Ans. To Homework for Chapter 2

1. **15 points total** — **Distribution of points**

(a) 2 points

For using a correct equation relating distance, speed, and time — 1 point

$x = v\Delta t$

$\Delta t = \frac{x}{v}$

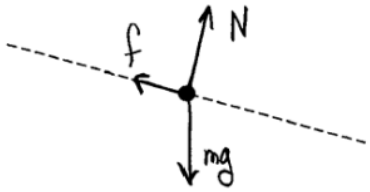
$\Delta t = \frac{21\text{ m}}{2.4\text{ m/s}}$

For the correct answer — 1 point

$\Delta t = 8.75\text{ s}$

Note: Only 1 point was awarded for the correct answer with no supporting work.

(b) 3 points



For each correct force that is correctly labeled, is attached to the dot, and has an arrowhead pointing in the correct direction, 1 point was awarded. — 3 points

For each incorrect vector, a point was deducted, with the minimum possible score being 0.

(c) 3 points

For recognizing that the sum of the forces upon the sled is zero — 1 point

$\sum F = 0$

Writing the equation for the forces acting along the slope,

$\sum F = mg\sin 15° - f = 0$, where f represents the force of friction

For equating the force of kinetic friction with the component of weight that acts down the slope — 1 point

$f = mg\sin 15°$

$f = (25\text{ kg})\left(9.8\text{ m/s}^2\right)\sin 15°$

For the correct answer — 1 point

$f = 63.4\text{ N}$ (64.7 N if $g = 10\text{ m/s}^2$ is used)

Note: Only 1 point was awarded for the correct answer with no supporting work.

Distribution of points

(d) 3 points

For equating the force of kinetic friction to the product of the coefficient of friction and the normal force — 1 point

$f = \mu N$

$\sum F = mg\cos 15° - N = 0$

For equating the normal force to the component of the sled's weight that is normal to the slope — 1 point

$N = mg\cos 15°$

$\mu = \frac{f}{N} = \frac{mg\sin 15°}{mg\cos 15°} = \tan 15°$

For the correct answer or for an answer consistent with the friction force obtained in (c) — 1 point

$\mu = 0.27$

Note: Only 1 point was awarded for the correct answer with no supporting work.

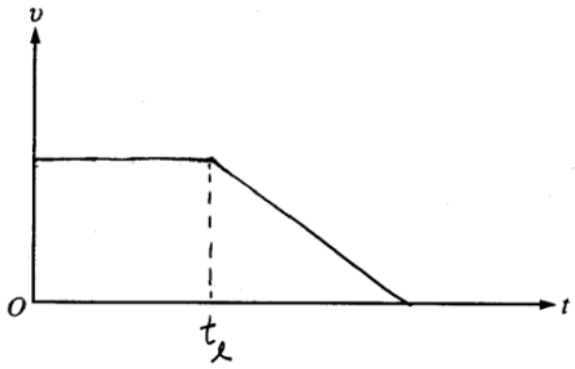
(e)

(i) 2 points

For implicitly or explicitly stating that the velocity of the sled decreases — 1 point

For explicitly stating that the acceleration of the sled is constant — 1 point

(ii) 2 points



For sketching a horizontal non-zero line — 1 point

For sketching a line of constant negative slope that begins at the right-hand end of the previously drawn horizontal line and also indicating the time t_ℓ on the graph — 1 point

Note: The second point was awarded only if the first point was awarded.

2. **15 points total** **Distributio 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).

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

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

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

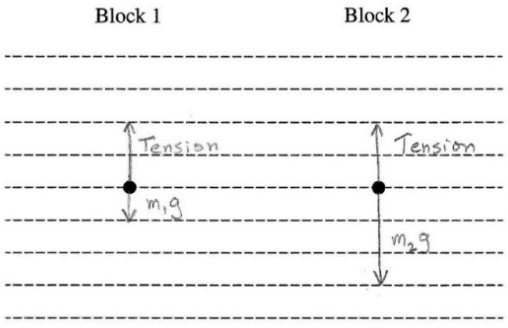
For the correct solution — 1 point

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

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

3. **7 points total** **Distribution of points**

(a) 2 points



For drawing two vectors starting on the dots that point upward, have the same length and are labeled as the tension force — 1 point

For drawing two vectors starting on the dots that point downward, where the vector for block 1 is smaller than the vector for block 2 and both are labeled as the gravitational force — 1 point

One earned point is deducted for drawing any extraneous vectors.

One earned point is deducted for vector lengths that do not allow the system to accelerate in the proper direction.

(b) 3 points

For writing an equation for Newton's second law for block 1 — 1 point

$m_1a = T - m_1g$

For writing an equation for Newton's second law for block 2 — 1 point

$m_2a = m_2g - T$

For eliminating T to obtain an equation that can be solved for the acceleration — 1 point

$T = m_1a + m_1g$

$m_2a = m_2g - m_1a - m_1g$

$(m_2 + m_1)a = (m_2 - m_1)g$

$a = (m_2 - m_1)g/(m_2 + m_1)$

Alternate solution — *Alternate points*

The system of two blocks must move as a unit, so the acceleration of the system is the acceleration of block 2.

For writing an equation showing that the net force acting on the system is the difference in masses times the acceleration of gravity — *1 point*

$F_{net} = (m_2 - m_1)g$

For writing an equation that relates the net force to the sum of the masses and the acceleration of the system — *1 point*

$F_{net} = (m_2 + m_1)a$

For writing an equation that can be solved for the acceleration in terms of the variables used in the summation of forces equations — *1 point*

$(m_2 + m_1)a = (m_2 - m_1)g$

$a = (m_2 - m_1)g/(m_2 + m_1)$

(c) 2 points

The acceleration of the new system, and thus of block 2, is smaller.

For indicating that the mass of the system is larger — 1 point

For a clear indication that the tension on block 2 is greater — 1 point

Alternate solution — *Alternate points*

For indicating that the mass of the system is larger — *1 point*

For indicating that the net force exerted on the system stays the same — *1 point*

Notes:

No points are earned for a correct prediction without a reasonable attempt at an explanation.

No points are earned for an incorrect prediction, regardless of the explanation.