

Philosophy 1103: Introduction to Philosophy of Science

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Answers to Practice Quiz 2

1. In 1543 Copernicus published his famous book, *On the Revolutions of the Heavenly Spheres*.

(i) Describe the apparent motions of the superior planets, as viewed from earth, before the use of telescopes. [2 marks]

They generally move to the east, along the ecliptic. When in opposition to the sun, however, they briefly turn around and move west.

(ii) How did Ptolemy explain these motions? [2 marks]

Each planet moves around an epicycle in such a way that the vector from the centre of the epicycle to the planet is parallel to the earth-sun vector.

(iii) How did Copernicus explain these motions? [2 marks]

These planets each orbit the sun along a circle that is larger than the earth's orbit. The planet appears to move east when the earth overtakes it.

(iv) Why did Copernicus regard his explanation of these data to be better than Ptolemy's? [2 marks]

A single cause, the earth's own motion, replaced the epicycles for Mars, Jupiter and Saturn, and eliminated the unexplained connection with the sun's orbit.

(v) Does the argument in part (iv) involve his theory predicting the data more accurately, or does he think it is superior in some non-empirical respect? Explain your answer. [2 marks]

It's a non-empirical improvement. The new model is simpler and less ad hoc.

2. (i) Summarise the ‘Copernican abyss’ argument *against* the Copernican model. [2 marks]

To explain the absence of an annual stellar parallax, Copernicus had to greatly expand the celestial sphere (about 700x), creating a bizarre and pointless empty space in the universe.

(ii) Describe any assumptions involved in the argument that are not based on empirical data. [2 marks]

The universe shouldn't be too large, and shouldn't contain large voids.

3. In 1610 Galileo published *Starry Messenger*, a book describing his observations of the heavens using a telescope.

(i) In your own words, summarise what Galileo saw when he observed the moon, and Venus, using his telescope. [2 marks]

Moon: There are mountains and craters.

Venus: It shows a full range of phases, from crescent to full.

(ii) Did either of these observations disprove Ptolemy's model of the heavens? Explain your answer. [1 mark]

Venus at full phase disproved Ptolemy, as it meant that Venus was sometimes on the far side of the sun.

(iii) Did either of these observations provide evidence against Aristotle's worldview? Explain your answer. [1 mark]

Mountains on the moon showed that the moon wasn't a perfect sphere, contrary to Aristotle.

(iv) Did either of these observations prove that the earth moves, or provide evidence for its motion? Explain your answer. [1 mark]

The Venus observation refuted Ptolemy, so might have supported the earth's motion to some extent. But Tycho's model predicted the same thing, so it wasn't proof.

4. In 1912, Alfred Wegener presented evidence supporting continental drift. One piece of evidence was the global distribution of marsupials, animals such as kangaroos and opossums that carry their young in a pouch. Marsupials, Wegener pointed out, are largely confined to Australia and South America, which are separated by thousands of miles of ocean. He concluded that, long ago, Australia must have been joined to South America—probably via Antarctica.

(i) We have seen that inductive reasoning generally depends on a background paradigm. Do you think Wegener's reasoning here depends on either of the paradigms below concerning the origin of species? Explain your answer. [2 marks]

Paradigm 1: New species were all created separately by God, from time to time over geological history. Each such species was placed in all the locations (with suitable landscape, climate etc.) where it could flourish.

Paradigm 2: New species develop from previous species by descent with modification. Each new type of animal (species, genus, family, order, class, etc.) then originates in *one* location only, as it would be much too improbable for two separate populations, evolving independently in different locations, to end up being the same type.

Wegener seems to be assuming Paradigm 2 (evolution). He's assuming that the marsupials originated in one location only. In that case, the marsupials could not have ended up in 2 continents that are permanently separated by a wide ocean. (Kangaroos can't swim.) So the continents were once joined.

(ii) How might a scientist working in the other paradigm explain the same data above concerning marsupials? [2 marks]

An advocate of special creation would have no reason to believe in continental drift. If God saw that Australia and South America were both nice spots for marsupials, he could have placed them in both locations simultaneously.

5. Sometime around 1583, Tycho Brahe developed his own model of the universe, that was different from both the Ptolemaic and Copernican systems.

(i) Describe the basic features of Tycho's model. [2 marks]

The earth is stationary at the centre of the universe. The moon and sun orbit the earth, and all the other planets orbit the sun.

(ii) Explain why the existence and (moderate) popularity of this model made it hard for Galileo to prove the earth's motion. [2 marks]

The astronomical predictions for Tycho's model are identical to those of Copernicus. So Galileo cannot prove the motion of the earth by any observation of the heavens.

6. In the *Dialogue Concerning the Two Chief World Systems*, Galileo wrote:

Now there is one motion which is most general and supreme over all, and it is that by which the sun, moon, and all other planets and fixed stars—in a word, the whole universe, the earth alone excepted—appear to be moved as a unit from east to west in the space of twenty-four hours. This, in so far as first appearances are concerned, may just as logically belong to the earth alone as to the rest of the universe, since the same appearances would prevail as much in the one situation as in the other. ...

... First, let us consider only the immense bulk of the starry sphere in contrast with the smallness of the terrestrial globe, which is contained in the former so many millions of times. Now if we think of the velocity of motion required to make a complete rotation in a single day and night, I cannot persuade myself that anyone could be found who would think it the more reasonable and credible thing that it was the celestial sphere which did the turning, and the terrestrial globe which remained fixed.

(i) What hypothesis is Galileo arguing for in this passage? [1 mark]

The earth rotates on its axis (daily)

(ii) What hypothesis is Galileo arguing against? [1 mark]

The celestial sphere rotates on its axis (daily)

(iii) What observation does Galileo refer to? [1 mark]

The apparent daily rotation of the heavens around the earth.

(iv) Does the data support one hypothesis over the other, or his argument based on non-empirical assumptions? Explain your answer. [2 marks]

It's non-empirical. He assumes that the motion is more likely to belong to the smaller sphere.

7. Identify each of the following sentences as either true or false. (Write T or F in the space provided.)
[8 marks]

- T The Church of Rome in Galileo's day generally believed that the earth was stationary.
- F Galileo was continually in conflict with the Church of Rome over scientific questions.
- F Galileo argued his case against the Aristotelian philosophers with great patience and tact.
- T Galileo, using his telescope, observed things that disproved the ancient 'geocentric' model of Ptolemy.
- T An enemy of Galileo sent a copy of Galileo's *Letter to Castelli* to the Roman Inquisition, trying to get Galileo into trouble.
- T In a letter to Foscarini, Cardinal Bellarmine stated that if there were real proof of the earth's motion, then certain Bible verses would have to be reinterpreted.
- F The new Pope, Urban VIII, was especially hostile to Galileo and would not allow him to publish anything concerning the earth's motion.
- T Galileo was found suspect of heresy, and forced to renounce his Copernican position.