I. Mia is $d=25$ m away from a building. She kicks a soccer ball at an angle of $\theta=30^\circ$ above the horizontal. The speed of the ball just after she kicks it is 30 m/s.

a) What is the maximum height in the air that the ball reaches?

b) At what height, $h$, will the ball go into the open window?

c) Mia kicks the ball again at the same angle, but this time at a speed of 16 m/s. Does the ball make it to the building? If not, how far away from the building does it hit the ground?
II. A spring (k=600 N/m) is at the bottom of an inclined plane that makes an angle \( \theta = 30^\circ \) with the horizontal. The spring is compressed 0.10 m by a block of mass \( M = 3.0 \) kg that is placed against it, as shown below. The block is then released from rest.

![Diagram of a compressed spring on an inclined plane]

a) Determine the speed of the block just as it loses contact with the spring, (assume the plane is frictionless)

\[ v_{\text{loses contact}} = \] 

b) How high up the incline (\( L \) in the diagram) will the block travel before it stops momentarily?

\[ L = \] 

c) Next you repeat the experiment, but first you roughen up the block with sandpaper so that there is now friction between the block and the plane. If the coefficient of friction is now \( \mu = 0.2 \), how high up the incline (\( L' \) in the diagram) will the block travel before it stops momentarily?

\[ L' = \]
3. A 2.3-kg mass is projected from ground level with a velocity of 30 m/s at some unknown angle above the horizontal. A short time after being projected, the mass barely clears a 1.6-m tall fence. Disregard air resistance and assume the ground is level. What is the kinetic energy of the mass as it clears the fence?

a) 0.35 kJ  
b) 0.73 kJ  
c) 0.41 kJ  
d) 0.67 kJ  
e) 0.19 kJ

4. The blocks shown are released from rest with the spring in its equilibrium position. The pulley and the horizontal surface are frictionless. If \( k = 400 \) N/m and \( M = 2.3 \) kg, what is the maximum extension of the spring?

a. 55 cm  
b. 66 cm  
c. 11 cm  
d. 33 cm  
e. 22 cm

5. To the right are shown three situations, A, B, and C, each involving a block sliding along a plane with friction. The blocks and planes are made of identical materials and are of the same sizes, and the block has the same initial speed in all three situations. Each of the blocks slides until it stops due to friction. Rank the three in order of increased internal energy, \( \Delta U_{\text{int}} \), of the block-Earth-surface system, from GREATEST to LEAST.

a) A, B, C  
b) C, B, A  
c) C, A, B  
d) B, A, C  
e) they are all three the same
6. A 500 kg car travels around a highway curve (radius 0.15 km) at a constant speed of 25 m/s. What is the magnitude of the net force acting on the driver, whose mass is 100 kg?

   a) 0.80 kN
   b) 0.34 kN
   c) 2.4 kN
   d) 2.1 kN
   e) 0.42 kN

7. A tennis player receives a shot with the ball \( m_b = 60 \) g traveling horizontally with a speed \( v_o = 45 \) m/s and returns it with a speed \( v_f = 30 \) m/s in the opposite direction. If the ball is in contact with the racket for 0.02 s, determine the average force that the racket exerts on the ball.

   a) 225 N
   b) 135 N
   c) 90 N
   d) 45 N
   e) 275 N

8. Alice shoots a pebble horizontally with her slingshot from a window that is at a height \( H \) and it lands a distance \( D \) away from the building. She then shoots a pebble with the same initial velocity from a different window, but this time the pebble lands a distance \( D/2 \) away. How high is the window from which Alice takes her second shot?

   **Explain your reasoning**

   a. \( H \)
   b. \( H/2 \)
   c. \( H/4 \)
   d. \( 4H \)
   e. \( 2H \)