#### **Review Clickers**

### Chapter 3: The Science of Astronomy

BENNETT DONAHUE SCHNEIDER VOIT

# #COSMICPERSPECTIVE

EIGHTH EDITION

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### How was careful observation of the sky used in early cultures?

- a) to determine the seasons
- b) to decide when to plant crops
- c) to navigate on long voyages
- d) all of the above
- e) A and B only

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- b) in ancient Greece
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In what ways do most people employ scientific thinking in everyday life?

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- b) They use trial and error experiments to test ideas.
- c) They predict things before they happen.
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#### What characterizes a scientific explanation?

- a) It is based on the ideas of the smartest people.
- b) The more ancient the wisdom, the better the explanation.
- c) It is based on observations.
- d) It is tested through prediction and experiments.
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#### A scientific theory must:

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- b) Be discarded or revised if it fails to explain what is observed in any experiment
- c) Include a working hypothesis and provide a welltested explanation to support or reject it
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What method or processes do scientists use when they are doing science?

- a) observing the world; looking for patterns that can be clues to underlying laws
- b) sorting, classifying, or measuring
- c) suggesting a hypothesis, which explains what has been seen already and predicts something not yet seen
- d) doing an experiment or collecting data to test the hypothesis
- e) all of the above

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Do you think scientists follow the steps of the scientific method given in the previous slide in order (step 1, then 2, then 3...)?

- a) yes-the *scientific method* is always followed
- b) no
- c) often, but not always, as exceptions exist

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An example: cases when observations are not available; in these cases, the process starts with a model, that is based on a hypothesis, thus replacing the missing observations (e.g., geology, cosmology, etc.)

### Do you think that the scientific method involves much creativity?

a) yesb) no

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### a) yes

b) no

Sometimes, scientific work resembles art work, in the sense that it is subjective (i.e., lack of observations) in which case the hypothesis made expresses the preference of the scientist

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What is special about *scientific* knowledge, compared to other ways of knowing?

- a) It is based on data.
- b) It has gone through a process of *prediction* and *testing*.
- c) Scientists *not* involved with the original discovery test it before (peer-reviewing) and after (testing / scrutiny) it has been published.
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#### What is *pseudoscience*?

- a) something that looks like science but isn't
- b) something that often uses scientific words but not the method of science
- c) something that may want the respectability of science but does not follow the procedures needed to deserve it
- d) all of the above

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#### Hallmarks of science:

- 1. No divine intervention natural caused only
- 2. Simplicity ('Occam's razor')
- 3. Testable predictions only

What are some of the common characteristics of pseudoscience?

- a) It explains things people care about that may not have other explanations.
- b) It is based on *postdiction* not *prediction*. It explains after the fact.
- c) If it fails, there is always an excuse-the theory is *not* discarded.
- d) Uses scientific-sounding jargon incorrectly (e.g., energy flows....).
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The great scientist and teacher, Richard Feynman, said science is, "A way of trying not to fool yourself." What do you think he meant?

- a) Scientists are very smart. Become a scientist and you will know more.
- b) It is natural to believe our own ideas, but not to want them critically tested. Science forces us to test our ideas.
- c) Subconsciously, we tend to see evidence that agrees with our ideas and ignore that which doesn't. In science, different groups of scientists repeat experiments, removing some of this bias.
- d) all of the above
- e) B and C

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#### e) B and C

Whose suggestion that the Sun is the center of the solar system was first taken seriously by many people?

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# What did Tycho do that advanced astronomy significantly?

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#### Johannes Kepler

- a) came up with a theory–elliptical orbits–that explained Tycho's very accurate data.
- b) found that planets don't orbit at constant velocitythey speed up when nearer the Sun.
- c) discovered the relationship between orbital period and a planet's distance from the Sun.
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#### Science Hallmark #3!

Could you distinguish between Earth and Sun-centered solar system models by observing Venus with a telescope?

- a) yes, it would show phases
- b) no, either model shows phases
- c) yes, in one model apparent size is correlated with phases
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Suppose a comet had a very eccentric orbit that brought it quite close to the Sun at closest approach (perihelion) and beyond Mars when furthest from the Sun (aphelion), but with an average distance of 1 AU. How long would it take to complete an orbit and where would it spend most of its time?

- a) one year, mostly beyond Earth's orbit
- b) one year, mostly within Earth's orbit
- c) more than one year, mostly beyond Earth's orbit
- d) less than one year, mostly within Earth's orbit
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Consider two asteroids in the inner solar system, one which orbits at an average distance of 3 AU and one which orbits at an average distance of 4 AU. Also consider two comets in the outer solar system, one which orbits at an average distance of 31 AU and one that orbits at an average distance of 32 AU. Which pair will have the larger difference in orbital speeds?

- a) The comets.
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- c) They difference in orbital speeds will be the same for each pair.
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In science, saying that something is a theory means that it is really just a guess.

- a) Yes, but a guess by a highly educated person.
- b) Yes, but it has strong support by other scientists.
- c) No, a hypothesis only becomes a scientific theory after it has been well tested.
- d) No, it must have detailed mathematical equations to back it up.
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- a) Yes, and it was therefore subsequently referred to as the "Copernican revolution."
- b) Yes, and it was subsequently used by navigators to explore the New World.
- c) Yes, because there was a growing recognition that the Ptolemaic model was inaccurate.
- d) No, it was not substantially more accurate than the Ptolemaic model.
- e) No, it was only after spacecraft explored the solar system that scientists were convinced of its validity.

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Which of the following statements uses the word *model* correctly, in a scientific sense?

- a) If our textbook's author were put in jail, he would surely be a model prisoner.
- b) A geocentric system, with planets traveling around epicycles which orbit Earth, is a reasonable model of solar system motions.
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