1. (Uniform circular motion, 5/ea.)

An 800-kg car with a linear speed of 20 m/s runs in a radius 400-meter unbanked curve, assuming the static friction force is the reason to keep the car from slipping away (see the diagram on the left).

(a) What is the magnitude of centripetal acceleration? Ans. ___________ \( 1 \text{ m/s}^2 \)

(b) What is the required centripetal force acting on the car? Ans. _______ 800 N

(c) What is the angle between the centripetal force acting on the car and the velocity of the car? Ans. _______ 90°

(d) What is the required static coefficient [use \( g = 10 \text{ m/s}^2 \)]? Ans. _______ 0.1

2. (Work, energy, 5/ea.)

A ski-patrol lowers a rescue sled with victim, having a total mass of 100 kg, down a 60.0° slope at a constant speed, as shown in left. The dynamic coefficient of friction between the sled and the snow is 0.1.

Please use \( g = 10 \text{ m/s}^2 \)

(a) How much work is done by friction as the sled moves 60 m along the hill? Ans. ___________ - 3000 J

(b) How much work is done by the tension, \( T \), in the rope on the rescue sled in this distance? Ans. _______ 49200 J

(c) What is the work done by the gravitational force on the sled-victim system? Ans. _______ 52200 J

(d) What is the work done by the normal force exerted on the sled-victim system? Ans. _______ 0

(e) What is the total work done by all the forces acting on the sled-victim system? Ans. _______ 0

(f) What is the value of potential energy for the sled-victim system lost in this process? Ans. _______ 52200 J

3. (Momentum conservation, 1D collisions, 5/ea.)

As shown in left, a ball with mass \( m_1 = 2 \text{ kg} \) is traveling towards another ball with mass \( m_2 = 6 \text{ kg} \), initially at rest on a frictionless surface. Assumption: elastic collision.

(a) What is the momentum of \( m_1 \) ball before collision? Ans. _______ 10 \text{ kg.m/s}

(b) What is the total momentum of \( m_1-m_2 \) system before collision? Ans. _______ 10 \text{ kg.m/s}

(c) What is the velocity of ball \( m_1 \) after collision? Ans. _______ - 2.5 \text{ m/s}

(d) What is the velocity of ball \( m_2 \) after collision? Ans. _______ 2.5 \text{ m/s}

(e) What is the value of energy after collision for the \( m_1-m_2 \) system? Ans. _______ 25 \text{ J}

4. (Torque and statics, 5/ea.)

A rigid bar (ignore its own weight, consider it as 1D system) is being balanced horizontally by the forces of \( F_1 \) and \( F_2 \), located at the distance \( d_1 \) and \( d_2 \) away from the reference stand (point O) as shown in left, respectively. For \( F_2 = 200 \text{ N} \), \( d_2 = 1 \text{ m} \), and \( d_1 = 0.5 \text{ m} \), Find:

(a) the value of \( F_1 \), Ans. _______ 400 \text{ N}

(b) the torque of \( F_1 \) with the reference point O, Ans. _______ 200 \text{ N.m}

(c) the torque of \( F_2 \) with the reference point O, Ans. _______ - 200 \text{ N.m}

(d) the force on the bar exerted from the reference stand, Ans. _______ 200 \text{ N}

(e) the force on the stand exerted by the bar, Ans. _______ 200 \text{ N}

Note: Equations given below are for your reference only.

<table>
<thead>
<tr>
<th>Uniform circular motion</th>
<th>( a_c = \frac{v^2}{r} ); ( a_c = r\omega^2 )</th>
<th>( F_c = ma_c ); ( v = r\omega )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work, energy</td>
<td>( w = Fd )</td>
<td>( KE = \frac{1}{2}mv^2 ); ( PK = mgh )</td>
</tr>
<tr>
<td>Momentum, collision</td>
<td>( p = mv )</td>
<td>Momentum conservation: ( \Delta p = 0 )</td>
</tr>
<tr>
<td>Statics, torque</td>
<td>Condition-1: ( F_{net} = 0 )</td>
<td>Condition-2: ( \tau_{net} = 0 )</td>
</tr>
</tbody>
</table>