CoreModels

Rock Cycle

A Core Learning Goals Activity for Science and Mathematics

Summary: Student understanding of the processes involved in the rock cycle is reinforced through building and manipulating a computer model.

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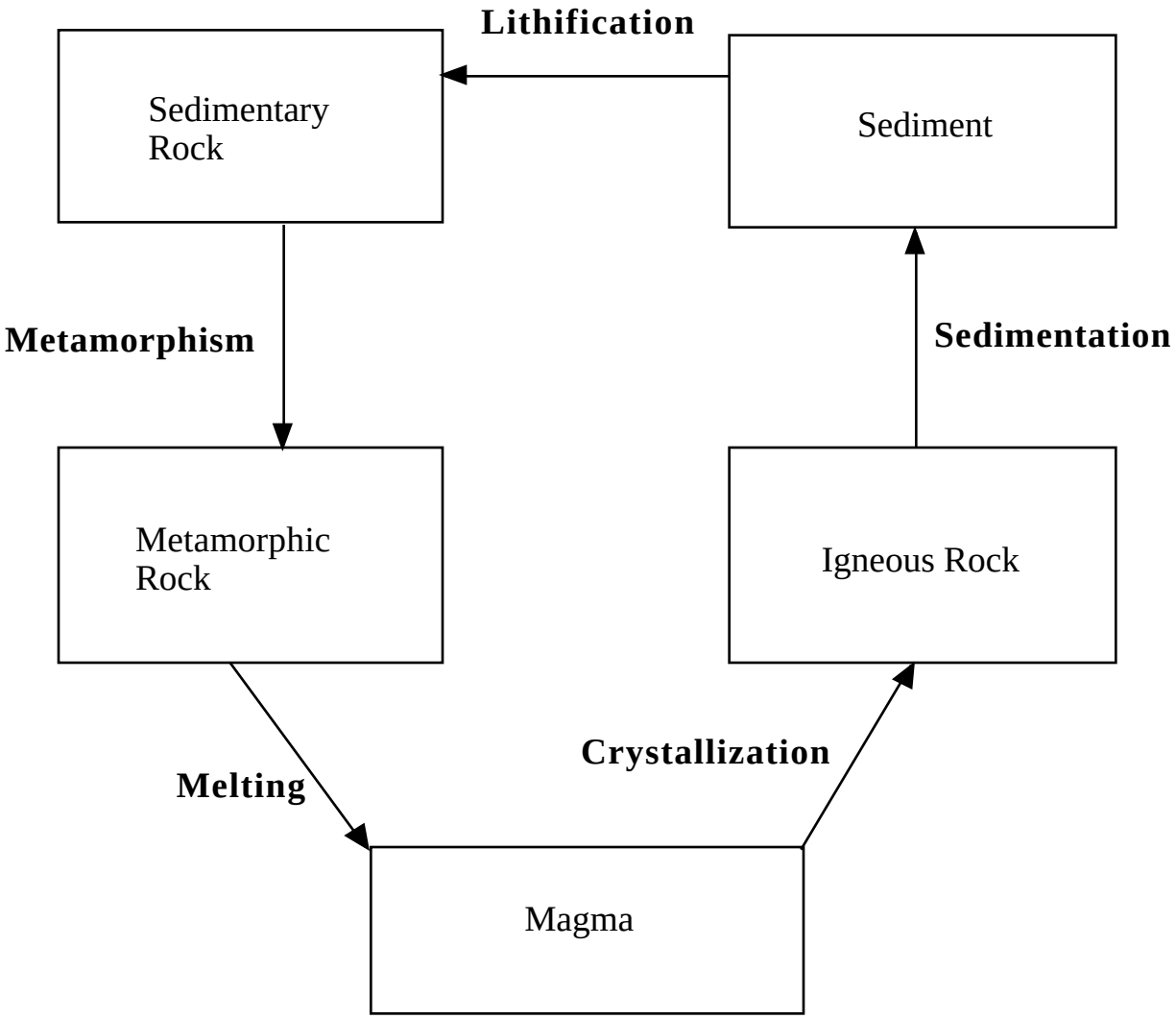
Maryland Virtual High School
51 University Blvd. East **(301) 649-2880**
Silver Spring, MD 20901 **http://mvhs.mbhs.edu**

Rock Cycle Part I
Answer Key

Q1. The answer below shows the five major processes which make up the rock cycle.

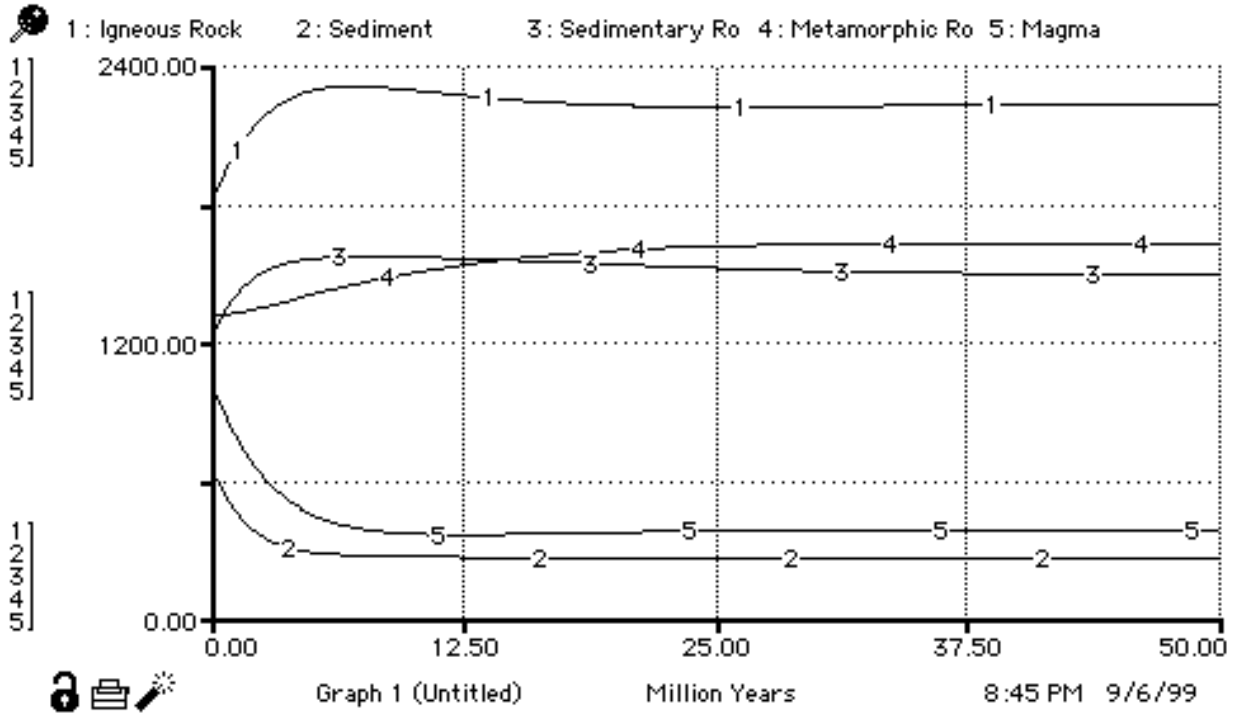


Q2. Igneous rock should be **31%** of the total rock.

Q3. The **Lithification** flow should remove one-half of the **Sediment** stock and add it to the **Sedimentary Rock** stock. STELLA will do the subtraction and addition for us because we have the flow pointing in the right direction, but we must enter the correct formula in the **Lithification** flow. What should the formula for **Lithification** be?

0.5*Sediment

Q4. Sketch the graph on the axes provided, labeling all parts as described in the Level I Generic Graph Questions.



Q5. Referring to your copy of the Graph Interpretation Guidelines, describe in full each curve.

The Igneous Rock curve increases at an ever decreasing rate for the first 6 million years, and then it decreases slightly and soon levels off to a horizontal line. The Sediment curve decreases at an ever decreasing rate for the first 5 million years, and then it levels off to a horizontal line. The Sedimentary Rock curve increases at an ever decreasing rate for the first 5 million years and then levels off to a horizontal line. The Metamorphic Rock curve increases very slowly for the first 27 million years and then levels off to a horizontal line. The Magma curve decreases at an ever decreasing rate for the first 10 million years and then levels off to a horizontal line. Although the cycle is not in equilibrium at the beginning, it achieves equilibrium after 30 million years.

Q6. Explain the relationship between the Igneous Rock curve and the Magma curve.

The Igneous Rock curve increases as the Magma curve decreases because Magma is transformed into Igneous Rock. Therefore, more Igneous Rock implies less Magma.

Q7. Explain the relationship between the Sediment curve and the Sedimentary Rock curve.

The Sediment curve decreases as the Sedimentary Rock curve increases because Sediment is transformed into Sedimentary Rock. Therefore, more Sedimentary Rock implies less Sediment.

Q8. According to the graph, the amount of rock in each category 50 million years from now will be different from the current amounts. Does this imply that the total amount of rock on Earth will change in the future? Justify your answer.

No, the total amount of rock should remain the same. The higher amounts seen in Igneous Rock, Sedimentary Rock and Metamorphic Rock will be offset by the lower amounts seen in Sediment and Magma.

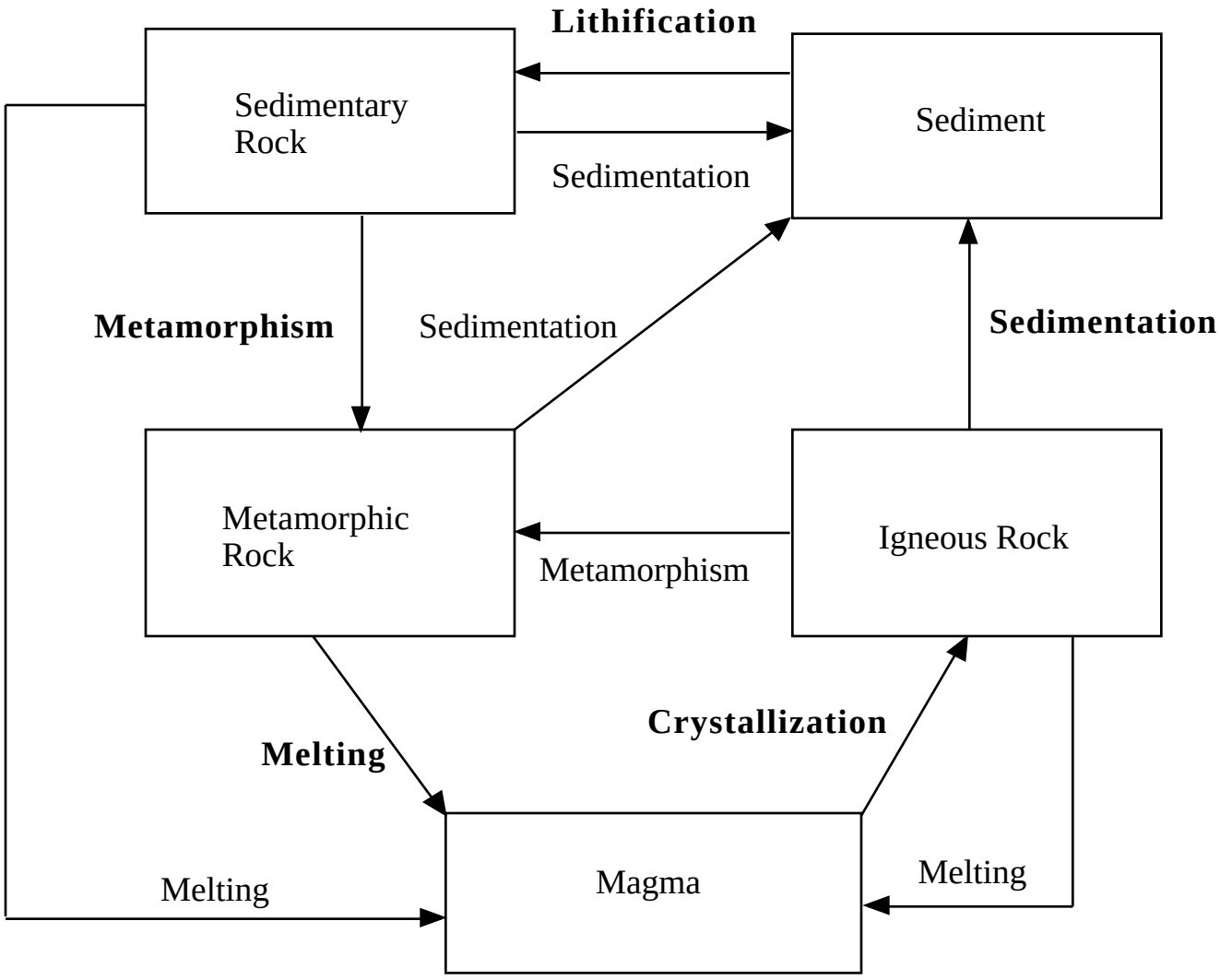
Q9. Using the values in the numeric displays, find the sum of the masses of rock 50 million years from now.

$5974 * 10^{24}$ grams

Q10. Does your answer to Q9 reflect the Law of Conservation of Mass? Please explain why or why not.

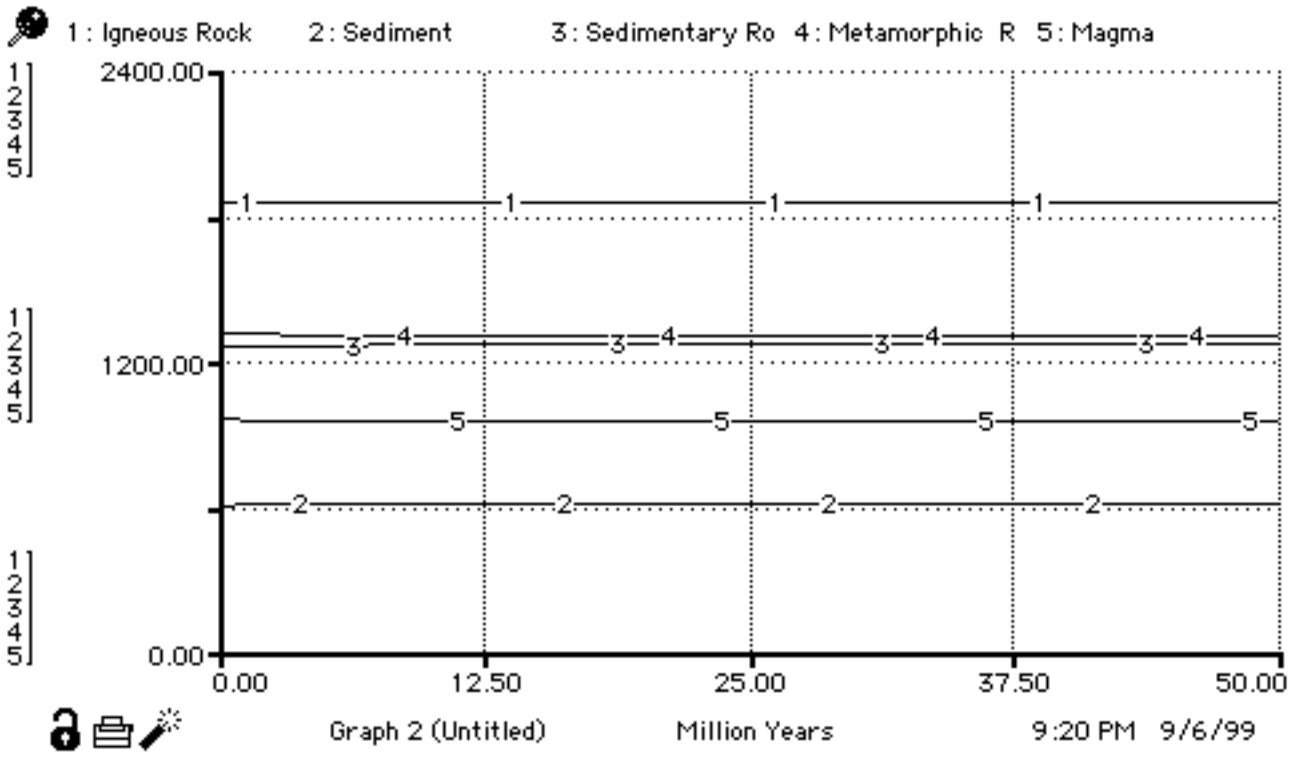
Yes, the final amount of rock is the same as the initial amount of rock.

Rock Cycle Part II
Introduction
Answer Key



Rock Cycle Part II
Answer Key

Q1. Referring to the Level I Generic Graph Questions, sketch the graph on the axes provided. (Do not forget to label your lines/curves.)



Q2. What does the graph show about the different types of rock for the given time period?

The horizontal lines show that the system is in equilibrium after a slight adjustment at the beginning. Therefore, the quantities of rock types are remaining constant.

Q3. What is the term used to describe this state or condition?

Equilibrium, or steady state.

Q4. Which stock is drained by the Metamorphism process?

Sedimentary Rock

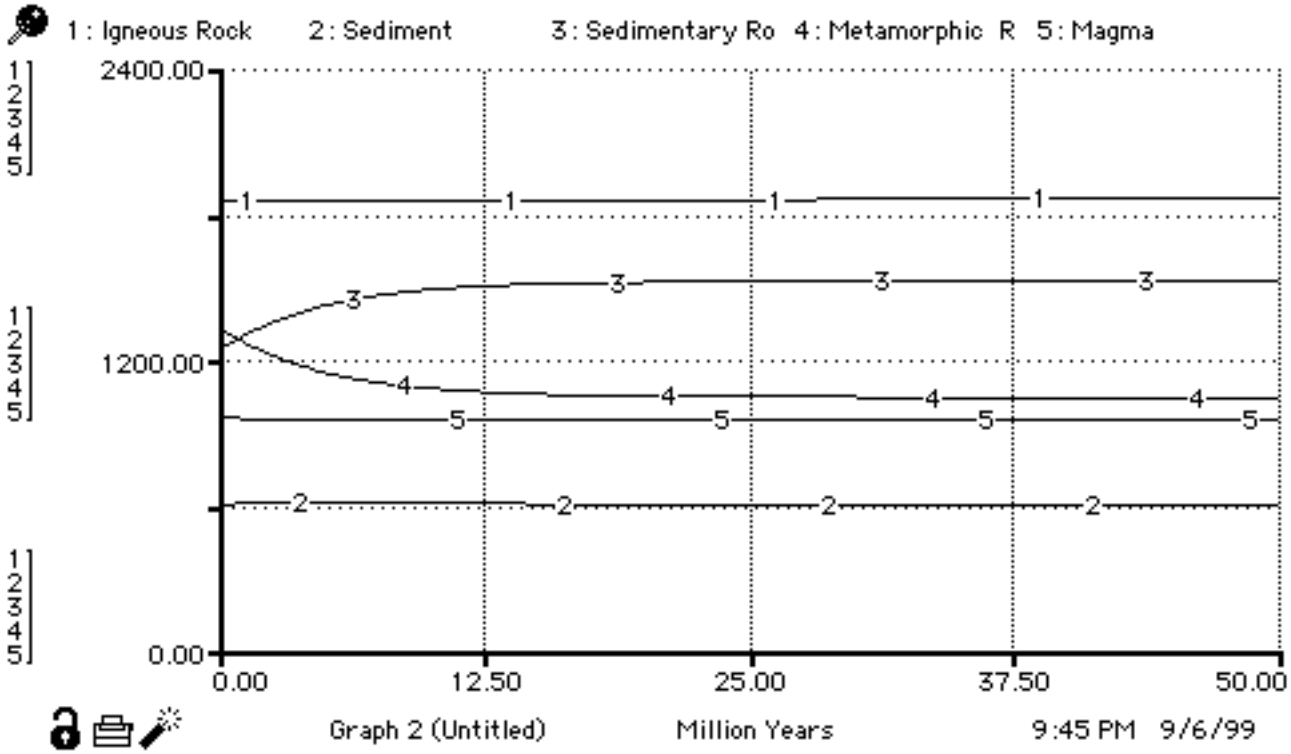
Q5. Which stock is filled by the Metamorphism process?

Metamorphic Rock

Q6. What effect do you expect the decreased rate of Metamorphism to have on these two stocks?

Sedimentary Rock should increase and Metamorphic Rock should decrease.

Q7. Referring to the Level I Generic Graph Questions, sketch the graph on the axes provided. (Do not forget to label your lines/curves.)



Q8. Referring to the Generic Graph Guidelines, describe in full the curves on the graph.

Igneous Rock, Sediment and Magma still appear to be constant. The decreased level of tectonic activity has resulted in a a slower rate of metamorphism. Therefore, the amount of Sedimentary Rock increases while the amount of Metamorphic Rock decreases. The symmetry of those two curves indicates that one goes up as much as the other goes down. This makes sense since whatever is not removed from Sedimentary Rock is also not added to Metamorphic Rock. Both curves start to level off to new equilibrium levels after 13 million years.

Q9. Explain why the sedimentary rock stock increased to a new equilibrium when the MetaRate decreased in value.

Sedimentary Rock increased because the one of the outflows decreased while all other flows stayed the same.

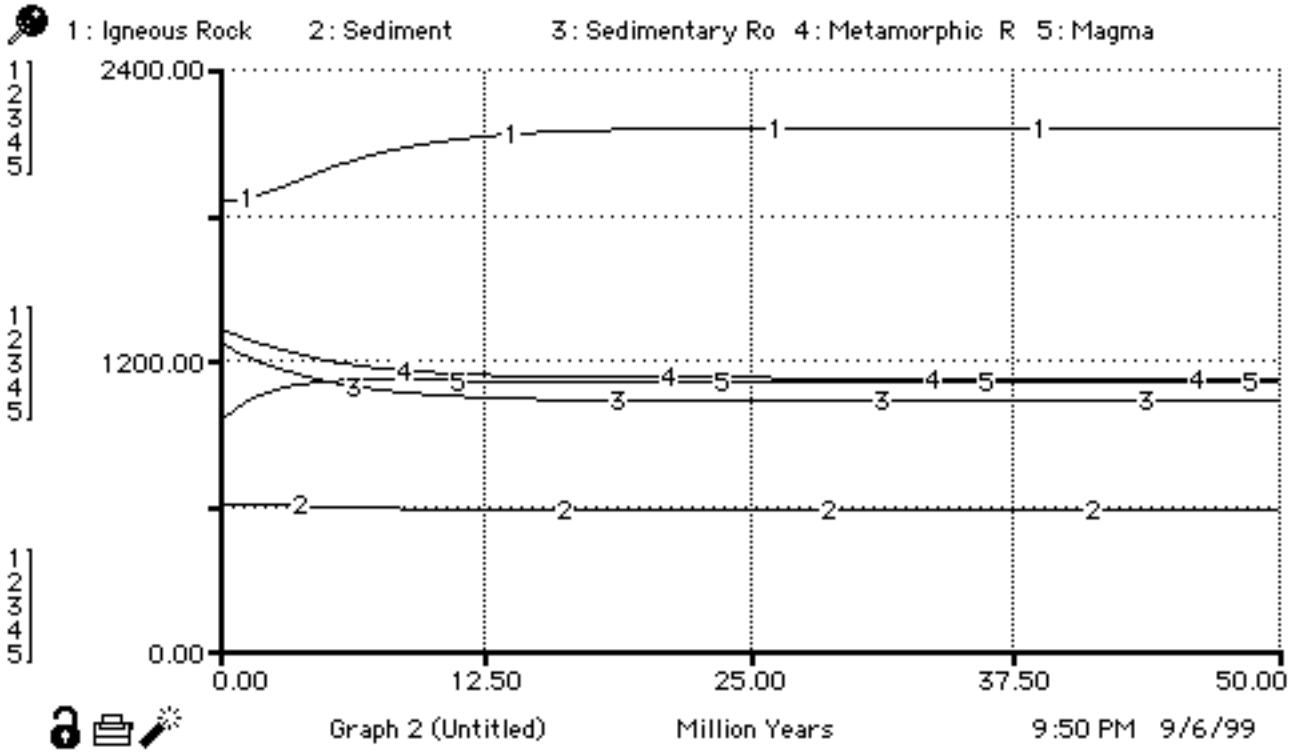
Q10. Explain why the metamorphic rock stock decreased to a new equilibrium when the MetaRate decreased in value.

Metamorphic Rock decreased because one of the inflows decreased while all other flows stayed the same.

Q11. Before running the model, predict what will happen to the amounts of igneous rock, magma, metamorphic rock, sedimentary rock and sediment.

Student answers will vary.

Q12. Referring to the Level I Generic Graph Questions, sketch the graph on the axes provided. (Do not forget to label your lines/curves.)



Q13. Compared to your graph from Scenario 1, which stocks are affected by this change and how do they change?

Sediment is the only stock which seems to show no effect from increased volcanic activity. Sedimentary and Metamorphic Rocks decrease before reaching a new equilibrium. This is due to higher melting rates which convert Sedimentary and Metamorphic Rocks to Magma more quickly. Magma increases, but as not as much as expected. This is probably due to the feedback to the Crystallization process which results in more Igneous Rock being formed. Since Igneous, Sedimentary and

Metamorphic Rocks all convert to Sediment, the increase in Igneous must be offset by the decreases in Sedimentary and Metamorphic resulting in Sediment remaining at a steady state.

Q14. Does the rock cycle come to a new equilibrium? How is it altered?
Yes, there is a new equilibrium. Sedimentary and Metamorphic Rocks are lower than before, and Magma and Igneous are higher.

Q15. What are the inflows of Metamorphic Rock?
Metamorphism and IgnMetamorphism

Q16. What are the outflows of Metamorphic Rock?
MetaSedimentation and Melting

Q17. What do the last inflow values add up to?
102.97 + 105.75 = 208.72

Q18. What do the last outflow values add up to?
100.18 + 108.53 = 208.71

Q19. How does this show that Metamorphic Rock has reached equilibrium?
Inflow is same as outflow to the nearest tenth.

Q20. Demonstrate the concept of equilibrium for a rock type other than Metamorphic by showing that the total inflow equals the total outflow.
Answers will vary depending on rock type chosen.

Extension: A cooling Earth

Q21. Referring to the Level I Generic Graph Questions, sketch the graph on the axes provided. Also, describe your scenario in the space provided.

Answers will vary.