Name:

Lab-Sect. no.:

Signature:

Duration: 75 minutes
Show all your work for full/partial credit!
Include the correct units in your final answers for full credit!
Unless otherwise stated, quote your results in SI units!
1. **Multiple Choice**  
For each statement below, circle the correct answer (TRUE or FALSE, no reasoning required).

(a) If only conservative forces are acting on a particle, the kinetic energy of that particle is conserved.
   TRUE  FALSE

(b) When a stone is launched from the edge of a cliff with a given initial speed, its final speed when hitting the bottom does not depend on the launch angle (neglect friction and air drag).
   TRUE  FALSE

(c) If the net work applied to a moving object is negative, the speed of the object must decrease.
   TRUE  FALSE

(d) If there is no net torque acting on a rigid rotator, its angular speed must be zero.
   TRUE  FALSE

(e) The moment of inertia of a rotating object is a vector quantity.
   TRUE  FALSE

(f) Angular momentum is a vector quantity.
   TRUE  FALSE

<table>
<thead>
<tr>
<th>No.</th>
<th>Points</th>
<th>Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sum</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2.) **Energy Conservation and Non-Conservative Work** (18 pts.)

A skier is sliding on a frictionless horizontal snow surface at a speed of 22 mph. He then encounters a rough horizontal ice patch of length 4.3 m, and, after that, slides down an incline of height 8.5 m (no friction on the incline). The kinetic friction coefficient between the skies and the rough ice is 0.35; neglect air drag. 

(a) What is the speed of the skier right after crossing the ice patch?

(b) What is the speed of the skier at the bottom of the hill?

(c) If the mass of the skier is 78 kg, how much non-conservative work has been done on the ice patch?
3.) *Inelastic Collision* (18 pts.)

Car 1 (mass $m_1 = 1750 \text{ kg}$) and car 2 (mass $m_2 = 2500 \text{ kg}$) are colliding at an intersection. Before the collision, car 1 was going due east at a speed of 36 mph (as retrieved from the board computer), while car 2 was moving due south. After the collision, both cars are stuck together, leaving the collision point at an angle of 70 degrees south of east.

(a) What was the speed of the stuck-together vehicles right after the collision?

(b) What was the speed of car 2 before the collision? Did it violate the speed limit of 40 mph?

(c) How much energy went into the deformation of the vehicles?
4.) *Simple Harmonic Motion* (18 pts.)

A 3kg block, moving on a frictionless horizontal surface, is attached to an ideal spring with force constant $420 \text{N/m}$. Initially, the block has a speed of $3.5 \text{m/s}$ at a displacement of $-0.3 \text{m}$ away from the equilibrium position of the spring.

(a) Calculate the amplitude of the motion.

(b) Calculate the maximal force on the block during the motion.

(c) Calculate the period of the motion.
5.) *Rotational, Translational and Potential Energy*  
(14 pts.)
Starting from rest at an initial height of 55 cm, a solid steel ball rolls down a hill without slipping. After reaching the bottom, it climbs up another hill with a frictionless surface, where the spinning motion does not change. Neglect any friction losses.

(a) What is the speed of the ball’s center of mass at the bottom of the hill?

(b) To what vertical height above the bottom point does the ball rise again?
6.) \textit{Torque and Angular Acceleration} \hspace{1cm} (14 pts.)

A hunter runs out of ammunition and is chased by a bear. The hunter runs through the open door of his mountain hut. The door, which has a mass of 20\textit{kg} and is 1.2\textit{m} wide, must be turned through 90\textit{degrees} to be closed. The hunter applies a constant torque of 190\textit{Nm} to the door.

(a) What is the angular acceleration of the door? (Treat the door as a thin rod.)

(b) How much time does it take for the door to close?