Remove this sheet AFTER the exam starts and place your name and section on the next page.

**Instructions:**
- Do not open the test until you are told to do so.
- Write your final answer in the box provided
- If you finish with less than 5 minutes remaining, please stay seated until the exam is over.
- Stop work immediately when time is over; pass exams to the aisle; stay seated until all exams are collected. Working after time is over is an automatic 10 point deduction.

**Guidelines:**
- Assume 3 significant figures for all given numbers unless otherwise stated
- Show all of your work – no work, no credit
- Include units for all answers
- Include directions for all vectors

<table>
<thead>
<tr>
<th>Time</th>
<th>111 Front</th>
<th>111 Back</th>
<th>Est 209</th>
<th>Est 201</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:10</td>
<td>S1a Daniel</td>
<td>S1b Andrew</td>
<td>S1c Rachel</td>
<td>S1d Tayler</td>
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<tr>
<td>9:40</td>
<td>S2a Daniel</td>
<td>S2b Andrew</td>
<td>S2c Rachel</td>
<td>S2d Tayler</td>
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<tr>
<td>11:10</td>
<td>S3a Tyler</td>
<td>S3b Andrew</td>
<td>S3c Rachel</td>
<td>S3d Tayler</td>
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<tr>
<td>12:40</td>
<td>S4a Daniel</td>
<td>S4b Brandi</td>
<td>S4c Jason</td>
<td>S4d Sarah</td>
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<tr>
<td>2:10</td>
<td>S5a Tyler</td>
<td>S5b Brandi</td>
<td>S5c Jason</td>
<td>S5d Sarah</td>
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<tr>
<td>3:40</td>
<td>S6a Tyler</td>
<td>S6b Brandi</td>
<td>S6c Jason</td>
<td>S6d Sarah</td>
</tr>
</tbody>
</table>
1. (1 pt) A cart is being pushed as shown so that the acceleration is 4 ft/s². Neglect friction and air resistance. The force P on the cart is:
   a. 1.5 pounds
   b. 4 pounds
   c. 48 pounds
   d. 1545 pounds

2. What is the friction force between the box and the ground?
   a. 12 lb
   b. 15 lb
   c. 18 lb
   d. 30 lb

3. (1 pt) A tractor is accelerating at 4 ft/s² while pulling a trailer. The coupling force on the tractor is 600 pounds. The coupling force on the trailer is:
   a. < 600 lb
   b. = 600 lb
   c. > 600 lb
   d. cannot determine from given information

4. (1 pt) Butch Jones throws a football straight up. Considering air resistance, the magnitude of the acceleration of the football the instant after release is:
   a. greater than gravity
   b. equal to gravity
   c. less than gravity
   d. cannot determine from given information

5. (1 pt) The work done by the normal force when pushing the block is:
   a. negative
   b. 0
   c. positive
   d. cannot determine from given information

6. (1 pt) During which type of collision is mechanical energy conserved?
   a. perfectly elastic
   b. inelastic
   c. perfectly inelastic
   d. all of the above

7. (1 pt) A spring has a stiffness of 1200 N/m. Determine the force required to stretch the spring 0.2 m.
   a. 24 N
   b. 48 N
   c. 120 N
   d. 240 N
8. (1 pt) During the ballistic pendulum experiment, a ball is shot into a catcher. After the ball is embedded in the catcher and the combination is swinging up, what is conserved?
   a. energy
   b. momentum
   c. both energy and momentum
   d. neither energy or momentum

9. (1 pt) The location of the center of mass of the object to the right is at point:
   A. 
   B. 
   C. 
   D. 

10. (1 pt) A car starts from rest. The tangential acceleration of the car is 4 ft/s², the normal acceleration is 3 ft/s², and the total acceleration is 5 ft/s². The speed of the car after 2 seconds is
    a. 6 ft/s
    b. 8 ft/s
    c. 10 ft/s

11. (1 pt) A car is going around a circle. What are the signs of the centripetal acceleration when the car is at point A?
    a. x: + y: +
    b. x: - y: +
    c. x: + y: -
    d. x: - y: -

12. (1 pt) A person stands on a rotating platform while holding a spinning bicycle wheel. When they turn the bicycle wheel over, the person starts to rotate. This is due to:
    a. Conservation of linear energy
    b. Conservation of angular energy
    c. Conservation of linear momentum
    d. Conservation of angular momentum

13. (4 pts) The screen in the AMB auditorium is 6 smoots wide by 4 meters high. How many rolls of wallpaper does it take to cover the screen? 1 smoot = 5 ft 7 inches; 1 roll of wallpaper covers 30 ft².
14. (7 pts) Andrew flies his drone 400 feet due north. He then flies the drone 500 feet at 30° south of west, followed by flying it 300 feet at 40° east of north. Determine the direction he needs to fly the drone to get back to the starting point.

15. (7 pts) Brandi is driving her car at 80 ft/sec. She slows down at a rate of 6 ft/s² for 4 seconds. She then slows down at a rate of 9 ft/s² until coming to a stop. Determine the total distance Brandi traveled from when she started to slow down until she came to a stop.
16. (7 pts) Tyler throws a football from a height above the ground of 5 ft and at a 20° angle from the horizontal. The football hits the ground 1.2 seconds later. Determine the horizontal distance the football travelled.

17. (7 pts) Sarah is flying her airplane at 320 mph due south with respect to the ground. The wind is blowing at 20° north of east. Sarah's speed with respect to the air is 360 mph. Determine the wind speed.
18. (7 pts) Jason is pushing a 40 lb cart up a ramp with a 19 lb force. Determine the magnitude of the acceleration. Neglect friction and drag. **FBD = KD required**

19. (7 pts) Daniel is pushing on a 50 pound box of his fraudulent tax returns with a force of 45 pounds. Determine the minimum additional force P to keep the box from sliding. **FBD required**
20. (7 pts) Rachel is riding a roller coaster with a total weight (coaster and riders) of 6000 pounds, as shown. The speed at point A is 20 ft/s, and the speed at point B is 45 ft/s. The distance along the track between points A and B is 210 ft. Determine the average retarding force between points A and B.

21. (7 pts) Tayler is sliding a Rube-Goldberg device across a floor. The device is moving at 4 m/s when it hits a spring. Determine the maximum distance the spring compresses.
22. (7 pts) Professors McCord and Schleter are driving their Priuses as shown in the figure. Professor McCord rear ends Prof. Schleter and after the collision, Prof. Schleter is traveling at 55 ft/s. Determine the coefficient of restitution between the Priuses. Assume both Priuses have the same mass.

23. (7 pts) Nate builds a bracket as shown. Determine the moment about point A. Give the magnitude of the moment and direction as clockwise or counterclockwise.
24. (7 pts) Prof. Jeldes (weight of 150 lb) is riding a 70 ft radius Ferris Wheel that is spinning at a constant rate 5 rpm. Determine the normal force on Prof. Jeldes when he is at the location shown. \((FBD = KD \text{ required})\)

25. (7 pts) Prof. Bennett releases from rest a 14 pound bowling ball and it rolls down the incline as shown. The radius of the bowling ball is 4.25 inches. Determine the speed of the bowling ball at the bottom of the incline. \(I_{\text{solid sphere}} = \frac{2}{5}mr^2\)