CAPA 06: Solutions

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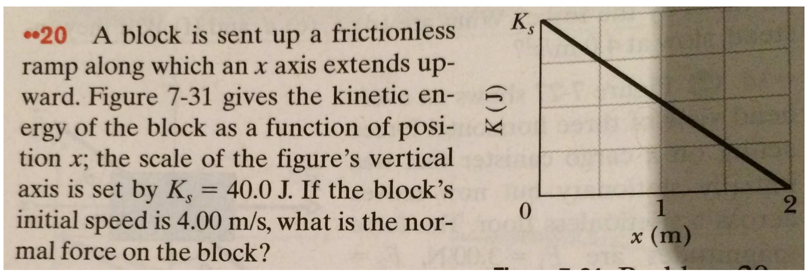
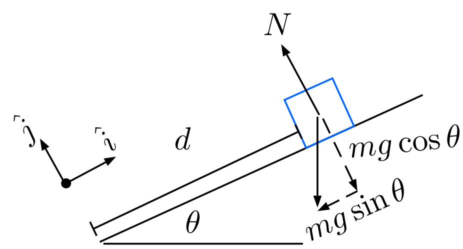


••20 A block is sent up a frictionless ramp along which an x axis extends upward. Figure 7-31 gives the kinetic energy of the block as a function of position x; the scale of the figure's vertical axis is set by $K_s = 40.0$ J. If the block's initial speed is 4.00 m/s, what is the normal force on the block?



Solution Looking at the graph we can infer the following:

At x = 0, $KE_i = 40$ J, at x = d = 2, $KE_f = 0$ and implicitly $v_f = 0$

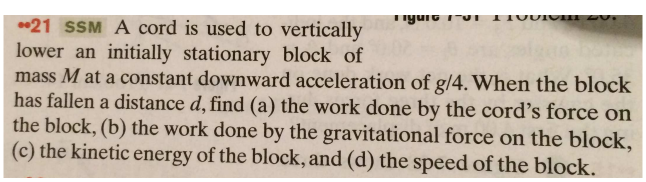
KE decreases uniformly (linearly) from a positive value to zero

$$KE_i = \frac{1}{2}mv_i^2 \;\Rightarrow 40 = \frac{1}{2}m(4)^2 \;\Rightarrow m = 5\ kg$$

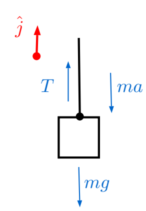
$$\Delta KE = \Sigma W \quad \Rightarrow \; KE_f - KE_i = mg\sin\theta\,(-\hat{\imath})\cdot\; d\,(\hat{\imath})$$

$$\Rightarrow (0-40)\ J = -(5\ kg)(9.8\ m/s^2)\sin\theta \quad \Rightarrow \quad \sin\theta = \frac{40}{98} \quad \theta = 22.74°$$

$$(N - mg\cos\theta)\,\hat{j} = 0 \quad \Rightarrow \; N = mg\cos\theta = (5\ kg)(9.8\ m/s^2)\cos(22.74°) = 45.2\ N$$



••21 SSM A cord is used to vertically lower an initially stationary block of mass M at a constant downward acceleration of $g/4$. When the block has fallen a distance d, find (a) the work done by the cord's force on the block, (b) the work done by the gravitational force on the block, (c) the kinetic energy of the block, and (d) the speed of the block.



Solution

$$(T - mg)\,\hat{j} = -ma\,\hat{j}\,; \quad a = g/4 \quad \Rightarrow T = (mg + mg/4) = 3mg/4$$

$$(a)\; W_c = (T)\,\hat{j}\cdot d\,(-\hat{j}) = -3mgd/4$$

$$(b)\; W_g = mg\,(-\hat{j})\cdot d\,(-\hat{j}) = mgd$$

$$(c)\; \Delta KE = \Sigma W \quad KE_f - KE_i = W_c + W_g = mgd - 3mgd/4 = mgd/4 \;\Rightarrow KE_f = mgd/4$$

$$(d)\; \frac{1}{2}mv_f^2 = mgd/4 \quad v_f = \sqrt{\frac{gd}{2}}$$

••12 A can of bolts and nuts is pushed 2.00 m along an x axis by a broom along the greasy (frictionless) floor of a car repair shop in a version of shuffleboard. Figure 7-26 gives the work W done on the can by the constant horizontal force from the broom, versus the can's position x. The scale of the figure's vertical axis is set by W_s = 6.0 J. (a) What is the magnitude of that force? (b) If the can had an initial kinetic energy of 3.00 J, moving in the positive direction of the x axis, what is its kinetic energy at the end of the 2.00 m?

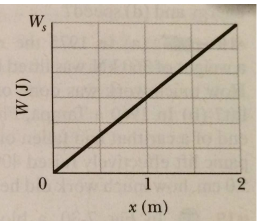


Figure 7-26 Problem 12.

<u>**Solution**</u> Looking at the graph, the work done (W) is uniformly increasing (linear) as a function of displacement (x). Therefore the force must be constant and in the direction of displacement.

$$(a)\ W = Fd \quad \Rightarrow F = \frac{W}{d} = \frac{6\,J}{2\,m} = 3\,N$$

$$(b)\ \Delta KE = \Sigma W \quad \Rightarrow KE_f - 3\,J = 6\,J \quad KE_f = 9\,J$$