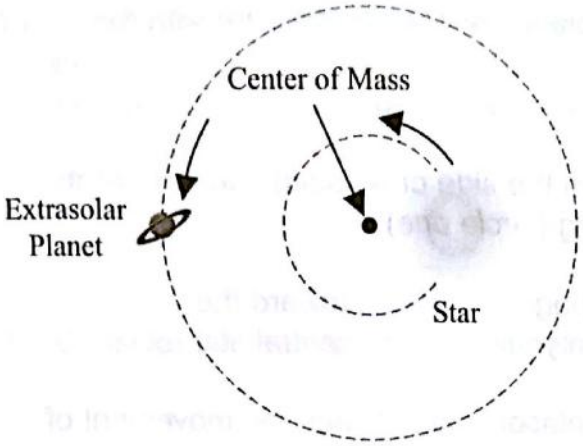


Figure 1. Extrasolar Planet and Star as Seen from Above (*not to scale*)

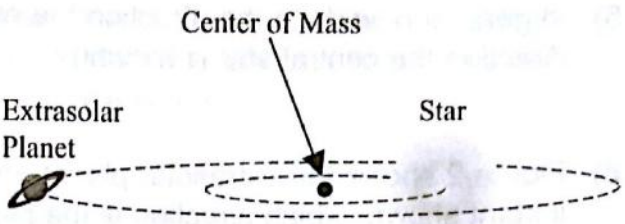


Figure 2. Extrasolar Planet and Star as Seen Edge-On or from the Side. Note that the extrasolar planet is moving toward you. (*not to scale*)

1) Figure 1 and Figure 2 show the orbits of the same extrasolar planet and star from two different points of view. As an extrasolar planet orbits around a star, the gravitational attraction between the two objects causes the central star to make a small orbit around the system's center of mass. Which object travels in the largest orbit (*circle one*)?

extrasolar planet | the star | they have the same-sized orbit | you can't determine which has the larger orbit

2) Which object takes a greater amount of time to complete one orbit (*circle one*)?

extrasolar planet takes longer | central star takes longer | they both take the same amount of time | you can't determine which takes longer

Explain your reasoning.

3) At the instant shown in Figure 1, which direction is the extrasolar planet moving (*circle one*)?

toward the bottom of the page | toward the top of the page | toward the central star

4) At the instant shown in Figure 1, which direction is the central star moving (*circle one*)?

toward the bottom of the page | toward the top of the page | toward the extrasolar planet

5) In general how does the direction the extrasolar planet is moving compare with the direction the central star is moving?

6) Figure 2 shows the extrasolar planet and star from the side or as seen edge-on. At the instant shown, which direction is the planet moving (*circle one*)?

coming out of the page directly toward you | moving into the page directly away from you | toward the central star

7) Two students are having a discussion about the relationship between the movement of the star and planet and the Doppler Shift of the light coming from the star.

Student 1: *Since Figure 2 states that the extrasolar planet is moving out of the page, directly toward us, then the light from the star we observe will be blueshifted.*

Student 2: *I disagree, the light from the star will be redshifted because the star is moving the opposite direction the planet is moving.*

Do you agree or disagree with either or both of the students? Explain your reasoning.

8) Suppose instead that the extrasolar planet (shown in Figures 1 and 2) became much more massive, but continued orbiting at the same distance. How would your observations from Earth be different (*circle one*)?

the star's light would be shifted even more | the star's light would be shifted less than before | no change in the light would be observed

Explain your reasoning.

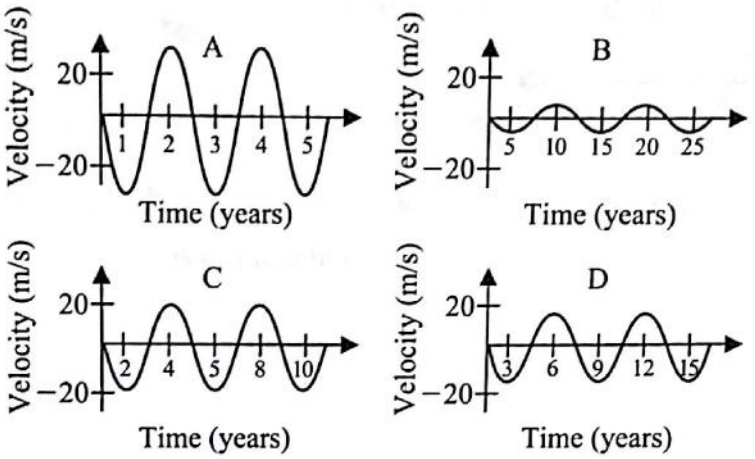
9) Suppose instead that the extrasolar planet (shown in Figures 1 and 2) moved farther away from the star, but continued to have the same mass. How would your observations from Earth be different (*circle one*)?

the star's light would be shifted even more | the star's light would be shifted less than before | no change in the light would be observed

Explain your reasoning.

10) Under what condition would you **not** observe a star's light to ever undergo Doppler Shift even when there is an extrasolar planet orbiting the star? Explain your reasoning and include a drawing to illustrate your answer in the space below.

11) Consider the four graphs shown below which show the radial velocity of four stars.



a) From which star would you observe the greatest Doppler Shift? Explain your reasoning.

b) Which planet has the longest orbital period? Explain your reasoning.

12) Given the location marked with the dot on the star's radial velocity curve, at what location (A–D) would you expect the planet to be located at this time? Explain your reasoning.