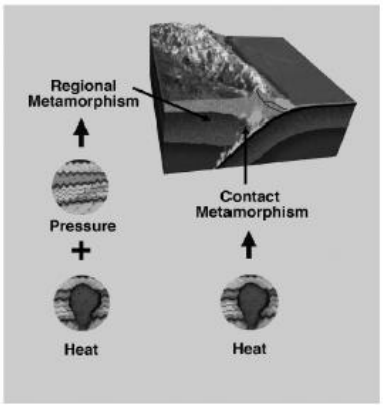
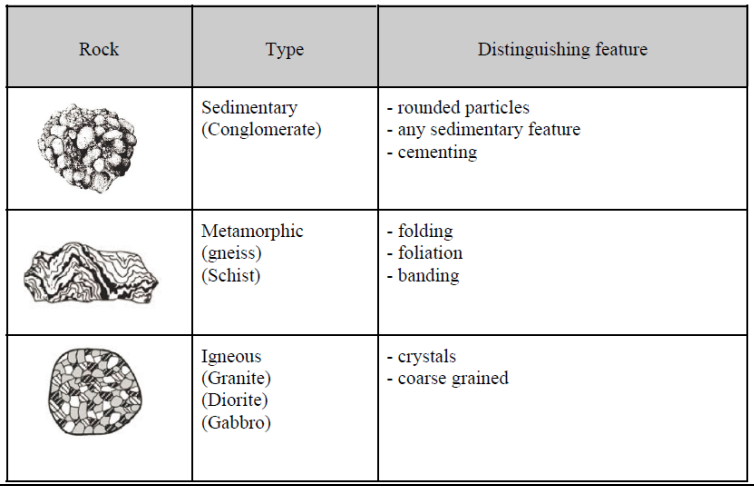
Earth Systems 3209
Public Exam Review Ch. 7
Solutions

1. A	15. B	29. C
2. C	16. B	30. B
3. B	17. D	31. A
4. D	18. D	32. B
5. A	19. A	33. C
6. A	20. A	34. A
7. A	21. D	35. B
8. A	22. B	36. D
9. A	23. A	37. D
10. B	24. A	38. B
11. B	25. C	39. B
12. B	26. D	40. A
13. C	27. B	41. B
14. C	28. C	42. D

43	Regional metamorphism is often associated with extensive mountain building where enormous amounts of heat and pressure are generated. High heat and high pressure cause the parent rock to behave plastically which results in the recrystalizeation and deformation (folding) of the parent rock. This often changes the appearance and mineralology of the rock. Fluids present in the parent rock also aid in the formation of metamorphic rock. A foliated texture is often seen in this type of metamorphic environment.
44	Regional metamorphism occurs in environments that are exposed to conditions of extreme heat and pressure. Such environments include deep within mountain systems along convergent boundaries and also deep within geosynclines along the margins of continents.
45	Subduction boundaries have two tectonic plates colliding which causes extreme pressure. As one tectonic plate subducts beneath another to great depths within the mantle, melting occurs. Also as one tectonic plate subducts, water is carried down with the descending plate. This outlines the three conditions associated with metamorphism, pressure, heat, and chemically active fluids. Areas within the over-riding (continental) tectonic plate coincide with mountainous areas which experience high pressure and high heat which causes regional metamorphism. Areas immediately surrounding the rising molten magma and lava at the surface, experience high heat which causes contact metamorphism.

46	Two of the main factors that affect metamorphism is temperature and pressure. During regional metamorphism, both heat and pressure are present which cause rocks to change (metamorphosis) over a large area. For example, the interior of mountainous environments experience regional metamorphism, (see diagram). Whereas, during contact metamorphism, only heat is needed to cause rocks to change (metamorphosis) over a relatively smaller area. For example, the area immediately surrounding (in contact with) hot molten rock (see diagram). 
47	Sedimentary rocks may change to form metamorphic rocks when exposed to either of the following conditions: high heat, high pressure, and being altered by chemical fluids. • Heat generally bakes a rock and causes the texture and/or mineral composition to change form resulting in the formation of metamorphic rock. • Pressure causes sedimentary particles (minerals) to compress which may result in the reorganization of the particles (elements) to form metamorphic textures and/or metamorphic minerals. • Chemical fluids often cause the rock texture and chemical composition of the minerals to alter, forming a metamorphic rock.
48	Anthracite is the highest grade of coal and is associated with slate because both rocks have been exposed to similar conditions and are metamorphic in origin. Anthracite is not commonly associated with shale and sandstone because shale and sandstone are sedimentary in origin.
49	Shale is a clastic sedimentary rock that is capable of being metamorphosed. As shale is buried deeper and deeper in Earth's crust (e.g. within the folded mountains at a continent to continent plate collision), heat and pressure increase. Consequently, the degree of metamorphism will also increase (i.e. low grade through to high grade), producing a predictable sequence of rocks as follows: Low grade metamorphism will occur at locations **A** and **B**. Shale is metamorphosed into slate at location **A** due to low heat and pressure as well as the presence of hot chemical fluids. Slate is metamorphosed into phyllite at location **B** due to increasing heat and pressure as well as the presence of hot chemical fluids. Medium (or intermediate) metamorphism will occur at location **C** due to increasing burial. With such increasing burial comes increasing heat and pressure in association with hot chemical fluids. Such agents of metamorphism serve to change phyllite into the metamorphic rock called schist. High grade metamorphism will occur at location **D** due to the converging of plates as well as increasing burial. The result will be extremely high amounts of heat and pressure that, combined with hot chemical fluids, will lead to the metamorphism of schist into gneiss.

50	**Foliated:** show layering or banding of different minerals created by the alignment of minerals during metamorphism (Ex: schist, gneiss, slate) **Non foliated:** a mass or network of intergrown crystals consisting of one mineral with no layering or banding (Ex: marble, quartzite, hornfels)
51	Metamorphic textures seen in metamorphic rocks are different from its parent rock because of two reasons: 1. Minerals become recrystallized and result in a more dense crystalline rock. For example, in both marble and quartzite the mineral grains reorganize on the atomic scale to form larger crystals with a denser texture. This results in a harder more dense crystalline rock. 2. Minerals tend to realign to form a foliated texture. For example, Gneiss forms when the minerals in granite realign to form a banded appearance of similar minerals. The atoms reorganize on the atomic scale to form bands of lighter and darker minerals.
52	(i) Convergent boundaries are when two crustal plates collide due to the converging motion of convection currents in the upper mantle (i.e. asthenosphere). There are three types of plate collisions which include: oceanic-oceanic; oceanic-continent; and continent-continent. All three types of plate collisions, due to the compressional forces that serve to generate pressure and heat, can result in regional metamorphism. The locations of the regional metamorphism could be in the sedimentary rocks that comprise continental shelves and the igneous rocks that comprise the continents. Contact metamorphism occurs when molten comes into contact with cold, pre-existing rocks. Molten results from the melting of crustal plates that have been subducted down into the mantle. Subduction of crustal plates occurs only at oceanic-oceanic and oceanic-continent collision locations. When the molten moves up through the cold, preexisting rocks of the crust, the result is metamorphism or baking of the rocks by the heat that is generated from the molten. (ii) The metamorphic texture that is evident in the diagram below is foliation or banding.
53	A: metamorphic - features include folding (bending), foliation, recrystallization, contact and regional metamorphism. B: sedimentary - features include layering, bedding, stratification, and symbols for sedimentary rocks. C: igneous - features include magma, molten rock, vent, volcano, and lava layers
54	

Rock	Type	Distinguishing feature
	Sedimentary (Conglomerate)	- rounded particles - any sedimentary feature - cementing
	Metamorphic (gneiss) (Schist)	- folding - foliation - banding
	Igneous (Granite) (Diorite) (Gabbro)	- crystals - coarse grained