AP® PHYSICS B
2008 SCORING GUIDELINES

Question 2

15 points total **Distribution of points**

(a) 4 points

For a correct application of Newton's 2nd law for the two-block system 1 point

$F = (m_A + m_B)a$

Note: Newton's 2nd law may be applied to each block separately to produce an equivalent solution.

For a correct determination of the acceleration 1 point

$$a = \frac{F}{(m_A + m_B)} = \frac{4.0 \text{ N}}{(2.0 \text{ kg} + 8.0 \text{ kg})}$$

$a = 0.40 \text{ m/s}^2$

For correct substitution of the acceleration into Newton's 2nd law for one of the blocks 1 point

$F_{spring} = m_A a$ (or $F - F_{spring} = m_B a$)

For the correct solution (consistent with the value of the acceleration found above) 1 point

$F_{spring} = (2.0 \text{ kg})(0.40 \text{ m/s}^2)$ (or $F_{spring} = 4.0 \text{ N} - (8.0 \text{ kg})(0.40 \text{ m/s}^2)$)

$F_{spring} = 0.80 \text{ N}$

Note: A correct free-body diagram for each block could earn 1 point each.

(b) 2 points

For a correct expression relating spring force to extension 1 point

$F_{spring} = kx$

For the correct solution using the spring force from part (a) 1 point

$$x = \frac{F_{spring}}{k} = \frac{0.80 \text{ N}}{80 \text{ N/m}}$$

$x = 0.010 \text{ m}$

(c) 3 points

For correctly indicating that the acceleration will be the same as before 1 point

For a correct justification (only if the previous point was awarded) 2 points

Examples:

- Explaining that in both cases there is a 4.0 N force pulling a combined mass of 10 kg, and hence the acceleration will be the same in the two cases.
  (Note: One point was awarded when the student noted that either the net force acting on the system of two blocks or the mass of the system is unchanged. For full credit, the student must have noted that both the force and mass are the same in the two cases.)
- Applying Newton's 2nd law to each block and calculating an acceleration with the same value as in part (a).

Question 2 (continued)

Distribution of points

(d) 3 points

For correctly indicating that the spring extension is greater than in part (b) 1 point
For a correct justification (only if the previous point was awarded) 2 points
Examples:

- The spring force on the 8.0 kg block produces the same acceleration as the spring force on the 2.0 kg block in part (a); hence the spring force is greater than in part (a) so the extension is greater.
- Applying Newton's 2nd law to show that the new spring extension is 0.040 m.

Notes:

- A partial justification worth a single point may note that the spring is pulling on a larger mass than before, or may note that the force exerted by the spring is larger than before (without explaining why this force is larger).
- Students who answered part (c) by saying that the acceleration is greater could earn 2 points here by noting that the force exerted by the spring on block B must be larger in order to give the larger mass a greater acceleration.

(e) 3 points

For indicating that, after block A impacts the wall, mechanical energy is conserved 1 point
For correctly applying conservation of energy, equating the energy immediately after block A hits the wall to the energy when the spring is at maximum compression 1 point

$$K_{before} + U_{before} = K_{after} + U_{after}$$

$$\frac{1}{2}m_B v^2 + 0 = 0 + \frac{1}{2}kx^2$$

For the correct solution 1 point

$$x = \sqrt{\frac{m_B v^2}{k}} = \sqrt{\frac{(8.0\text{ kg})(0.50\text{ m/s})^2}{80\text{ N/m}}}$$

$$x = 0.16\text{ m}$$

AP® PHYSICS B
2010 SCORING GUIDELINES (Form B)

Question 1

10 points total | **Distribution of points**

(a) 2 points

For a correct conservation of energy equation for this situation — 1 point

$mgh_i = mgh_f + \frac{1}{2}mv_f^2$

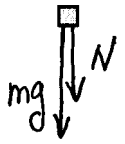
$v_f = \sqrt{2g\left(h_i - h_f\right)}$

$v_f = \sqrt{2\left(9.8\ \text{m/s}^2\right)(2.0\ \text{m} - 0.50\ \text{m})}$

For the correct answer — 1 point

$v_f = 5.4\ \text{m/s}$ (or 5.5 using $g = 10\ \text{m/s}^2$)

(b) 3 points



For correctly drawing and appropriately labeling the weight of the block — 1 point

For correctly drawing and appropriately labeling the normal force — 1 point

For no extraneous forces — 1 point

(c) 2 points

At the top of the track, the net force on the block is the centripetal force

$ma = mv^2/r = mg + N$

The condition for minimum speed is that the normal force is zero.

For a correct equation that can be solved for the minimum speed — 1 point

$mv_{\text{min}}^2/r = mg$

$v_{\text{min}} = \sqrt{rg}$

$v_{\text{min}} = \sqrt{(0.60\ \text{m})\left(9.8\,\text{m/s}^2\right)}$

For the correct answer — 1 point

$v_{\text{min}} = 2.4\ \text{m/s}$

Question 1 (continued)

Distribution of points

(d) 3 points

For a correct conservation of energy equation for this situation — 1 point

$mgh_{\min} = mg(2r) + \frac{1}{2}mv_{\min}^2$

$h_{\min} = 2r + \left(v_{\min}^2 / 2g\right)$

For correctly substituting the value of $v_{\min}$ from part (c) — 1 point

$h_{\min} = 2(0.60 \text{ m}) + \left((2.4 \text{ m/s})^2 / 2\left(9.8 \text{ m/s}^2\right)\right)$

For the correct answer — 1 point

$h_{\min} = 1.5$ m