Discovering Dark Energy Names of Group:
Part I: SNe Ia as Standard Candles
1) Explain what measurements are needed to measure the distance and redshift to supernova Ia.
2) In his Nobel Prize acceptance speech, Adam Riess mentions that the distant supernova were a thousand times further way than nearby supernova, and thus a million times harder to observe. Explain this statement.
3) What are two types of corrections that were made to "standardize" SNe Ia as standard candles.

Part II: Hubble Diagrams and Expanding Universe

Below are two diagrams. The left is a traditional Hubble diagram, while the right is the diagram you saw on the slides.

- 4) On the diagram on the left, sketch what a constant expansion rate of the Universe looks like (start your line at 0,0 in the bottom left hand corner). On the right hand plot, this is the dotted line the "expected distance" is the distance based on the expansion rate observed in nearby galaxies.
- 5) Now consider a "heavy weight" matter dominated universe that is deaccelerating over time. Would more distant galaxies be moving faster or slower than in a constant expansion universe? Draw a line for a deaccelerating universe and label it in the left hand diagram
- **5a)** Now draw a deaccelerating universe in the right hand diagram. Consider whether the distance at a given redshift would be larger or smaller than expected based on constant expansion. Would a supernova at high redshift appear brighter or fainter than in a universe with constant expansion?
- 6) Now draw an accelerating universe in both diagrams. Would a supernova with at high redshift appear brighter or fainter than in a universe with constant expansion?

