

Question 2: Translation Between Representations (TBR)

12 points

A	For indicating that K_{block} is zero	Point A1
	For drawing bars with positive heights for U_A and U_B	Point A2
	For drawing a bar for U_B with a height that is twice the height of the bar drawn for U_A	Point A3
Scoring Note: This point may be earned regardless of the signs of either bar.		

Example Response

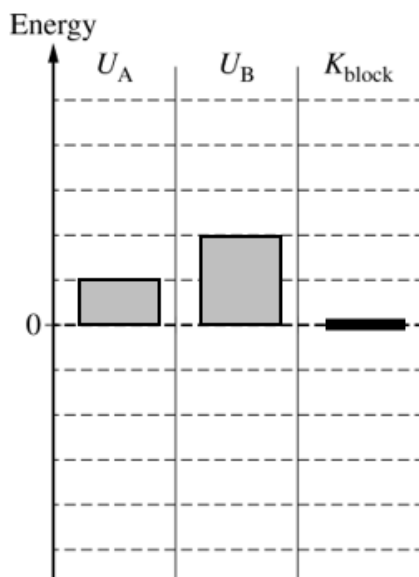


Figure 3

B	For a multistep derivation that includes energy conservation or simple harmonic motion	Point B1
	For relating the presence of both springs to the behavior of the system	Point B2
	For relating positions $x = x_1$ and $x = \frac{1}{2}x_1$ to the oscillation of the block	Point B3
	For a correct expression for v in terms of given quantities	Point B4

Example Responses

$$E_{\text{tot},0} = U_A(x_1) + U_B(x_1) + K_{\text{block}}(x_1)$$

$$E_{\text{tot},f} = U_A\left(\frac{1}{2}x_1\right) + U_B\left(\frac{1}{2}x_1\right) + K_{\text{block}}\left(\frac{1}{2}x_1\right)$$

$$E_{\text{tot},0} = \frac{1}{2}(k)(x_1)^2 + \frac{1}{2}(2k)(x_1)^2 + 0$$

$$E_{\text{tot},f} = \frac{1}{2}(k)\left(\frac{1}{2}x_1\right)^2 + \frac{1}{2}(2k)\left(\frac{1}{2}x_1\right)^2 + K_{\text{block}, \frac{1}{2}x_1}$$

$$E_{\text{tot},0} = E_{\text{tot},f}$$

$$\frac{1}{2}kx_1^2 + kx_1^2 = \frac{1}{8}kx_1^2 + \frac{1}{4}kx_1^2 + K_{\text{block}, \frac{1}{2}x_1}$$

$$\frac{3}{2}kx_1^2 = \frac{3}{8}kx_1^2 + K_{\text{block}, \frac{1}{2}x_1}$$

$$K_{\text{block}, \frac{1}{2}x_1} = \frac{9}{8}kx_1^2$$

$$\frac{1}{2}mv^2 = \frac{9}{8}kx_1^2$$

$$v = \frac{3}{2}x_1\sqrt{\frac{k}{m}}$$

$$x = x_{\text{max}} \cos(\omega t + \phi)$$

$$x(t) = x_1 \cos \omega t$$

$$v(t) = -x_1 \omega \sin \omega t$$

OR

$$k_{\text{eff}} = k + 2k = 3k$$

$$\omega = \sqrt{\frac{3k}{m}}$$

$$\frac{x_1}{2} = x_1 \cos \omega t_{\frac{1}{2}x_1}$$

$$\cos \omega t_{\frac{1}{2}x_1} = \frac{1}{2}$$

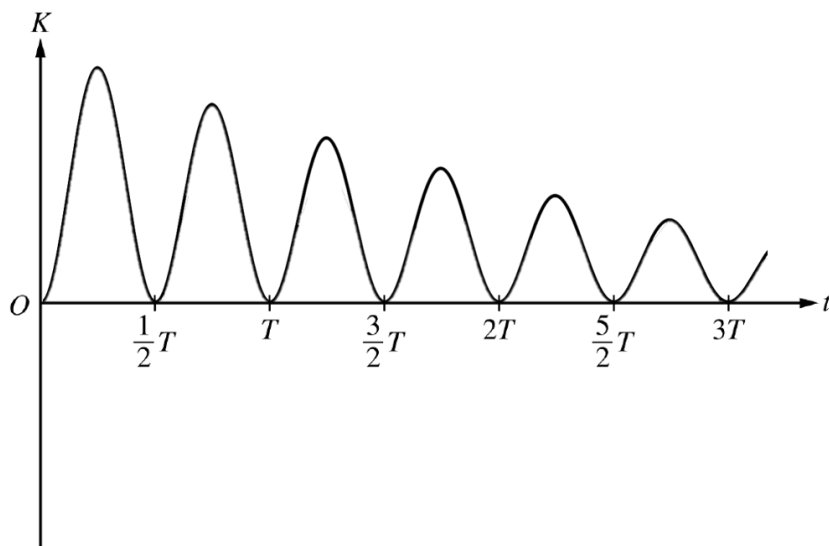
$$t_{\frac{1}{2}x_1} = \frac{\pi}{3\omega}$$

$$v_{\frac{1}{2}x_1} = -x_1 \omega \sin \omega t_{\frac{1}{2}x_1}$$

$$v_{\frac{1}{2}x_1} = -x_1 \sqrt{\frac{3k}{m}} \sin \frac{\pi}{3}$$

$$v = \left| v_{\frac{1}{2}x_1} \right| = \frac{3}{2}x_1 \sqrt{\frac{k}{m}}$$

C	For sketching a curve that starts at zero and is always positive or zero	Point C1
	For sketching a periodic curve with zeros that have a period of $\frac{1}{2}T$	Point C2
	For sketching a periodic curve with a decreasing amplitude	Point C3

Example Response

Scenario 2

Figure 5

D	For indicating one of the following: • The period increases. • The rate at which the graph approaches zero increases. • The maximum value of K over each period is less than the graph drawn.	Point D1
	For a correct justification relevant to the feature indicated	Point D2

Example Responses

The period of the graph increases. The period of a simple harmonic oscillator increases with increasing mass.

OR

The rate at which the graph approaches zero amplitude increases. Because the mass of the block is larger, the force of friction is greater, which causes the block to lose energy at a greater rate.