the second ore body is 100 times smaller than that of the first, calculated as $S_1/S_2 = (\pi \cdot R_1 \cdot r_1) / (\pi \cdot R_2 \cdot r_2) = (R_1 \cdot r_1) / (R_2 \cdot r_2) = (1000\ m \cdot 500\ m) / (100\ m \cdot 50\ m) = 100$.
The graphical representation of the figure is shown below.



Answer:
1) Africa, southern Africa (or southern part of Africa)
2) Diamonds

3) 100 (the surface exposure area of the second ore body is 100 times smaller than that of the first.)

Assessment criteria
Criterion 1: 3 points.
Criterion 2: 3 points.
Criterion 3: 4 points.

Field of Science 3. Geochemistry and Geophysics

Task 9
Entry level (2 points)

To which class of minerals does zircon ($ZrSiO_4$) belong?

a) Sulfides
b) Sulfates
c) Silicates
d) Arsenides

Answer: c.

Task 10
Entry level (2 points)

Geophysicists are conducting an experiment. The voltage in the electric power line is 220 V, and the resistance of the ore sample is 88 Ω. What is the electric current in the ore sample?

a) 0,25 A
b) 0.4 A
c) 2.5 A
d) 25 A

Answer: c.

Task 11
Intermediate level (4 points)

Which two of the following materials (substances) are not attracted to a magnet or are attracted the least?

a) Glass
b) Cast iron
c) Steel
d) Cobalt
e) Diamond
f) Copper

Answer: a, e.

Field of Science 4. Meteorology and Atmospheric Sciences

Task 12
Entry level (2 points)

Identify the atmospheric layer with the following characteristics:

- It is the lowest and densest layer of the atmosphere;
- Nearly all air and water vapor are concentrated in it, where fog, clouds, and precipitation form.

a) Stratosphere
b) Troposphere
c) Asthenosphere
d) Mesosphere

Answer: b

Task 13
Entry level (2 points)

Which greenhouse gas has the highest global warming potential, considering that climate change is linked to the presence of greenhouse gases in the atmosphere, but their contributions to global warming differ?

a) CO_2
b) H_2O
c) **SF_6**
d) CH_4

Answer: c

Task 14
Intermediate level (4 points)

Select two accurate statements that describe Los Angeles–type smog.

a) This is wet smog formed with the participation of fog.
b) **This is dry smog resulting from photochemical reactions.**
c) **Los Angeles-type smog contains gases and aerosols at elevated concentrations.**
d) Los Angeles-type smog contains mainly solid particles entering the atmosphere from natural sources.
e) Los Angeles-type smog does not have a significant impact on human health due to its short duration.

Answer: b, c.

Field of Science 5. Mineralogy

Task 15
Entry level (2 points)

To which class of minerals does arsenopyrite (FeAsS) belong?

a) Sulfides
b) Sulfates
c) Silicates
d) Arsenides

Answer: a.

Task 16
Entry level (2 points)

When studying minerals under the microscope, an optical phenomenon is observed: as light passes from an optically rarer medium to an optically denser medium, the angle of refraction of the light ray...

a) is always smaller than the angle of incidence
b) is always equal to the angle of incidence
c) is always greater than the angle of incidence
d) does not depend on the angle of incidence

Answer: a.

Task 17
Intermediate level (4 points)

Which two of the following are non-ferrous metals?

a) Tin ore
b) Iron ore
c) Copper ore
d) Gold ore
e) Marble
f) Peat

Answer: a, c.

Field of Science 6. Environmental Sciences

Task 18
Entry level (2 points)

Which of the following is the main energy source for living organisms?

a) Sunlight
b) Movement of air masses
c) Electromagnetic field
d) Minerals

Answer: a

Task 19
Entry level (2 points)

Which of the following is a renewable natural resource?

a) Coal
b) Wood
c) Oil
d) Gas

Answer: b

Task 20
Intermediate level (4 points)

Which two groups of organisms are pioneers in colonizing lifeless substrates during primary succession?

a) Methanogenic bacteria
b) Lichens
c) **Mosses**
d) Diatoms
e) Perennial herbs
f) Trees

Answer: b, c.

Field of Science 7. Physical Geography

Task 21
Entry level (2 points)

What is a consequence of the Earth's axial rotation?
a) the alternation of day and night
b) the existence of the International Date Line
c) the deflection of wind to the left
d) the deflection of wind to the right

Answer: a

Task 22
Entry level (2 points)

The World Ocean is composed of the following parts:

a) oceans, seas, bays, and straits
b) oceans, seas, islands, bays, and continents
c) oceans, islands, peninsulas, and mountains

Answer: a

Task 23
Intermediate level (4 points)

Fill in the blanks using the words provided below, placing them in the correct order.
“A cyclone is a(n) _____ rotating air vortex with _____ atmospheric pressure at its center, which increases toward the periphery. Cyclones develop in the temperate and polar latitudes of both hemispheres due to the collision of contrasting air masses and the influence of Earth’s rotation.”

a) descending
b) moderate
c) ascending
d) high
e) low
f) medium

Answer: c, e.

Field of science 8. Ecology

Task 24
Entry level (2 points)

_____ are the representatives of non-cellular life forms. Indicate the missing word.

a) Fungi
b) Viruses
c) Bacteria
d) Protozoa

Answer: b

Task 25
Entry level (2 points)

What percentage of the biosphere's phytomass is composed of higher plants?

a) 0,2%
b) 68%
c) 99,8%
d) 32

Answer: c

Task 26
Intermediate level (4 points)

Select two human viral diseases.

a) AIDS
b) Giardiasis
c) Tetanus
d) Polio
e) Plague

Answer: a, d

Task 27
Advanced level (8 points)

Black fur color is dominant over white in guinea pigs. Two heterozygous males and females were crossed. What phenotypes will the first-generation offspring exhibit?

Note: A complete solution must include your method and reasoning. Providing the final answer alone will not suffice.

Solution:
Given: A—black (dominant), a—white (recessive)
Parental generation: ♀ Aa × ♂ Aa
Gametes: A, a and A, a
F 1 — ?
F1:
F1: AA, Aa, Aa, aa
b b b w

Answer: ¾ of the first-generation hybrids will be black, ¼ will be white.

Assessment criteria
Criterion 1: 2 points.
Criterion 2: 4 points.
Criterion 3: 2 points.

Field of Science 9. Mining and Mineral Processing

Task 28
Entry level (2 points)

Which element increases a metal's resistance to corrosion?

a) Hydrogen
b) Aluminum
c) Nickel
d) Iron

Answer: c.

Task 29
Entry level (2 points)

Find the volume of a mine workings shaped like a cube with a base area of 36.

a) 1296
b) 108
c) 72
d) 216

Answer: d.

Task 30
Intermediate level (4 points)

Which two countries from the list are leaders in gold production?

a) Ghana
b) Russia
c) Saudi Arabia
d) Brazil
e) China
f) South Africa

Answer: b, e.