

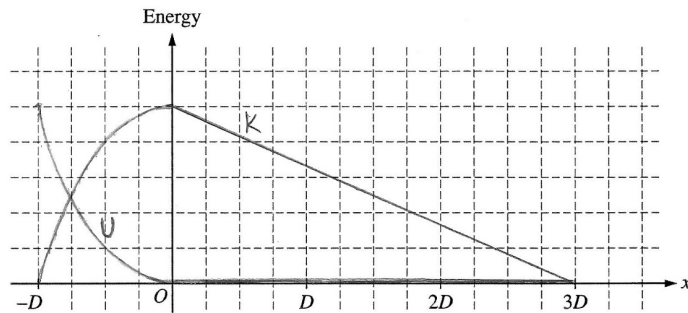
2015 SCORING GUIDELINES

Question 3

12 points total

Distribution
of points

(a) 4 points



- For sketching either energy curve with a reasonably correct shape between $x = -D$ and $x = 0$, with zero and maximum values at the correct locations 1 point
- For sketching two curves from $x = -D$ to $x = 0$ with shapes and values such that the total energy is constant (even if the curves are incorrect) 1 point
- For sketching potential energy equal to zero from $x = 0$ to $x = 3D$ 1 point
- For sketching kinetic energy as a linear function from its maximum value at $x = 0$ to zero at $x = 3D$ 1 point

(b)

(i) 1 point

- For identifying that the student is correct that the block will have more energy when it leaves the spring 1 point

(ii) 1 point

- For identifying that the student is incorrect about the new final position of the block because the spring's energy does not scale linearly with its compression 1 point

2015 SCORING GUIDELINES

Question 3 (continued)

Distribution
of points

(c) 3 points

- For indicating that the final energy in the spring (which becomes the mechanical energy of the block as it reaches the rough track) is four times the original energy in the spring 1 point

- For indicating that the frictional force remains the same 1 point
- For equating the initial energy in the spring to an expression that shows that the energy dissipated by friction is proportional to the distance the block slides down the rough track 1 point

Example:

$$U_1 = \frac{1}{2}kD^2 \text{ and } U_2 = \frac{1}{2}k(2D)^2 \text{ so } U_2 = 4U_1$$

$$W_1 = \mu mg(3D) \text{ and } W_2 = \mu mg\Delta x_2$$

$$W_1 = U_1 \text{ and } W_2 = U_2 = 4U_1 = 4W_1$$

$$\mu mg\Delta x_2 = 4(\mu mg(3D))$$

$$\Delta x_2 = 4(3D) = 12D$$

(d) 3 points

- For indicating that the student's correct reasoning that the block has more energy in the second situation is expressed by the calculations comparing the initial energy in the spring 1 point

- For indicating that the student's correct reasoning that the block will slide farther is expressed by an equation that indicates that the work done by friction to stop the block in the second situation is some factor greater than the work done in the first situation 1 point

- For indicating that the student's incorrect reasoning that energy scales linearly with the spring's compression is corrected by the expression for the initial energy of the spring 1 point