Exam #2

1. With regard to the pelites from Dutchess County: The samples range from relatively low grade near the Hudson River (in the west) to relatively high grade as you move inland toward the Taconic Mountain "highlands." (The mountains actually are not very high today, but they used to be.) Explain this geographic distribution of samples as it relates to present day geography and the Taconic Orogeny. Why are low grade samples found where they are? Why are high grade samples found where they are? Etc.

2. Some metamorphic areas are said to represent "Franciscan-type" metamorphism, others are "Barrovian-type" metamorphism. Still another is "Buchan-type metamorphism" metamorphism. Why the differences? Why are some metamorphic terranes metamorphosed along different (apparent) paths than others? What are some characteristic and distinctive minerals and mineral assemblages that let you differentiate between these three "facies series?"

3. What are metamorphic zones and how do they relate to isograds? Generally, when we talk about metamorphic zones, we are talking about pelitic rocks. The zone concept works much better for pelitic rocks than for other sorts of rocks. Why?

4. Define each of the following:

a. *Gibbs free energy*

b. *protolith*

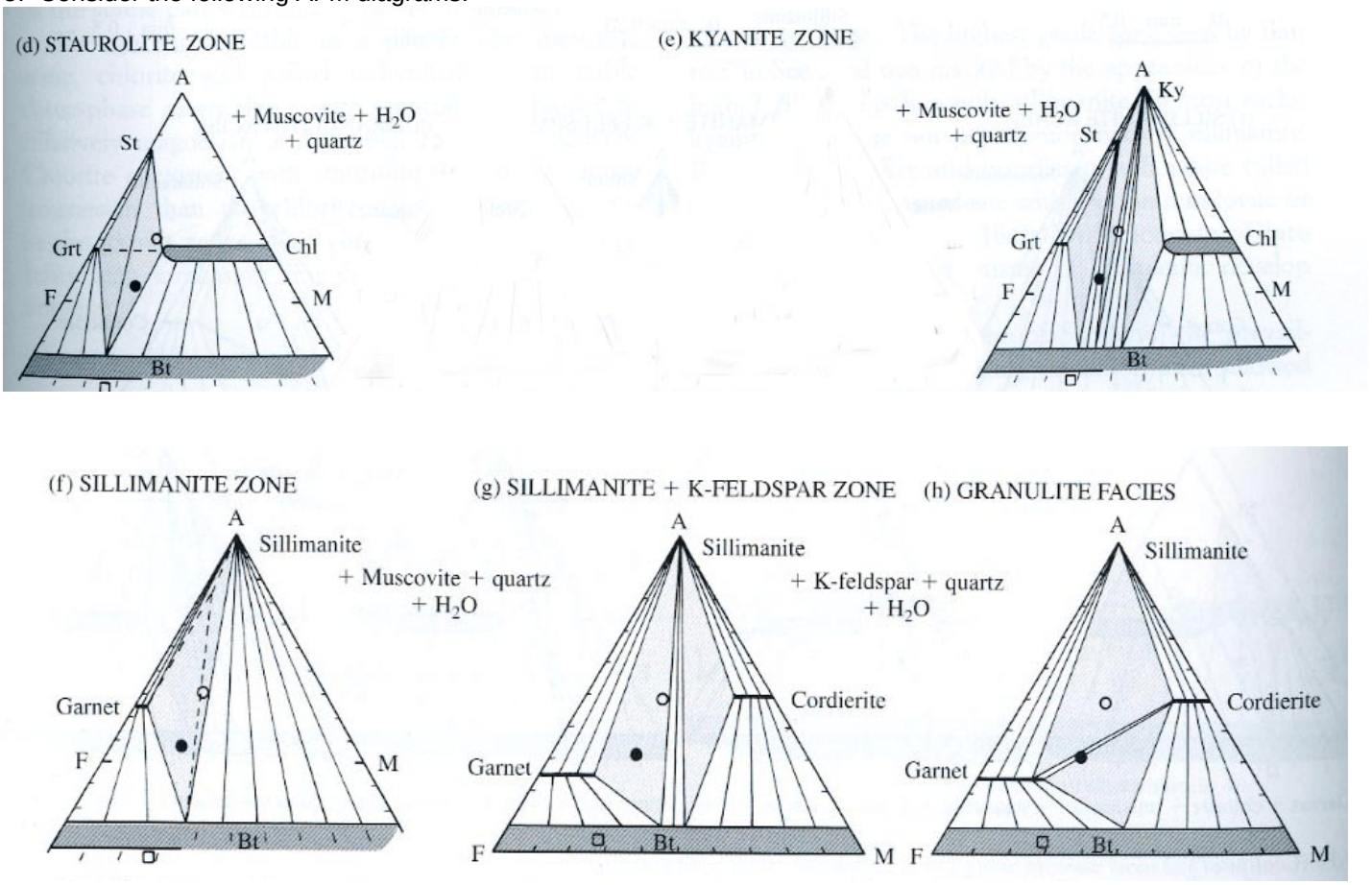
c. *metasomatism*

d. *prograde metamorphism and retrograde metamorphism*

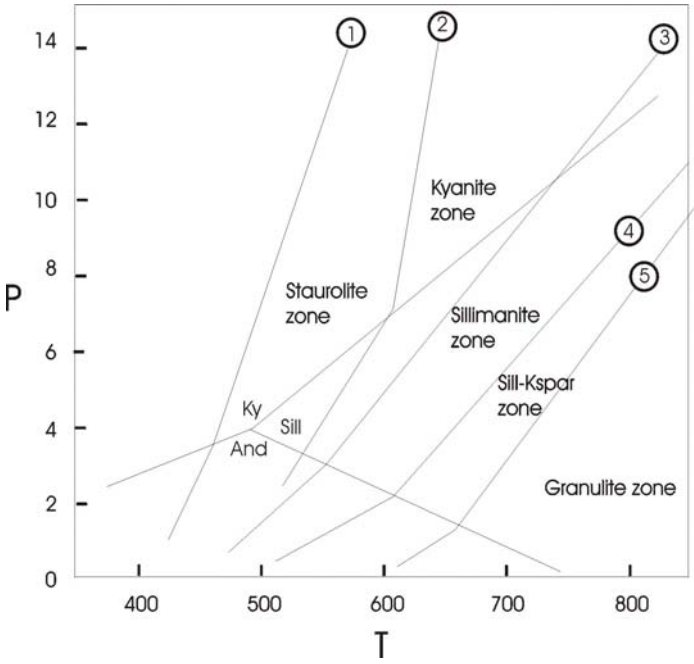
e. *eclogite*

f. *porphyroblast*

5. Consider the following AFM diagrams:



You have AFM diagrams, for five different metamorphic zones. From low to high *metamorphic grade*, the zones are: staurolite, kyanite, sillimanite, sillimanite + K-feldspar, and granulite.



<== This PT diagram goes along with the AFM diagrams above.

The boundaries between zones are indicated by numbered reactions in the PT diagram. (Reactions #2 and #3 are each actually a couple of reactions that take place at just about the same PT conditions.)

6. What does the phrase *metamorphic grade* mean?

Refer to the diagrams on the previous page for the next two questions:

7. Consider a rock with composition shown by the solid dot in the AFM diagrams. What minerals would be present in that rock in each of the metamorphic zones? (Do not forget the minerals that must be present if we use AFM diagrams such as the ones shown.)

staurolite zone minerals:

kyanite zone minerals:

sillimanite zone minerals:

sillimanite + K-feldspar zone minerals:

granulite zone minerals:

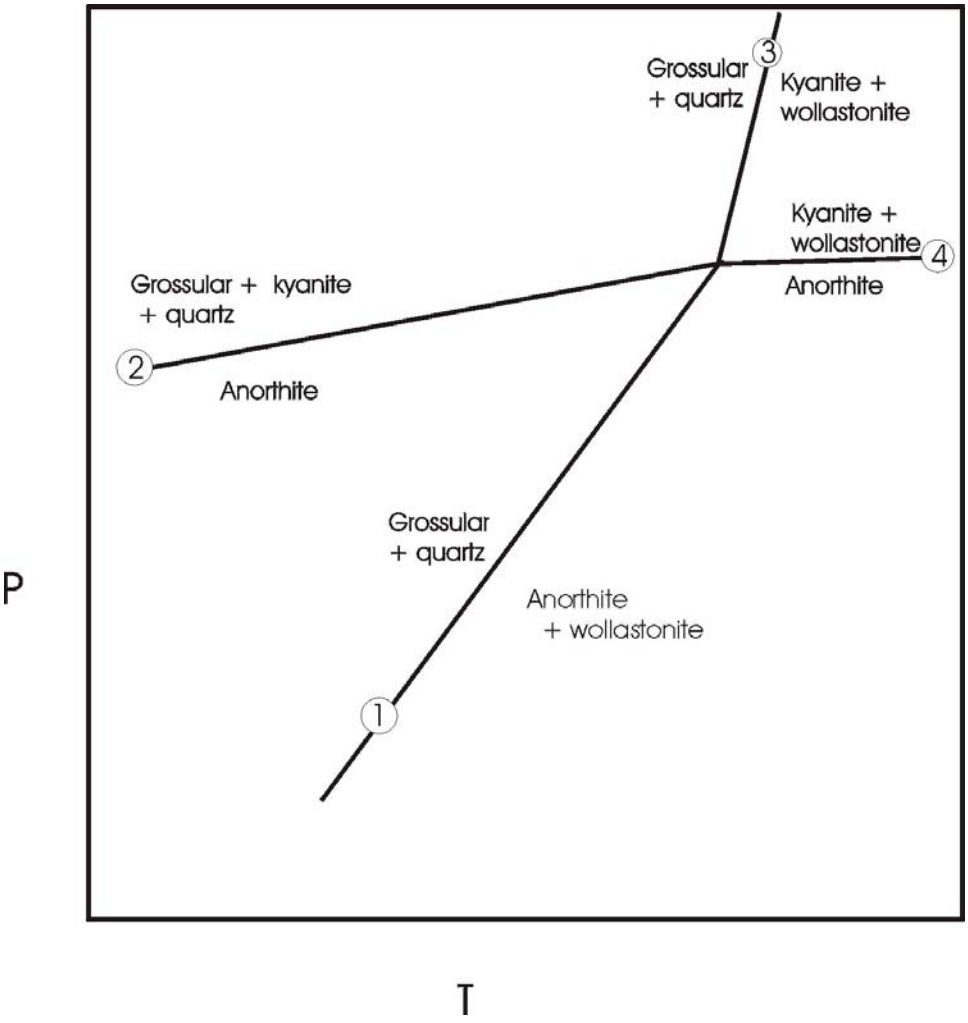
8. For each of the following minerals or mineral assemblages, tell me under what metamorphic conditions it is stable? (i.e., name a mineral zone or specifically describe where in P-T space). If there is a problem with the assemblage – for example it violates the phase rule – explain what may have caused the problem.

staurolite:

cordierite + biotite:

sillimanite + cordierite + garnet:

garnet + sillimanite + biotite + cordierite:



<== This diagram shows several reactions that intersect at an invariant point. The reactions are not balanced – and there is no need for you to balance them.

9. Parts of this question are tricky: Considering only the reactions shown, where on the above PT diagram are the following minerals or assemblages stable.? In your answer, use the reaction numbers. e.g., you might want to say "between reactions 3 and 4," or "anywhere on reaction 2," etc. "Nowhere" or " everywhere" are also potential answers.

anorthite

wollastonite

grossular + quartz

grossular + kyanite + quartz

anorthite + wollastonite + grossular + kyanite

grossular + quartz + wollastonite + kyanite

anorthite + wollastonite + grossular + kyanite + quartz