Here is a planet orbiting a star. It obeys Newton’s law of gravitation and Newton’s laws of motion. Therefore it also obeys Kepler’s laws. As it goes in the path 1 -> 2 -> 3 -> 4, consider the work being done by the star on the planet (by gravity). Circle all correct answers (there may be more than one in various cases.)

A. Negative work (W<0) is being done at point(s)  1  2  3  4
B. Zero work (W=0) is being done at point(s)  1  2  3  4
C. Positive work (W>0) is being done at point(s)  1  2  3  4

ANSWERS

Work is force times the component of displacement in the direction of the force. The gravity force is always directed from the planet toward the star. At points 1 and 3, the velocity vector is perpendicular to the force vector, so no work is being done. The answer to B is 1 and 3.

At points 2 and 4, the force vector has a component toward the left since the star is to the left of the planet. The velocity at 2 is completely to the right, so some negative work is being done, whereas at point 4, the velocity is completely to the left, so some positive work is being done. The answer to A is 2 and to B is 4.

You can also see that work must be negative at 2 and positive at 4, because the planet is slowing down at 2 and speeding up at 4 according to Kepler’s equal area law.