Write on the cover of the blue book:
1. Your name and PERM number
2. Your lecture section, i.e. TR 8 am
3. The name of your TA

ENTER ALL OF YOUR ANSWERS IN THE BLUE BOOK.
DON'T TURN IN THE TEXT OF THE EXAM AT THE END.

Scoring:
Questions 1 to 12, multiple choice: 5 points each
Questions 13 to 16, long answers: 20 points each
Maximum possible score: 140 points

DO NOT TURN THIS PAGE OVER UNTIL YOU ARE TOLD TO DO SO.
Question 1

Two people on roller blades throw a ball back and forth. They start off at rest. After a few throws, they are (ignore friction):

A: standing where they were initially  
B: standing farther away from each other  
C: standing closer together  
D: moving away from each other  
E: moving toward each other

Question 2

Suppose that rain falls vertically into an open cart rolling along a straight horizontal track with no friction. As a result of the accumulating water, the speed of the cart

A: increases  
B: does not change  
C: decreases

Question 3

A square block slides starting from rest from the top of a frictionless inclined plane. At the bottom of the inclined plane its velocity is \( V_B \). Next, a cylinder of the same mass is made to roll down the same inclined plane, also starting from rest. At the bottom of the inclined plane, the velocity of the cylinder is \( V_C \). Which of the following is true:

A: \( V_B = V_C \)  
B: \( V_B > V_C \)  
C: \( V_B < V_C \)

Question 4

A student is pulling on a rope tied to a crate of mass 10 Kg on a frictionless floor. The rope makes an angle of 30 degrees with the horizontal. The force applied by the student is 100 N. The acceleration of the crate is

A: 10 m/sec\(^2\)  
B: 5 m/sec\(^2\)  
C: 11.5 m/sec\(^2\)  
D: 8.7 m/sec\(^2\)  
E: zero  
F: 20 m/sec\(^2\)
**Question 5**

A ladybug sits at the outer edge of a merry-go-round, and a gentleman bug sits halfway between her and the axis of rotation. The merry-go-round makes a complete revolution once each second. The gentleman bug's angular speed is

A: half the ladybug's
B: the same as the ladybug's
C: twice the ladybug's
D: none of the above
E: impossible to determine

**Question 6**

A cart moving with velocity +v collides inelastically with an identical stationary cart on an airtrack. After the collision, the first cart is moving with velocity +v/3. The velocity of the second cart after the collision is

A: +v/3
B: +2v/3
C: v
D: -v/3
E: -2v/3
F: -v
G: zero
**Question 7**

A piano mover raises a 100 Kg piano at a constant velocity $v = 2$ m/sec using the frictionless pulley system shown in the Figure. With how much force is he pulling on the rope. Ignore friction and take $g = 10$ m/sec$^2$.

A: 2,000 N  
B: 1,500 N  
C: 1,000 N  
D: 750 N  
E: 500 N  
F: 100 N  
G: zero

**Question 8**

Two stones, one twice as heavy as the other, are dropped to the ground from the roof of a building. Just before hitting the ground, the heavier stone has

A: the same kinetic energy as the lighter one  
B: twice the kinetic energy of the lighter one  
C: four times the kinetic energy of the lighter one  
D: half the kinetic energy of the lighter one  
E: one fourth the kinetic energy of the lighter one
**Question 9**

Consider motion in one dimension. The potential energy of a body as a function of the x-coordinate is \( U(x) = Ax^3 + B \), where \( A = 3.0 \text{ J/m}^3 \) and \( B = 1.0 \text{ J} \). A body of mass 2.0 Kg is released from rest at \( x = 1.0 \text{ m} \). The speed of this body at \( x = 0.0 \text{ m} \) is

- A: 2.2 m/sec
- B: 2.0 m/sec
- C: 1.7 m/sec
- D: zero

**Question 10**

You are pushing a wooden crate horizontally at constant speed on a floor with coefficient of kinetic friction between the crate and the floor \( \mu_k = 0.5 \). You decide to turn the crate on end, reducing by half the surface area in contact with the floor. In the new orientation, to push the same crate across the same floor with the same speed, the force that you apply must be

- A: four times larger than before
- B: two times larger than before
- C: the same as before
- D: one half as large as it was before
- E: one fourth as large as it was before

**Question 11**

A car rounds a curve while maintaining a constant speed. Is there a net force on the car?

- A: no
- B: yes
- C: it depends on the sharpness of the curve
- D: it depends on the speed of the car
- E: it depends on **both** the sharpness of the curve and the speed of the car
**Question 12**

A student standing on the roof of the Physics building throws two identical balls, one straight up and one straight down, with the same initial speed. Neglecting air resistance, the ball that hits the ground with the greater speed is the one initially thrown

A: upward  
B: downward  
C: neither - they both hit at the same speed  
D: depends on the height of the building  
E: depends on the exact magnitude of the initial speeds  
F: depends on the mass of the ball

**Question 13**

Consider the frictionless track shown in the figure. A first block of mass \( M_1 = m \) is released from rest from a height \( h \). It collides elastically with a second block of mass \( M_2 = 2m \) on the horizontal portion of the track. This second block was initially at rest.

![Diagram of the block collision](image)

(a) What is the velocity of the first block just before it hits the second block? (5 points)

(b) What is the velocity (magnitude and direction) of the first block immediately after the collision? (10 points)

(c) How far up the track does the first block rise after the collision? (5 points)
**Question 14**

A uniform sheet of steel is shaped as shown in the figure.

Compute the x and y coordinates of the center of mass of the object **(20 points)**

---

**Question 15**

A person stands on a scale in an elevator. As the elevator starts, the scale has a constant reading of 600 N. As the elevator later stops, the scale reading is 400 N. Assume that the magnitude of the acceleration is the same during starting and stopping. Take \( g = 10 \text{ m/sec}^2 \).

(a) Find the mass of the person **(10 points)**

(b) Find the magnitude of the acceleration of the elevator **(10 points)**
**Question 16**

A mass starts from rest and slides a distance $d$ down a frictionless inclined plane of angle $\alpha$. While sliding, it contacts an unstressed spring of negligible mass, as shown in the figure:

![Diagram](image)

The mass slides an additional distance $x$ as it is brought momentarily to rest by compresion of the spring of force constant $k$. Find the initial separation $d$ between the mass and the spring. *(20 points)*