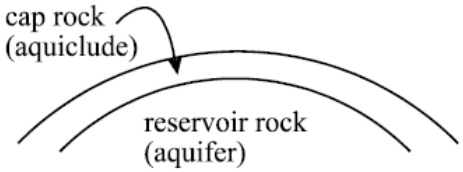
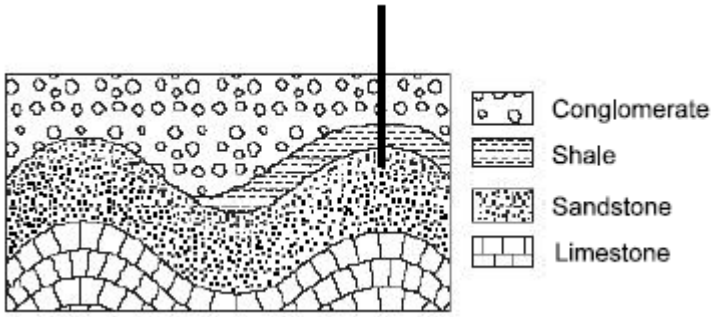
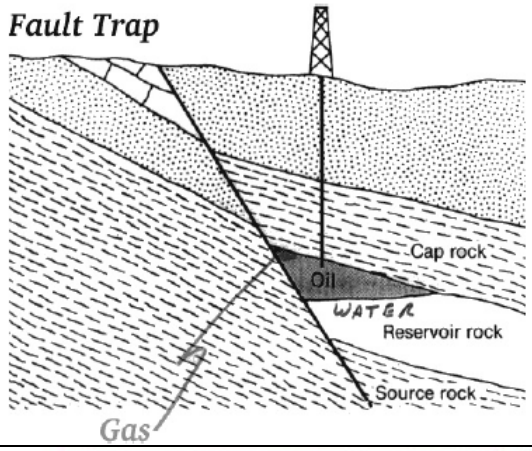
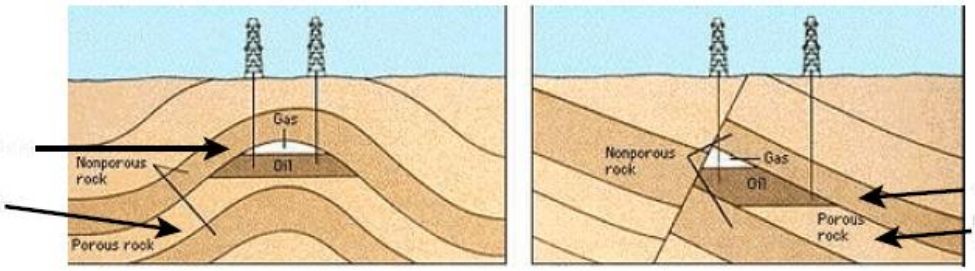
Earth Systems 3209
Public Exam Review Ch. 21
Solutions

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

53	In most cases oil is considered a non-renewable resource because when used, its gone. From a geological sense an argument can be made that oil may be considered a renewable resource. Keeping in mind the idea of uniformitarianism, the processes that created oil in the past are still occurring today. This suggest that oil will be produced in the future although the time span for this process is extremely long.
54	Since the Law of Uniformitarianism suggests that the present is the key to the past, processes occurring today and in the past will continue to occur in the future. From this perspective, the processes that created oil deposits in the past are likely to create oil deposits in the future. Even though this process will take considerable time, it is still occurring and, as such, oil may be considered renewable.
55	A **renewable resource** found in Newfoundland and Labrador can include; 1) trees, 2) fish, 3) water, 4) any other suitable resource. These resources are renewable because they have the ability to regenerate and replenish naturally. Therefore they are referred to as sustainable resources. A **non-renewable resource** found in Newfoundland and Labrador can include; 1) minerals and 2) fossil fuels such as oil. These resources are non-renewable because they do not have the ability to regenerate and replenish naturally and once the resource is exhausted it is gone forever. Therefore non-renewable resources are referred to as unsustainable resources.
56	An ore is defined as any material that can be mined for a profit. The mining and processing iron-rich rocks around Bell Island is not feasible at this time because of the markets elsewhere in the world can provide equal or higher grade iron for cheaper prices. Therefore it would not be profitable to mine the iron-rich sediments at this time.

57	The potential of a site to be developed into an active mine depends on a number of factors some of which include: 1) mineral mined for profit, economically feasible 2) mineral is in high demand and there is a need for the mineral 3) mine site meets all environmental criteria, environmental impact study completed on the site 4) location 5) cost of operation 6) availability of skilled work force
58	*Hydrothermal* - hot solutions react with rocks in which they pass and as a result the hot solutions becomes concentrated with metals in solution. When the hot solution enters a cooler environment, the metals precipitate from the solution and form metallic mineral deposits. Ex. gold in quartz. *Depositional* - form by a process of sedimentation. Mineral deposits form as a result of chemical precipitation, evaporation, and density deposits in water environments. Ex. gypsum and halite deposits or gold accumulating in water environments as placer deposits.
59	(i) Copper was concentrated by hydrothermal activity. Hot copper rich fluids moved through the surrounding rock and as the fluids cooled minerals rich in copper were precipitated. (ii) Either one of the following: *gold, lead, zinc, silver*
60	Economic minerals found associated with large igneous intrusions usually form as a result of hydrothermal activity. During this process, cold ocean waters move down through the ocean floor and become hot as it approaches the igneous intrusion. This hot water dissolves minerals rich in metals and carries it back toward the surface of the crust. The metals in the hot solutions precipitate (fall out of solution) as the water cools within the cracks in the ocean floor or it settles on the ocean floor as the hot solution re-enters the cold ocean water. This forms either metallic vein deposits or metallic sedimentary deposits on the ocean floor.
61	In a hydrothemal deposit, fluids (water) moving through the crust get heated because they are near an intrusion or because they are deep beneath Earth's surface (due to the geothermal gradient). These heated fluids can dissolve metallic ions in the rock and carry them in solution. As the heated water moves through cracks in the rock, it cools and the dissolved metals in the fluid may come out of solution (precipitate) and concentrate in veins. These veins often contain minerals rich in gold or copper.
62	Mineral deposits that are associated with large igneous intrusions include, magmatic deposits and hydrothermal deposits. Magmatic mineral deposits are those which are formed during crystallization of a magma, deep underground. The deposit can consist of massive ores in some cases, and disseminations of rare minerals in others. Hydrothermal mineral deposits are any concentration of metallic minerals formed by the precipitation of solids from hot mineral-laden water (hydrothermal solution). The solutions are thought to arise in most cases from the action of deeply circulating water heated by magma.
63	Hydrothermal (or vein) is the type of mineral deposit that could form at location A. Pressure from the magma intrusion causes fractures or cracks to form in the overlying sedimentary rock layers. Ground water in the overlying sedimentary rock layers is warmed by the heat that is radiating out from the magma intrusion. Warm water can dissolve large quantities of elements. As the warm water, which is enriched in elements, flows toward Earth's surface (away from the magma intrusion) through fractures or cracks, it begins to cool. Since cold water cannot dissolve elements as readily as warm water, elements in the form of minerals begin to precipitate out of the solution. The minerals comprise the fractures or cracks forming veins.

<table>
<tr><td>64</td><td>An explanation of any two of the following was accepted.
A) hydrothermal deposits - minerals concentrated by hot, aqueous solutions flowing through fractures and pore spaces of crustal rocks.
B) magmatic deposits - minerals concentrated by magmatic processes such as, fractional crystallization within a body of igneous rock.
C) sedimentary deposits - minerals concentrated by precipitation or evaporation of lake water or seawater.
D) placer deposits - minerals concentrated by flowing surface water in streams and along the shoreline where dense minerals accumulate.
E) residual deposits - minerals are concentrated by weathering processes where soluble materials are removed leaving behind the less soluble residue.</td></tr>
<tr><td>65</td><td>Gold can be concentrated by:
1) Hydrothermal deposits - Hot fluids dissolve and transport gold as it moves through Earth’s crust near major heat sources (magma). Gold carried in solution is later precipitated as it moves through areas of fractured rock in cooler areas near Earth’s surface to form vein deposits.
2) Placer deposits - Gold is eroded form rock and transported as part of the streams sediment load. The heavier and more dense gold tends to settle and accumulate in areas of lower stream energy to form placer deposits.</td></tr>
<tr><td>66</td><td><table>
<tr><th>Resource</th><th>How Formed</th><th>Use in Society</th></tr>
<tr><td>bauxite</td><td>secondary enrichment</td><td>aluminum foil</td></tr>
<tr><td>halite</td><td>evaporation, evaporite, or chemical sediment</td><td>road salt, or table salt</td></tr>
<tr><td>gold</td><td>hydrothermal, placer, or disseminated</td><td>jewelry, electronics, dental, etc...</td></tr>
</table></td></tr>
<tr><td>67</td><td>In general material with high porosity will have a high permeability. This means water can flow through the material easily. A material with low porosity will have a low permeability and water can not flow through the material easily.</td></tr>
<tr><td>68</td><td>Porosity refers to the amount of open space within a rock: whereas, permeability refers to the ability of a rock to transmit water through the pore space within a rock which is interconnected. A rock such as shale exhibits pore space, yet it is impermeable because its pore space is not connected. Vesicular basalt is another rock that contains porosity and is impermeable. Also pumice and clay (not a rock) was accepted as suitable examples.</td></tr>
<tr><td>69</td><td>The introduction of various technologies have benefitted geoscientist to examine Earth in the following ways;
1) GPS provides highly accurate reading to measure the motion of tectonic plates.
2) Satellite imagery and computerized mapping have improved geologic mapping techniques. More detailed topographic maps, aerial photographs, and mapping of the ocean floor.
3) Technologies may also benefit society by providing an early warning system for natural phenomena as tsunami’s, earthquakes, and volcanic activity.</td></tr>
<tr><td>70</td><td>(ii) Organic matter trapped in sediment(clays) transforms to oil as the sediment forms into a solid sedimentary rock (oil shales). This oil can later move and accumulate in areas to form oil traps.</td></tr>
<tr><td>71</td><td>The main spheres involved here are the biosphere and the geosphere but they may also include the hydrosphere. A living organism dies and is quickly buried by sediment. The organism is cut off from air and as it is buried deeper and deeper, heat and pressure along with the activity of anaerobic bacteria, converts former organic materials to keragen and finally to oil. One connection of the spheres show the biosphere as the living organism, the geosphere as the sediments that bury the organisms and porous rock that contains the oil, and the hydrosphere may be what the organisms were living in.</td></tr>
</table>

72	 NOTE: it is not necessary to show reservoir rock as gas, oil, and water • Oil rises due to its low density and is trapped by the cap rock, which is impervious. NOTE: this is only one example(anticline). Others include fault trap, salt dome, and stratigraphic (pinch-out) trap.
73	 To pool oil you need a structure which contains a cap rock and a reservoir rock, in this diagram the structure is an anticline. Shale is an impermeable rock and serves as a cap rock to hold the oil down. Sandstone is a porous and permeable rock and serves as a reservoir rock which stores the oil.
74	
75	 Note: Deformed sedimentary basins can display several structures, such as, folds, faults, salt domes, stratigraphic traps, etc., in which oil and gas can be trapped. The most common include folded anticline traps and faulted traps as seen in the diagrams above.
76	Oil would most likely be found at site #1. Fluids such as oil, gas and water can move through permeable rocks such as sandstone (aquifer). If the aquifer is folded as seen in the diagram, oil, because of its low density, can be trapped within the up-folds (anticlines) of the folded aquifer layer. This is why site #1 could hold oil, whereas, site #2 would not likely hold oil.

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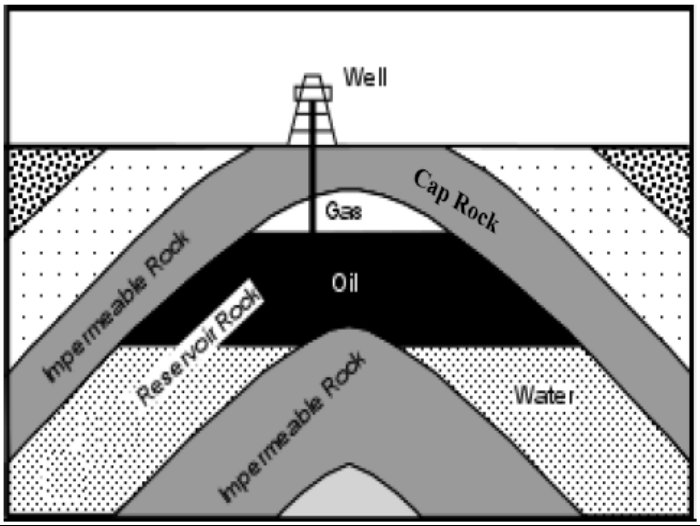

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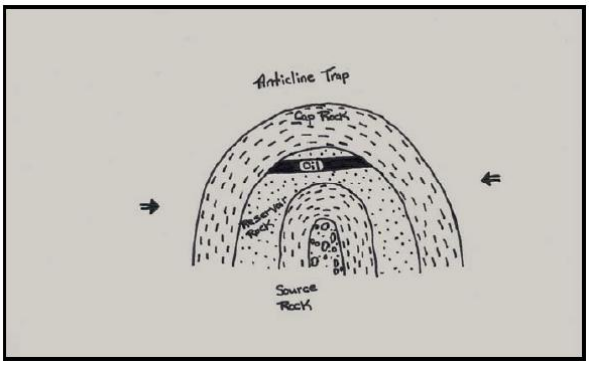
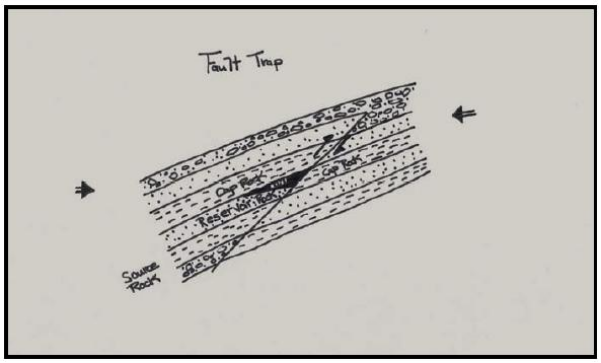
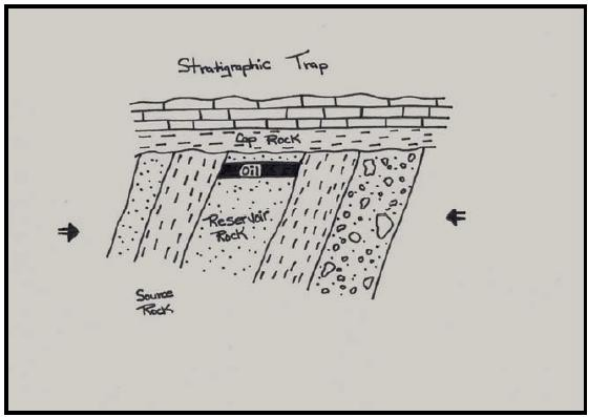
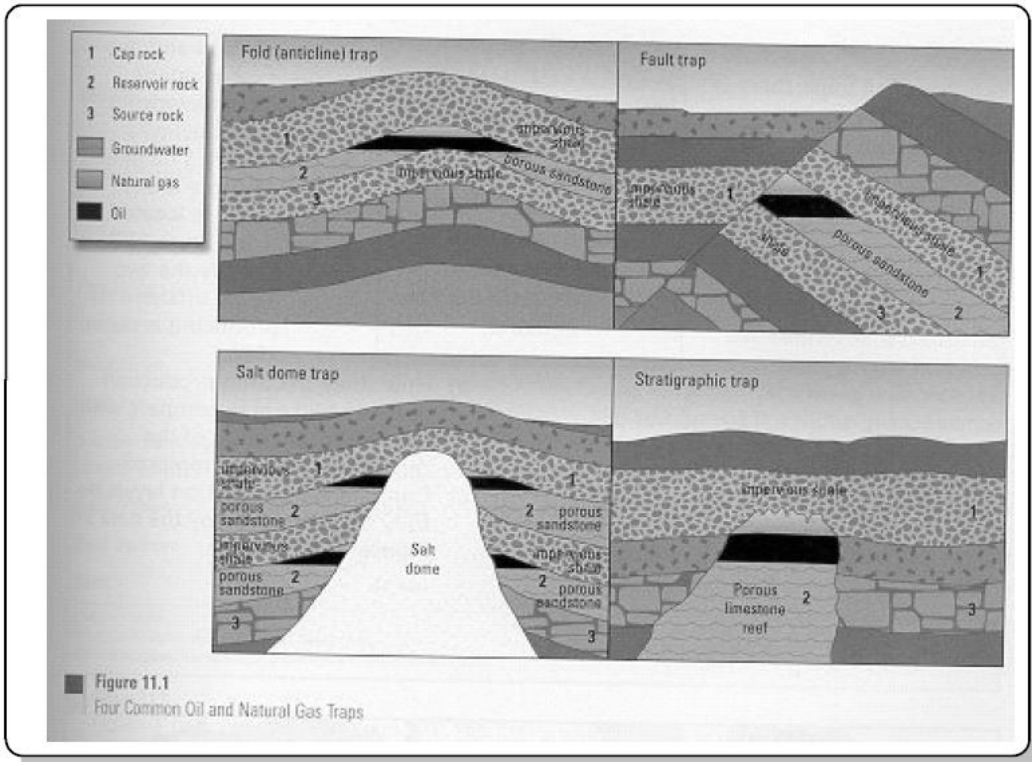






Anticline traps, fault traps, and stratigraphic traps are commonly associated with compressional forces. Note that reverse faults (hanging walls moves up in relation to foot walls) are the fault type that forms from compressional forces. Note that only stratigraphic
traps that involve angular unconformities are associated with compressional forces. The required components of either of the above oil traps include: source rock (e.g. shale); reservoir rock (e.g., sandstone, conglomerate, limestone); cap rock (e.g. shale); and the existence of oil in the trapped region of the reservoir rock. Note that the surface of the oil, as well as the gas and water if included in the diagram, in the trapped region should have a horizontal surface.

79	 An oil trap will form when a hydrocarbon-rich source rock (e.g. shale) is "covered" by a porous and permeable reservoir rock (e.g. sandstone). The reservoir rock must be buried by non-permeable cap rock (e.g. shale). With the proper combination of heat, pressure, and time, hydrocarbons located in the source rock will mature and be squeezed out into the reservoir rock due to increased burial. As a result of density and buoyancy, the hydrocarbons will migrate upward through the porous and permeable reservoir rock. The hydrocarbons will continue their upward journey until they encounter the nonpermeable cap rock, which will trap them.
80	The rocks that were encountered with increasing drill depth were shale, conglomerate, and shale. Shale is an example of a cap rock, conglomerate is an example of a reservoir rock, and shale is also an example of a source rock. The description of the geology of the area seems plausible for the formation and trapping of petroleum. Water in the reservoir rock can also be explained. First, there may not have been any organic matter rapidly buried within the source rock. As a result of no organic matter (i.e. kerogen), there was nothing to mature into petroleum to migrate to the reservoir rock and the trap. Secondly, despite the geology indicating possible cap, reservoir, and source rocks, there was no indication of an actual discovered trap type. Without a trap, the petroleum could have been dispersed throughout the reservoir rock and therefore there would not have been a deposit of petroleum to strike by drilling. Thirdly, it is possible that there was organic matter that eventually became petroleum; however, during migration through the reservoir rock and into the trap, it could have leaked out. For example, there could have been a fracture, fault, or crack in the cap rock and the petroleum, which is lower in density than water, could have been first to slowly leak out of the trap. Fourthly, the hole may have been drilled through the correct geology; however, it may not have been drilled in the correct location or on the correct angle and as a result, it may have missed the petroleum in the absolute top of the trap, but instead encountered the water that structurally sits below the petroleum.