

SI Geology - Full Discipline Demo

Metamorphic Rocks

Final Report - Answer Guide

Institution	Science Interactive University
Session	SI Geology - Full Discipline Demo
Course	SI Geology - Full Discipline Demo
Instructor	Sales SI Demo

Test Your Knowledge

Classify the following statements as true or false.

⚡ Any igneous, sedimentary, or metamorphic rock can become a metamorphic rock.	
⚡ Changes in pressure and temperature, as well as contact with hot fluids, can contribute to metamorphic rock formation.	
⚡ Contact metamorphism occurs across large areas, and is typically associated with thermal and hydrothermal metamorphism.	
⚡ Metamorphic rocks can form as a result of melting.	
⚡ Regional metamorphism is associated with tectonic plate collisions, folding rock layers, and mountain building processes.	
True	False
1	2

Correct answers:

1

Any igneous, sedimentary, or metamorphic rock can become a metamorphic rock.

Changes in pressure and temperature, as well as contact with hot fluids, can contribute to metamorphic rock formation.

Regional metamorphism is associated with tectonic plate collisions, folding rock layers, and mountain building processes.

2

Contact metamorphism occurs across large areas, and is typically associated with thermal and hydrothermal metamorphism.

Metamorphic rocks can form as a result of melting.

Match the terms to their definition.

⚡ Foliated	Process that occurs when small crystals of a mineral are slowly converted to larger and fewer crystals of the same mineral	1
⚡ Metamorphic grade	Metamorphic rocks with a layered appearance, similar to a deck of cards	2
⚡ Neocrystallization	Process that occurs when new minerals are formed from the existing elements within the protolith	3
⚡ Nonfoliated	Metamorphic rocks that exhibit characteristics like sheared grains, but no layering	4
⚡ Recrystallization	Classification used to determine the intensity or rank of metamorphism, measuring the degrees of difference between the protolith and the metamorphic rock	5

Correct answers:

- 1 Recrystallization 2 Foliated 3 Neocrystallization 4 Nonfoliated
5 Metamorphic grade

Classify the metamorphic rock textures as foliated or non-foliated.

	Foliated	Nonfoliated
☐ Crystalline	1	2
☐ Glassy		
☐ Gneiss		
☐ Microcrystalline		
☐ Phyllite		
☐ Sandy		
☐ Schist		
☐ Slate		

Correct answers:

1 Gneiss Phyllite Schist Slate

2 Crystalline Glassy Microcrystalline Sandy

Exploration

Which of the following does not result in the formation of metamorphic rocks?

- ☒ Melting ✓
- ☐ Changes in pressure
- ☐ Contact with hot fluids
- ☐ Changes in temperature

Contact metamorphism occurs locally in conditions of intense heat and low pressure.

- ☒ True ✓
- ☐ False

_____ occurs when minerals grow larger and form new minerals from existing elements within the protolith.

- ☐ Contact metamorphism
- ☒ Neocrystallization ✓
- ☐ Recrystallization
- ☐ Regional metamorphism

Which of the following textures is associated with foliated metamorphic rocks?

- ☐ Sandy
- ☐ Glassy
- ☒ Schist ✓
- ☐ Microcrystalline

The types of metamorphic rocks that form under low, intermediate, or high-grade metamorphism depend on the mineral composition of the protolith only.

- ☐ True
- ☒ False ✓

Exercise 1

What is the difference between recrystallization and neocrystallization?

Where might you find a rock like sample 17 being formed (metamorphosed) today?

How did you determine the composition of Sample 18 and Sample 21?

Which specimen(s) experienced pressures that were greater in one direction than the others? How do you know?

Photo 1: Metamorphic Rock Set
(SAMPLE ANSWER BELOW)





Data Table 1: Metamorphic Rock Identification
(SAMPLE ANSWER BELOW)

Sample	Texture	Grain Size	Other Textural Features	Composition	Rock Name
17	Foliated	Medium or coarse	Gneissic banding	Amphibole, biotite, quartz, feldspars	Gneiss
18	Nonfoliated	Medium	Equal-sized fused grains; effervesces	Calcite	Marble
19	Foliated	Fine	Rock cleavage; smooth, dull surfaces	Andalusite, biotite, muscovite, quartz	Slate
20	Foliated	Medium	Schistosity with large mica crystals	Biotite, chlorite, muscovite, quartz, garnet	Schist
21	Nonfoliated	Fine or medium	Sandy texture with fused grains	Quartz	Quartzite
22	Nonfoliated	Medium or coarse	Glossy with visible amphibole crystals	Amphibole, plagioclase feldspar	Amphibolite
23	Nonfoliated	Fine	Black and glossy; very light (low density)	Carbon	Anthracite
24	Foliated	Fine	Wavy foliation with a glossy sheen	Chlorite, muscovite, quartz	Phyllite

Exercise 2

What is a protolith?

How did the rocks in Zones 1 and 2 on the Metamorphic Zone Map form?

What geologic process formed the foliated rocks on the Metamorphic Zone Map? How do you know?

What is the temperature and pressure range that Sample 17 must have experienced?

What is the temperature and pressure range that Sample 19 must have experienced?

Data Table 2: Mineral Zones
(SAMPLE ANSWER BELOW)

Mineral Zone	Type of Foliation (slaty, phyllitic, schistosity, or gneissic banding)	Additional Metamorphic Minerals
Chlorite	Slaty or Phyllitic	Muscovite, biotite, quartz/feldspar
Biotite	Phyllitic or Schistosity	Muscovite, quartz/feldspar, chlorite, staurolite, kyanite, garnet
Garnet	Schistosity	Muscovite, biotite, quartz/feldspar, staurolite, kyanite
Kyanite	Schistosity	Muscovite, biotite, quartz/feldspar, staurolite, garnet
Sillimanite	Gneissic banding	Biotite, quartz/feldspar

Data Table 3: Metamorphic Zone Map
(SAMPLE ANSWER BELOW)

Zone #	Metamorphic Grade	Contact or Regional Metamorphism
1	Low or Intermediate	Contact Metamorphism
2	Intermediate	Contact Metamorphism
3	Intermediate	Regional Metamorphism
4	High	Regional Metamorphism
5	Intermediate	Regional Metamorphism
6	Low or Intermediate	Regional Metamorphism
7	Low	Regional Metamorphism

Data Table 4: Protoliths and Metamorphic Grade
(SAMPLE ANSWER BELOW)

Sample	Rock Name	Metamorphic Grade	Protolith
17	Gneiss	High	Shale or Granite
18	Marble	Low to High	Limestone
19	Slate	Low	Shale
20	Schist	Intermediate	Shale
21	Quartzite	Intermediate to High	Quartz Sandstone
22	Amphibolite	Intermediate	Basalt or Gabbro
23	Anthracite	Low	Bituminous coal or Peat
24	Phyllite	Low to Intermediate	Shale

Competency Review

Only igneous and sedimentary rocks can become metamorphic rocks.

- ☐ True
- ☒ False

Which of the following textures has a high metamorphic grade?

- ☒ Gneiss
- ☐ Schist
- ☐ Phyllite
- ☐ Slate

A nonfoliated, medium-grained metamorphic rock that effervesces would be identified as ____.

- ☐ quartzite
- ☒ marble
- ☐ phyllite
- ☐ slate

The most common change caused by metamorphism is ____, when small crystals of a mineral are slowly converted to larger and fewer crystals of the same mineral.

- ☐ neocrystallization
- ☐ metamorphic grading
- ☐ foliation
- ☒ recrystallization

A metamorphic rock that looks like a homogenous mass with no visible grains or foliation would have a ____ texture.

- ☐ slate
- ☐ microcrystalline
- ☒ glassy ✓
- ☐ schist

Slate exhibits a low metamorphic grade.

- ☒ True ✓
- ☐ False

Shale is a protolith of all of the following metamorphic rocks except ____.

- ☐ phyllite
- ☐ slate
- ☒ amphibolite ✓
- ☐ gneiss

Identify the metamorphic rock pictured below.



- ☐ Marble
- ☒ Quartzite
- ☐ Amphibolite
- ☐ Schist



Extension Questions

Anthracite is highly desired in the energy industry because it is the most "clean" variety of coal. Using your knowledge of metamorphic processes, how do you think this rock becomes so "clean" when compared to its protolith? (SAMPLE ANSWER BELOW)

Anthracite undergoes changes in temperature and pressure during metamorphism, resulting in a different composition than the protolith, bituminous coal. As a result of this process, anthracite is nearly pure carbon (86-97%) versus its protolith bituminous coal (45-86% carbon). This results in anthracite being considered a more "clean" option than its protolith.