This portion of the homework investigates the relationship between how long it takes a planet to orbit a star (orbital period) and how far away that planet is from the star (orbital distance). We will start by investigating an imaginary planetary system that has an average star like the Sun at the center. A huge Jupiter-like planet named Moto orbits close to the star, while a small Earth-like planet named Spec is in a far away orbit around the star. Use this information when answering the next four questions.

1.) Which of the two planets (Moto or Spec) do you think will move around the central star in the least amount of time?
   a.) Moto  
   b.) Spec

2. If Moto and Spec were to switch positions, would your answer to question 1 change?
   a.) Not really as the orbital times would remain the same; Spec would orbit in the time Moto used to and Moto would orbit in the time Spec used to
   b.) Moto would orbit more slowly than Spec did before because it is bigger and more massive
   c.) Spec would orbit faster than Moto did before because it is small and light

3.) Do you think the orbital period for Moto would increase, decrease, or stay the same if it were to move from being close to the central star to being much farther away?
   a.) increase  
   b.) decrease  
   c.) stay the same

4.) Imagine both Moto and Spec were in orbit around the central star at the same distance and that their orbital positions would never intersect (so that they would never collide). Do you think the two planets would have the same or different orbital periods?
   a.) Same  
   b.) Different
   c.) it depends on other factors

The graph to the right illustrates how the orbital period (expressed in years) and orbital distance (expressed in Astronomical Units, AU, 1 AU is the distance of the earth from the sun) of a planet are related.

5.) According to the graph, would you say that a planet’s orbital period appears to increase, decrease, or stay the same as a planet’s orbital distance is increased?
   a.) increase  
   b.) decrease
   c.) stay the same
6.) How far from the central star does a planet orbit if it has an orbital period of 3 years?  
   a.) about 5 AU b.) about 2.2 AU c.) about 1.7 AU  

7.) How long does it take Jupiter complete one orbit (it is 5.2 AU from the sun)?  
   a.) 3 years b.) about 11.4 years c.) it is not possible to tell from this graph  

8.) Based on your results from questions 6 and 7, which of the following best describes how a planet’s orbital period will change (if at all) when its distance to the central star is doubled?  
   a.) The planet’s orbital period will decrease by half.  
   b.) The planet’s orbital period will not change.  
   c.) The planet’s orbital period will double.  
   d.) The planet’s orbital period will more than double.  

9.) From Newton’s law of gravity, when the distance of a planet from its star is tripled, how does the gravitational force on the planet change?  
   a.) it doubles  
   b.) it is decreased by a three times  
   c.) it is decreased by nine times  
   d.) it stays the same  
   e.) it is increased by three times  

10.) If the distance of a planet from its star is doubled, how much farther does it have to travel to go all the way around its orbit? (you may assume a circular orbit, think about the circumference of a circle) Circumference = 2\pi r so doubling r doubles the circumference  
   a.) two times b.) four times c.) the same  

11.) Copernicus developed his theory of the solar system because  
   a.) he wanted to see if he could stir up some controversy  
   b.) he just wanted to try something different  
   c.) he wanted to simplify the Ptolemaic system  
   d.) he had a vision that the sun was at the center of the solar system  
   e.) his measurements of the sizes of the earth, moon, and sun argued that the sun was at the center  

12.) Look at the expression for escape velocity given in lecture (section called “Physical Laws”). If we are in orbit some distance away from the surface of the Earth, how does the velocity needed to escape the Earth’s gravity change?  
   a. it stays the same regardless of where you are b. the escape velocity will be higher  
   c. the escape velocity will be lower d. other information is needed  

13.) You are driving a car. You adjust your foot pressure on the accelerator so that the speedometer indicates the same value as you go around a corner. Which of the following statements is true:  
   a. because the car’s speed is constant, no forces are involved  

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b. because the car’s direction changes, a force is involved  
c. because the car must overcome friction and wind resistance, a force is involved  
d. both b. and c. are true

14.) Galileo's telescopes  
a. had really good lenses that allowed him to see fine details  
b. were limited in resolution by poor lenses and the need to reduce their apertures  
c. were the first ones ever made  
d. were really no better than those made by others

15.)  A container of air is resting on a table at room temperature. A hair dryer is turned on and pointed at the container thus heating up the air in the container.  
a. the air molecules in the container do not change their behavior  
b. the air molecules in the container slow down  
c. the air molecules in the container speed up  
d. the air molecules emit more radiation  
e. both c. and d.

16.) An object has a temperature of 500° K. An astronomer takes a spectrum and sees that the object’s output is largest at a wavelength of 6000 nm (1 nm = 10^-9 meters). The object cools down to 250° K. At what wavelength does the output peak now?  
a. 6000 nm  
b. 12000 nm  
c. 3000 nm  
d. in visible light  
e. in x-rays

17.) You and a friend are playing around on the university mall. One of you has a flashlight. Initially you stand 10 feet apart. The one without a flashlight uses a light meter to record the apparent brightness of the flashlight. The person holding the flashlight moves away so she’s 100 feet away from the light meter. How does the reading on the light meter change?  
a. it gets 90 units smaller  
b. it gets 100 times smaller  
c. it doesn’t change  
d. it gets larger

18.) A hotter object appears  
a. brighter and bluer than a cooler one  
b. dimmer and redder than a cooler one  
c. brighter and redder than a cooler one  
d. dimmer and bluer than a cooler one

19.) Tycho’s observation of an exploding star (a supernova) was significant because  
a. it was an illustration that the Aristolean view of the sky as unchanging was incorrect  
b. it helped him measure the distance to other stars  
c. it provided proof that he was the best astronomer around  
d. it actually was not important

20.) Which of the following were changes in the Copernican model of the Solar System as compared to Ptolemy’s model?  
a. the assumption that planets move on circular orbits  
b. the assumption that planets move at constant velocity along their orbits  
c. that the Sun is the center of the Solar System  
d. both a. and b.

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