PHY 1033 HIS 3931 IDH 331
Mid-term exam
Oct. 15, 2015

**Part I**   **(30 points) Mulitple choice.**   Choose the best selection

1.  Which of the following mathematical devices for describing the planetary motions in the heaven was the contribution of Ptolemy?

   a.  homocentric spheres
   b.  epicycles on deferent
   c.  eccentric circles
   d.  equant point
   e.  all of the above

2.  The comet of 1577 allowed Tycho to infer that

   a.  comets had elliptical orbits
   b.  there cannot be actual crystalline spheres carrying planets in their orbits
   c.  Aristotle's theory of comets was correct
   d.  comets are warnings of calamitous events
   e.  none of the above

3.  Which of the following telescopic observations by Galileo showed that Ptolemy's system could not be correct?

   a.  The Milky Way
   b.  Phases of Venus
   c.  Mountains on the Moon
   d.  Satellites of Jupiter
   e.  None of them

4.     What argument did Osiander make in the preface to De Revolutionibus Orbium Coelestium to try to soften Copernicus' message?

      a.   Copernicus had always been an exemplary Christian
      b.   Copernicus' system was equivalent to Tycho's

      c.   Copernicus was proposing his system only as a calculational scheme
      d.   A heliocentric system did not contradict scripture because the bible should not be taken literally
      e.   None of them

5.     Who first measured the circumference of the Earth?

      a.   Aristotle
      b.   Plato
      c.   Eudoxus
      d.   Aristarchus
      e.   Eratosthenes

6.     Which of the following principles that offended the Roman Catholic church in the late middle ages were *not* ideas held by Aristotle?

      a.   Eternity of the world (no beginning nor end of time)
      b.   Nature itself, rather than a deity, is the source of purpose in the universe
      c.   The Earth rotated on its axis once per day
      d.   The body's material form and the soul were the same and inseparable
      e.   A vacuum cannot exist

7.     Retrograde motion of the planets with respect to the fixed stars

      a.   is the observational consequence of different planetary speeds, in a heliocentric system
      b.   is impossible to explain in the Ptolemaic system
      c.   means that the planet reverses its velocity v and turns around in its path
      d.   refers to the fact that the ancient Greeks' understanding of the planets was backward
      e.   None of the above

8.     From ancient to medieval times, one of the most persuasive arguments against the motion of the Earth was that if one threw a stone straight up on a moving Earth, it would not fall at the point from which it had been thrown, but somewhere behind it.   Using the example of activities on a moving ship, Galileo argued that the stone landed in the same place because


   a.   the stone was pushed sideways by the air carried by the Earth
   b.   a magnetic force kept it moving with the Earth after it had been thrown upwards
   c.   the stone moved with the Earth because it was always attached to an invisible crystalline sphere
   d.   the stone's tendency is to return to its natural place of rest at the center of the Earth
   e.   the stone has a sideways component of its velocity equal to that of the rotating Earth




9.     The approach to the understanding of nature of the ancient Milesians and Pythagoreans differed essentially from earlier, mythopoeic societies because both the Milesians and Pythagoreans


   a.   believed that nature could only be understood by making empirical measurements
   b.   used mathematics to analyze the motion of objects on the Earth
   c.   believed that nature should be understood without considering divine influence
   d.   did not care about what things were made of
   e.   studied abstract mathematics exclusively and were not concerned with natural phenomena

10. Galileo deduced laws about falling bodies from inclined plane experiments

> 1. using a coating of ice to minimize friction
> 2. because he could slow down the motion and get better accuracy
> 3. because he was forbidden to use the leaning tower of Pisa due to his Copernican views
> 4. because he wanted to prove Aristotle's predictions right
> 5. because Giovanni de Medici had asked him to build a roller coaster in Florence

**Part II (40 points)   Short answer questions**.   Answer the following a briefly as possible. You should not   need more than one or two sentences and/or a small sketch, as appropriate.

1. Navigation.  On a clear night, a sailor measures the angle Polaris, the north star, makes with the horizon, finding 32 degrees.  What is the latitude of her ship?

**32 degrees N latitude**.

2. According to at least one account, Galileo was bored one day in a mass at the Pisa Cathedral, and noticed a chandelier swinging back and forth because of the wind.   What famous physical result did he notice?

**The period (time for 1 swing) was independent of the amplitude (extent of side-to-side motion) of the chandelier's oscillation.**

3.  Average velocity.  On I-75 heading northwest, your pickup travels 30 mi in 30 minute,   at which point you hit traffic, and slow down to 10 mph for the next 30 minutes. What is your average velocity, in mi/hr? Show your work.

**Total distance is 30 mi + 5 mi = 35 mi.   Total time is 1 hour.   Average speed is 35mph.
Average velocity is 35mph northwest.**

4.  Name and define with a careful definition or a diagram 2 of the 4 motions of the earth identified by Copernicus.

**_Rotation_: daily spinning on its axis; _revolution_: annual orbiting around the sun; _annual revolution of the Earth's axis_: Copernicus believed that the Earth's axis orientation would naturally change direction as the Earth went around the sun, he had to add this one to keep the axis pointing in the same direction, towards Polaris, as it was observed to do; _precession of the equinoxes_:   change in direction of the Earth's axis with a period of 20,000 years.   It points at Polaris now, but wobbles away, then comes back 20,000 years later.**
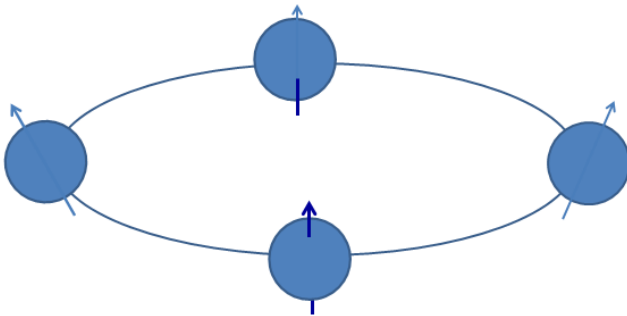
**Rotation**

North Pole

South Pole

**Revolution**



autumn

winter

summer

spring
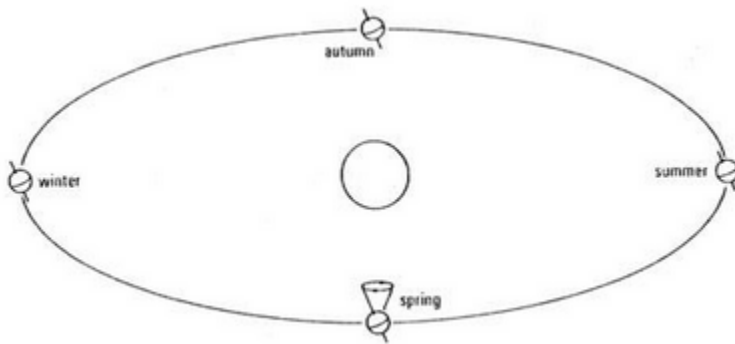
**Annual rotation of Earth's axis to keep it pointing in the same direction:**
**Copernicus thought that *without* this motion, the Earth would do this, with the axis pointing always "out":**



**Thus, to keep the axis pointing always in 1 direction, it had to rotate once/year.   This is no longer considered to be a physical motion, since the axis naturally points in the same direction for a spinning spherical Earth due to angular momentum conservation.**

**Precession of the Equinoxes.** Because the Earth is not a perfect sphere, the axis does rotate a bit, but much more slowly, with period of 26,000 years.
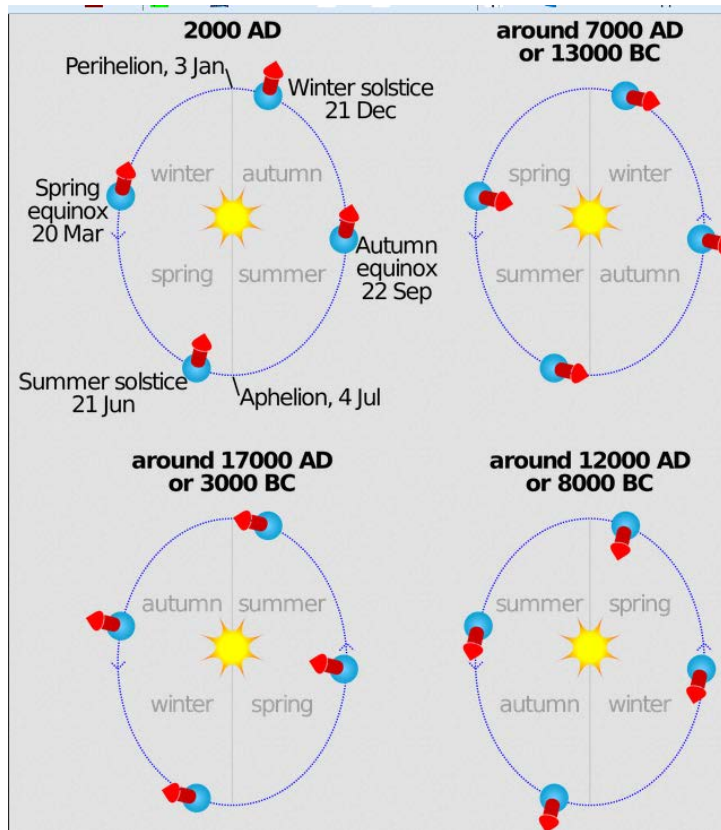
5. Centripetal acceleration.   A space station is designed as a ring of radius 20 m.

   a) How fast must it rotate if it is to simulate Earth's gravity at the edge (speed at the outer rim v)?

   **Centripetal acceleration $v^2/R$ at rim must be g ($\sim 10 m/s^2$) to simulate gravity. ($v^2/20=10$)$\Rightarrow$v=$\sqrt{200}$=14.1 m/s.**

   b) What is the corresponding angular velocity $\omega$?

   **$\omega$=v/R=14.1/20 = 0.71 Rad/s**

6. Exploration.   Name three reasons why the pace of European exploration of the globe quickened in the 15th century.

   **Commercial: desire for spices, other trade**
   **Spread of religion – converts**
   **New navigational techniques allowed**
   **(Africa specifically: Search for Prester John)**

7.   Planets travel at different velocities on their orbits at different times.

   a)  What is the modern understanding of this phenomenon?

       **Planets move in elliptical orbits, and when planets are closer to sun they move faster because the gravitational attraction is stronger**

   b)  Which early 17<sup>th</sup> century philosopher/mathematician gave the first correct explanation of this phenomenon, according to the modern view, and what forced him to this conclusion?

       **Johannes Kepler, who was unable to fit orbit of Mars within a Copernican scheme with   circular orbits, or even with circles and epicycles.**

8.   Choice: *either a) or b).   Do not do both.*

   a)  Describe the cosmology of Tycho Brahe and why it was observationally equivalent to Copernicus' system.

       **Tycho's system, where sun and moon orbit the Earth, but all other planets orbit the**

**sun, is observationally equivalent to Copernican system because is simply the Copernican system with a shift of the reference point from the Sun to Earth.**

b) Give two weird facts about Tycho and explain the background a bit.

    **I accepted:    artificial nose made out of metal to replace nose lost in duel**
                         **died after party when he was unable to urinate for 11 days**
                         **owned pet elk that died after drinking too much beer and falling down**
    **stairs**

**Part III.   (30 pts)   Essay.**   Choose **either** A **or** B (Do not do both).   Write in blue book.

A.  Discuss the evolution of heliocentric models of the cosmos.   When were these ideas first proposed?   What were the arguments for and against?   At what point did religion become part of the discussion, and what role did it play?   What were the primary competing models, and what were the advantages/disadvantages of both, as seen by ancient, medieval, and early modern philosophers?

B.   Discuss the following quote from Steven Weinberg

*I chose "Discovery" (of Modern Science as a subtitle) to suggest that science is the way it is not so much because of various adventitious historic acts of invention, but because of the way nature is.   With all its imperfections, modern science is a technique that is suffiently well tuned to nature so that it works – it is a practice that allows us to learn reliable things about the world.   In this sense, it is a technique that was waiting for people to discover it.*

Refer in your essay to the *way* the philosophers and mathematicians we have studied in the course chose to approach questions about the universe, both celestial and Earthly.