Correct Section Number  ----- (2) 
A. Multiple Choice \[ \times 10 = \] ----- (60) 
B. Long Problems 1) ----- (30) 
2) ----- (30) 
TOTAL POINTS ----- (242) 
Curved (%) ----- (100) 

IN COMPLETING THIS EXAM, YOU WILL NOT RECEIVE FULL CREDIT UNLESS YOU SHOW AND EXPLAIN HOW YOUR ANSWERS WERE OBTAINED. 
On problems with multiple parts, please attempt all parts. If you need an answer from a previous part and do not have it, show how you would solve it if you did have the answer. 
Constants are given on the last page, which you may detach and keep.
Section A. Multiple Choice (10 points each)
Circle your answer. Use the space next to each problem to show any work.

1) Two cars travel in the same direction along a straight highway, one at a constant speed of 58.0 mi/h and the other at 69.0 mi/h. Assuming that they start at the same point, how much sooner does the faster car arrive at a destination 10.0 mi away?

\[ t = 10.0 \text{ mi} \left( \frac{1}{58.0 \text{ mi/h}} - \frac{1}{69.0 \text{ mi/h}} \right) \]
\[ = 2.75 \times 10^{-2} \text{ hr} \]
\[ = 1.65 \text{ min} \]

(a) 9.90 seconds
(b) 1.66 minutes
(c) 2.75 minutes
(d) 9.90 minutes
(e) none of the above

2) A truck on a straight road starts from rest and accelerates at 2.15 m/s² until it reaches a speed of 20.0 m/s. Then the truck travels straight ahead for 685 m at constant speed. How long is the truck in motion?

\[ \begin{align*}
a & = 0, v_i, a \uparrow_2 \\
\Delta x_2 & = \frac{a_i v_i^2}{2} \\
\Delta t_2 & = \frac{\Delta x_2}{v_i} \\
\Delta t & = \Delta t_1 + \Delta t_2
\end{align*} \]

(a) 9.33 s
(b) 34.4 s
(c) 13.5 s
(d) 0.137 min
(e) none of the above

\[ \begin{align*}
\Delta t_1 & = \frac{v_i - v_0}{a} \\
\Delta t & = \frac{\Delta x_2}{v_i}
\end{align*} \]
\[ \begin{align*}
\Delta t & = \Delta t_1 + \Delta t_2 \\
\Delta t_1 & = \frac{20.0}{2.15} \\
\Delta t & = \frac{685}{20.0} \\
\Delta t_1 & = 9.30 \text{ s}
\end{align*} \]

3) Killer whales at Sea World routinely jump 7.7 m above the water. What is the vertical component of their velocity as they leave the water to achieve this?

\[ \begin{align*}
\vec{v}_{oy} & \uparrow \\
v_y^2 & = v_{oy}^2 - 2g \Delta y \\
\vec{v}_{oy} & \uparrow \\
v_{oy}^2 & = 2g \Delta y
\end{align*} \]

(a) 12 m/s
(b) 75 m/s
(c) 150 m/s
(d) 150.9 m/s
(e) none of the above
4) A small map shows City B to be 457 miles in a direction 5.04° north of east from City A. The same map shows that City C is 661 miles in a direction of 21.12° west of north from City B. Assuming a flat Earth, what is the magnitude of the east-west component of the displacement from City A to City C (i.e., how far east or west from City A is City C)?

(a) 217 miles east
(b) 161 miles west
(c) 198 miles west
(d) 238 miles west
(e) none of the above

\[
(AB)_x = 457 \times \cos 5.04° = 455 \text{ mi.}
\]

\[
(BC)_x = -661 \times \sin 21.12° = -238 \text{ mi}
\]

\[
(AB + BC)_x = 455 - 238 = 217
\]

5) As a projectile moves in its parabolic path, the velocity and acceleration vectors are perpendicular to each other

(a) everywhere along its path
(b) at the peak of its path
(c) nowhere along its path
(d) at the beginning and end of its path
(e) none of the above

Assume the motion begins and ends at ground level.

6) A weightlifter stands on a bathroom scale. He pumps a barbell up and down. As this is done, the reading on the bathroom scale

(a) increases
(b) decreases
(c) increases as the barbell accelerates upward and decreases as it accelerates downward
(d) decreases as the barbell accelerates upward and increases as it accelerates downward
(e) none of the above
Section B. Problems

1) (30 points) A peregrine falcon is moving horizontally at a speed of 200. mi/h at a height of 100. m above the ground when it brings its wings into its sides and begins to drop in free fall.

a) How long will it take for the bird to travel horizontally a distance of 150. m?

\[ \Delta x = v_{ox} t \]

\[ \Rightarrow t = \frac{\Delta x}{v_{ox}} = \frac{150 \text{m}}{200 \text{mi/h} \times 1609 \text{m/mi}} \]

\[ = 4.66 \times 10^{-4} \text{ hr} \]

\[ = 1.68 \text{ s} \]

b) How far will the bird fall vertically while traveling horizontally a distance of 150. m?

\[ \Delta y = \frac{1}{2} gt^2 \]

\[ = \frac{1}{2} \times 9.80 \times (1.68)^2 \]

\[ = 13.8 \text{ m} \]
2) (30 points) Two forces are applied to a car in an effort to move it, as shown in the figure. Refer to the horizontal direction of the figure as “x” and the vertical direction as “y”.

a) What is the resultant of these two forces? Remember to give components, as well as magnitude and direction.

\[
F_{\text{resultant}} = F_2 \cos \theta_2 - F_1 \sin \theta_1 = 137 \text{ N}
\]

\[
F_{\text{resultant}} = F_1 \cos \theta_1 + F_2 \cos \theta_2 = 840 \text{ N}
\]

\[
|F_{\text{resultant}}| = \sqrt{137^2 + 840^2} = 851 \text{ N}
\]

Angle w. x-axis \( \theta \) : \[
\tan \theta = \frac{F_{\text{resultant}}}{F_{\text{resultant}} \cos \theta} = \frac{840}{137} \implies \theta = 80.7^\circ
\]

b) If the car has a mass of 2500 kg, what acceleration does it have? Ignore friction.

\[
|a| = \frac{F_{\text{resultant}}}{m} = \frac{851}{2500} = 0.340 \text{ m/s}^2
\]
You are responsible for all relevant equations via your 3” x 5” note card that you brought to this exam. Here are some constants that may be relevant. If you need during the exam a constant that you do not find here, please notify an exam proctor.

\[ g = 9.80 \text{ m/s}^2 \quad 1 \text{ mi} = 1609 \text{ m} \]