

. (12 points, suggested time 25 minutes)

A small block of mass m_0 is attached to the end of a spring of spring constant k_0 that is attached to a rod on a horizontal table. The rod is attached to a motor so that the rod can rotate at various speeds about its axis. When the rod is not rotating, the block is at rest and the spring is at its unstretched length L , as shown. All frictional forces are negligible.

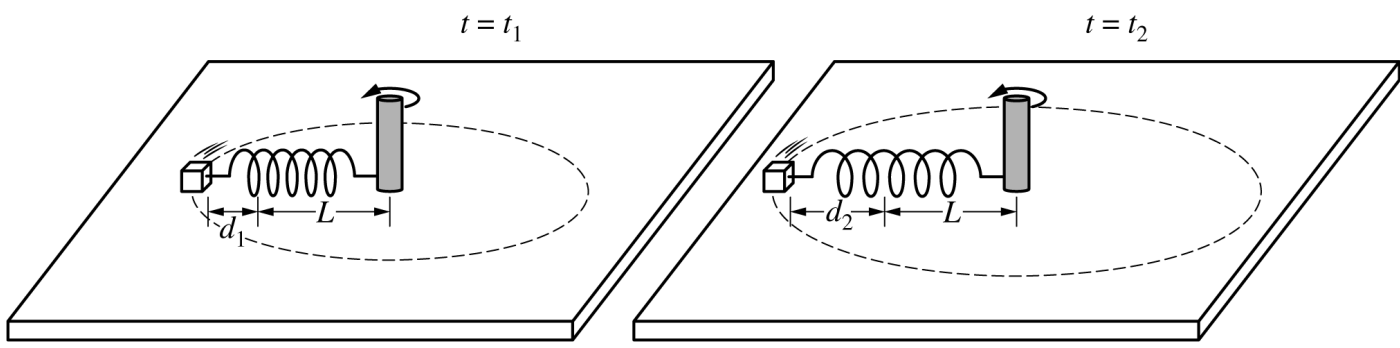


Figure 1

Figure 2

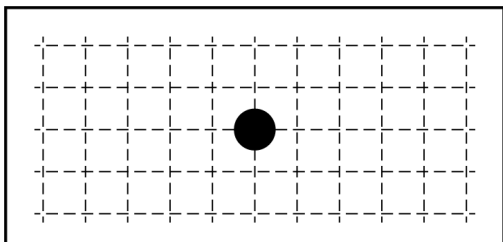
- (a) At time $t = t_1$, the rod is spinning such that the block moves in a circular path with a constant tangential speed v_1 and the spring is stretched a distance d_1 from the spring's unstretched length, as shown in Figure 1. At time $t = t_2$, the rod is spinning such that the block moves in a circular path with a constant tangential speed v_2 and the spring is stretched a distance d_2 from the spring's unstretched length, where $d_2 > d_1$, as shown in Figure 2.

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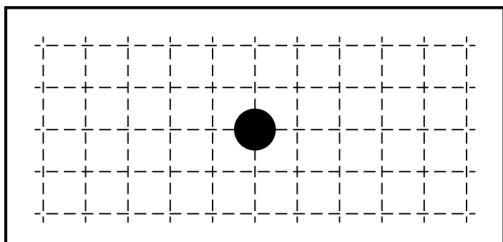
Continue your response to **QUESTION 3** on this page.

- i. On the following dots, which represent the block at the locations shown in Figure 1 and Figure 2, draw the force that is exerted on the block by the spring at times $t = t_1$ and $t = t_2$. The spring force must be represented by a distinct arrow starting on, and pointing away from, the dot.

Note: Draw the relative lengths of the vectors to reflect the relative magnitudes of the forces exerted by the spring at both times.



$t = t_1$



$t = t_2$

- ii. Referencing d_1 and d_2 , describe your reasoning for drawing the arrows the length that you did in part (a)(i).

- iii. Is the tangential speed v_1 of the block at time $t = t_1$ greater than, less than, or equal to the tangential speed v_2 of the block at time $t = t_2$?

_____ $v_1 > v_2$ _____ $v_1 < v_2$ _____ $v_1 = v_2$

Justify your answer without using equations.

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Continue your response to **QUESTION 3** on this page.

- (b) Consider a scenario where the block travels in a circular path where the spring is stretched a distance d from its unstretched length L .
- Determine an expression for the magnitude of the net force F_{net} exerted on the block. Express your answer in terms of m_0 , k_0 , L , d , and fundamental constants, as appropriate.
 - Derive an equation for the tangential speed v of the block. Express your answer in terms of m_0 , k_0 , L , d , and fundamental constants, as appropriate.

- (c) Does your equation for the tangential speed v of the block from part (b)(ii) agree with your reasoning from part (a) ?

_____ Yes _____ No

Explain your reasoning.

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