IESO 2026 TURIN

WRITTEN TEST 5 — MINERALS UNDER INTERROGATION

Forensic geology investigation using geological materials collected and analysed in the laboratory

Time: 40 minutes • Questions: 18 • Score: 18 points • Read all the data before answering. Only one correct answer for all questions.

INTRODUCTION

In September 2025, in an abandoned quarry of marly limestone in the Emilian Apennines, the body of a person who had been missing for several days was found. The body lies at the base of an artificial excavation face, partly covered by fine debris and rock fragments.

Investigators hypothesise that the victim may have been killed elsewhere and that the body was transported to the quarry and subsequently concealed there. The suspect owns an off-road vehicle frequently used to access rural areas.

Terminological note. In forensic geology, when two samples are compared, the correct technical terminology is "comparable", not "compatible". For this reason, the term "comparable" is used throughout this test.

Materials collected:

1. Soil and dust samples from the victim's clothing and shoes.
2. Soil and fine material from the mats, boot and mudguards of the suspect's vehicle.
3. Comparison samples from three reference areas:

Area A Quarry floor: calcareous-marly debris, angular limestone fragments, marine microfossils, high carbonate content (65–72%), weakly basic pH (7.8–8.2), light grey-hazel clay fraction.

Area B Lacustrine clay slope above the quarry: fine-grained plastic clays, absence of marine microfossils, low carbonate content (8–15%), neutral pH (6.9–7.2), greenish-grey clay fraction

Area C Alluvial plain frequently travelled by the suspect: rounded to sub-rounded clasts, heterogeneous mineralogy, moderate carbonate content (30–40%), neutral to basic pH (7.0–7.4), reddish-brown (ochre) clay fraction

Laboratory analyses performed: grain-size analysis; particle morphology and morphoscopy; mineralogical composition; carbonate content; pH measurement; colour of the clay fraction; identification and classification of microfossils.

SECTION 1 — GEOLOGICAL CONTEXT AND NATURE OF THE EVIDENCE — Questions 1–6

Question 1

The quarry was excavated in marly limestone. From the point of view of forensic geology, what diagnostic value does this lithology have?

A. Marly limestone can often be recognized by its relatively high carbonate content.
B. Marly limestone is distinguished by its characteristic combination of carbonate and clay minerals.
C. Marly limestone is distinguished mainly by the association of carbonate-rich rocks with fine-grained sediments.
D. Marly limestone is distinguished mainly by the marine microfossils it commonly contains.

Question 2

At the base of the excavation face there are angular limestone fragments. Which process best explains both their morphology and their location?

A. Gravitational detachment and fall from the excavation face, with little transport.
B. Fluvial transport that rounded the fragments before deposition.
C. Aeolian transport that concentrated coarse fragments after removing finer particles.
D. Frost shattering followed by prolonged transport that smoothed the fragment edges.

Question 3

Area A consists of marly limestone containing marine microfossils. Area B overlies Area A and consists of lacustrine clay without marine microfossils. Which interpretation is most strongly supported by these observations?

A. The two units were deposited at the same time in different basins.
B. Both units were deposited in marine environments at different water depths.
C. The depositional environment changed from marine to lacustrine conditions.
D. Marine microfossils were introduced into Area A after deposition.

Question 4

Why can soil and sediment samples be effective forensic evidence in criminal investigations?

A. Soil is readily transferred between people, objects, and locations during contact.
B. Many soil characteristics remain unchanged under all post-depositional conditions.
C. Any material found on clothing is automatically considered conclusive forensic evidence.
D. Different environments often produce distinctive combinations of geological characteristics.

Question 5

The principle that "every contact leaves a trace" underlies the possibility of linking a suspect to a place through transferred geological material. Which statement applies it correctly to this case?

A. Soil transfer occurs only when contact is prolonged and deliberate.
B. Transferred material always retains the exact composition of the source area.
C. The absence of transferred material proves that contact never occurred.
D. Transferred material may originate from more than one source.

Question 6

The suspect claims never to have visited the quarry and to have travelled only through the alluvial plain. Which finding on the vehicle would best support this claim?

A. Material comparable with both Areas A and C.
B. Material comparable with Area C, but not with Area A.
C. Material without marine microfossils.
D. Material with intermediate carbonate content between Areas A and C.

SECTION 2 — ANALYSIS AND COMPARISON OF THE SAMPLES — Questions 7–15

Question 7

The carbonate content is 68% in the clothing sample, 71% in Area A, and 36% in Area C. What is the best forensic interpretation of this observation?

A. The clothing sample originated with certainty from Area A.
B. The clothing sample cannot be compared with either reference area.
C. The clothing sample is more comparable with Area A than with Area C.
D. Carbonate content is not useful for forensic comparison.

Question 8

The clay fraction of a sample recovered from the clothing is reddish-brown. Which interpretation is best supported?

A. The colour reflects weathering of carbonate-rich sediments and is consistent with Area A.
B. The colour reflects oxidation of iron-bearing minerals and is consistent with Area C.
C. The colour reflects organic-matter accumulation under reducing conditions and is consistent with Area B.
D. The colour is influenced by moisture content and has no diagnostic value

Question 9
Grain morphoscopy of a sediment sample shows pitted surfaces and a high degree of rounding. Which interpretation is most strongly supported?
A. The grains have a biochemical origin, consistent with the presence of marine microfossils.
B. The grains were deposited close to their source and are most consistent with Area A.
C. The grains formed in a low-energy lacustrine setting and are most consistent with Area B.
D. The grains experienced prolonged transport and are most consistent with Area C.

Question 10
The material recovered from the victim's clothing shows 68% carbonate, angular limestone fragments, marine microfossils, pH 7.9, and a grey-hazel clay fraction. With which reference area is it most comparable and why?
A. Area A, because the combination of characteristics is most consistent with this area.
B. Area B, because its pH is closest to the measured value.
C. Area C, because alluvial sediments commonly contain mixed geological materials.
D. None of the areas, because forensic samples must match every characteristic exactly.

Question 11
Marine microfossils occur in the clothing sample and in Area A, but not in Areas B or C. Given that marine sediments are widespread in the Apennines, how should this correspondence be interpreted?
A. The correspondence is necessarily coincidental, and therefore with no forensic value, because marine sediments are regionally widespread.
B. The correspondence suggests a high probability that both samples have the same origin.
C. The correspondence could be useful if a specific microfossil association can be localized.
D. The correspondence has a high probability of coincidence since Apennines marine sediments are always the same.

Question 12
The vehicle mats contain material with 70% carbonate, angular clasts, and marine microfossils. The mudguards contain material with 36% carbonate, rounded clasts, and no microfossils. What do these observations best suggest?
A. The vehicle came into contact with Area A, but something inside it came into contact with Area C.
B. The vehicle came into contact with both Areas A and C.
C. The vehicle came into contact with Area C, but something inside it came into contact with Area A.
D. The samples cannot be compared because they came from different parts of the vehicle.

Question 13
The suspect claims never to have visited Area A, while declaring that he travelled with the vehicle only Area C. Considering the data reported in Question 12, what is the correct forensic interpretation?
A. The suspect is probably lying, since he probably visited both Areas A and C.
B. The mat material may have been deposited by somebody else.
C. There is a contradiction on the suspect account, but this on its own does not establish guilt.
D. The presence of material comparable with Area A proves that the vehicle transported the body.

Question 14
Among the analysed parameters, which provides the strongest discrimination between Area A and the other two reference areas?
A. Carbonate content and mineralogic composition.
B. Colour and texture of the clay.
C. A specific marine biotic association.
D. pH value of unmanipulated samples.

Question 15
An examined sample and a reference sample are considered comparable when:
A. They were collected using the same laboratory procedures.
B. They underwent similar post-depositional changes.
C. They were collected from the same location.
D. They are consistent across several independent characteristics.

SECTION 3 — INTERPRETATION AND LIMITS OF FORENSIC GEOLOGY — Questions 16–18

Question 16
During evidence handling, material from an unknown sealed sample bag is accidentally transferred into another unknown sample bag before analysis. What is the consequence?
A. The contamination has compromised the validity of both samples.
B. Only the receiving sample is affected.
C. The transferred material can always be identified by colour.
D. The transfer is unimportant when the quantity is small.

Question 17
The report states that material from the vehicle mat is comparable with Area A. The investigating magistrate asks whether this means the vehicle certainly visited the quarry. What is the correct response?
A. Yes. Comparable samples prove that the vehicle visited the quarry.
B. No. Comparability supports an association but does not prove a unique source or direct visit.
C. Yes. Geological comparability is equivalent to a positive identification.
D. No. Geological evidence can contribute to legal proceedings only according to local law.

Question 18
What is the appropriate role of forensic geology within a criminal investigation?
A. To replace biological (i.e. DNA) evidence when these are unavailable.
B. To reconstruct and prove a suspect's movements using geological evidence.
C. To provide geological evidence to be integrated with other forensic elements.
D. To provide definitive proof of the crime scene (i.e. where the crime was committed).