Hunting for Planets Answer Key

1. In the model, how did you change the light intensity of the star?
I moved the planet in front of the star. When I made the planet big, it dimmed the star more than smaller planets.

2. Which planet would be most easily detected with the light-intensity method of planet hunting?

Planet C

3. Explain your answer.
Planet C is the largest planet. Larger planets cause more dimming of the star as they pass it. They block more of the star, so the dimming effect is larger. Smaller planets cause smaller dimming because they block less of the star's light. A large dimming effect is easier to detect than a small dimming effect. Therefore, Planet C would be easiest to detect via the light-intensity method of planet hunting.

4. How certain are you about your claim based on your explanation?
Student answers will vary.

5. Explain what influenced your certainty rating.
Student answers will vary. Scientific evidence includes evidence from the model.
Students may be uncertain that the planet's orbit completely covers the star. This is something that they can test with the model. If the planet orbits such that only the top of the planet crosses the star, the dimming effect of a large planet could equal the dimming effect of a medium-sized or small planet. This means that the largest planet is not necessarily the easiest planet to detect.

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6. Take a snapshot showing a large planet that has no dimming effect on its star.

7. How did you make a large planet undetectable with the transit method?

Students' responses should say this or something similar: I made the planet orbit at an angle close to 90 degrees. This made the planet detectable with the wobble method, but it was completely undetectable with the transit method. This is because the telescope needs to see the planet cross in front of the star to be detectable via the transit (light-intensity) method.

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8. Take a snapshot that shows a small planet that has some dimming effect on its star.

9. How did you make a small planet detectable by the transit method?

Students' responses should say this or something similar: I made the planet orbit at a 0 degree angle. This made the small planet detectable by the transit method. The dimming effect isn't very large (the scale on the graph shows that the topmost and bottommost numbers are the same, meaning that the scale is very small), but it is detectable because the telescope can see that the planet crosses in front of the star.

10. A scientist measures the light from a star over two weeks (14 days) and obtains the graph shown below.

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The scientist concludes that there is not a planet around the star.
Do you agree with the scientist?
no

11. Explain your answer.
The scientist has only waited 14 days for the light intensity to change. This is not long enough to wait when using the transit method. This is because the transit of the planet across the star is very brief. The signal appears for only a small portion of the planet's orbiting time, unlike with the velocity graph, which shows the continuous motion of the star, caused by the continuous motion of the star. The orbital period of Earth is 365 days. The orbital periods of the outer planets in our solar system is much longer. I would want to wait for at least 1000 days before concluding that I wouldn't see any drop in light intensity from this star.

12. How certain are you about your claim based on your explanation?
Student answers will vary.

13. Explain what influenced your certainty rating.
Student answers will vary. Scientific evidence includes specific reference to experiments with the model. Students may be uncertain about the orbital period of the planet, that 14 days would be a long enough time to detect the drop in light intensity caused by a transiting planet. Students may also be uncertain that the planet is orbiting in a plane detectable to the telescope.

14. Is it possible to detect a really small planet when there is a lot of noise in the data?
no

15. Explain your answer.
When there is a lot of noise, the signal from a small planet can be obscured. This makes it very difficult to find a small planet when there is a lot of noise.

16. Most of the planets that have been discovered using the transit method have had large diameters. Why?
Most planets detected via the transit method have had large diameters because large planets cause the most dimming effect on the star. Smaller planets have less of a dimming effect. Larger effects are easier to detect than smaller effects.

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17. Based on the graph, could there be a planet orbiting this star?
Yes. There is definitely a planet there.

18. Explain your answer. What more information would you want to be sure of your answer?
There is a regular, visible signal of dimming on this graph. It appears at regular intervals, meaning that it is due to some periodic movement, such as that of an orbiting planet. There is a lot of noise in the data, but the signal is large enough to detect.
To be really sure, I would want to have less noise in the data. If there were less noise, I could determine whether the signal is real or not.

19. Based on the graph, could there be a planet orbiting this star?

I'm not sure if there is a planet there.

20. Explain your answer. What more information would you want to be sure of your answer?
There is so much noise in this data that it is impossible to see whether or not there is a signal. I would want to have a similar graph with much less noise to be able to determine whether or not there is a planet present.

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21. A star was picked at random and light intensity was measured over a long period of time. The resulting light intensity graph is shown below.

Could there be a planet orbiting this star?
Student answers will vary.

22. Explain your answer.
The graph shows that there is no dimming effect on the star. This could be for a number of reasons. The first reason is that there is no planet orbiting this star. But it is possible to have a planet and not detect it on this graph. If the scientists didn't wait long enough, they might not have detected a planet. It could be that the planet's orbit takes a longer time than they measured. Or it could be that the planet orbits at an angle that is not detectable by the telescopes. If the planet's orbiting angle is not very close to the same plane as the telescope, the planet's transit will not be detected by the telescope. Or the planet could orbit in a detectable orbital plane, but it could be so tiny that it causes very little dimming effect on the star.

23. How certain are you about your claim based on your explanation?
Student answers will vary.

24. Explain what influenced your certainty rating.
Student answers will vary. Scientific evidence includes specific reference to experiments with the model. Students may be uncertain that the scientists collected enough data to know that there's not a planet around the star. They may also be uncertain about the orbiting angle and size of the planet.

25. Which star did you get?
Student answers will vary.

26. Do you think that there is a planet orbiting your star?
Student answers will vary. If students use the Zoom feature of the graphs, the answer should be yes.

27. Take a snapshot to support your conclusions.
Snapshots of each of the HAS stars follow, along with a description of likely orbit of the planet.

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HAS329

HAS329 planet is detectable via the wobble method, but not by the transit method. There is too much noise in the data to detect the planet via the transit method.
The velocity change is very small, meaning that this is either a very small planet, or a large planet orbiting at a very steep angle.

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HAS612

HAS612 planet is detectable by wobble method and transit method. Although there is a lot of noise in the data, the signal is still large enough to be detectable.
The velocity change is very large, indicating that this a large planet orbiting at an angle close to 0 degrees. The light intensity graph supports this, as there is a readily detectable change in light intensity that corresponds to the star movement in the velocity graph.

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HAS781

HAS781 planet is detectable by wobble method and transit method. There is some noise in the data, but the signal is still large enough to be detectable.
The velocity change is medium-large, indicating that the planet is likely to be quite large. The light intensity graph indicates that the orbital angle close to 0 degrees, as there is a readily detectable change in light intensity that corresponds to the star movement in the velocity graph. The planet likely has a large diameter, with a medium mass, making it likely to be a gaseous planet.

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HAS873

HAS873 planet is detectable via the wobble method, but not by the transit method. There is too much noise in the data to detect the planet via the transit method.
The velocity change is very large, meaning that this is large planet. It probably orbits at a steep angle since it is completely undetectable by the transit method.

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HAS954

HAS954 planet is detectable via the wobble method and the transit method. There is little noise in the data.
The velocity change is very small, meaning that this is likely a small to medium-sized planet or a large planet orbiting at a steep orbital angle. The orbital angle cannot be too steep though, because the planet is clearly detectable via the transit method.

28. Explain your answer.
Student answers will vary. Students should describe the data in the velocity and light intensity graphs. See the descriptions beneath the snapshots for examples of correct interpretations.

29. How certain are you about your claim based on your explanation?
Student answers will vary.

30. Explain what influenced your certainty rating.
Student answers will vary. Scientific evidence includes specific references to data on the velocity and light intensity graphs. Students may be uncertain that the signal is distinct from the noise in the data. Students may be unsure about the size and orbital angle of the planets. (Note that this is added information; students are not required to speculate on the size or orbital angle of the planets.)

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31. Describe an example in which you were very certain from the graphs how the solar system was set up and why you were certain.
Student answers will vary. Students should cite specific information from the graphs.

32. Describe an example in which you were uncertain from the graphs how the solar system was set up and why you were uncertain.
Student answers will vary. Students should cite specific information from the graphs.

33. How successful were you in detecting others' planet setups? What made it more difficult?
Student answers will vary. Students should note that noise in the data made planets more difficult to detect. They may also note that planets are more readily detectable via the wobble method than the transit method.

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