1. Please print your name and enter your seat number to identify you and your examination.
   Student’s Printed Name: _______________________________ Recitation Section Number: ___
   Seat Number: ______________

2. The University has a nationally recognized Honor Code, administered by the Student Honor Council. The
   Student Honor Council proposed and the University Senate approved an Honor Pledge. The University of Maryland
   Honor Pledge reads:
   "I pledge on my honor that I have not given or received any unauthorized assistance on this
   assignment/examination."  Student’s Signature (in ink please): _______________________

This test consists of 4 parts, each worth 25 points. The exam is printed on 7 pages and is to be
completed in 50 minutes. Please check that you have a complete exam. In most cases partial
credit will be given, so show your work. If you need additional space use the reverse side of the
sheets, or ask for additional paper. Some of the following information may be useful in the exam.

\[ g = 9.8 \text{ m/s}^2 \]

SCORING TABLE (Each student should check the addition of his own score.)

<table>
<thead>
<tr>
<th>Problem</th>
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1.  
   a)  (8 points) A fighter jet is moving at a constant speed circling once every 20 seconds around a horizontal circular path of radius 500 m. What is the acceleration of the jet? What is the “g-force” (the ratio of your answer to the acceleration due to gravity)?

   b)  (6 points) Newton’s law of universal gravitation is represented by
   \[ F = G \frac{M_1 M_2}{r^2} \]
   where \( F \) is the gravitational force exerted by one object on another, \( M_1 \) and \( M_2 \) are the masses of the objects, and \( r \) is the separation distance. Force has the SI units kg·m/s². What are the SI units of the proportionality constant \( G \)?

   c)  (5 points) Carry out the following arithmetic operations expressing your answer to the appropriate number of significant figures:
   (i) the sum of the measured values 752, 34.1, 0.83, and 2.9
   (ii) the product 0.003 2 \( \times \) 356.3

   d)  (6 points) A rectangular plate has a length of (21.3 ± 0.2) cm and a width of (9.8 ± 0.1) cm. What is the percentage error in each length? What is the percentage error in the area?
2. a) A particle moves in one dimension according to the relation \( x(t) = 12t^2 - 18t - 2t^3 \) where \( x \) is in meters and \( t \) in seconds.
   
i) (3 points) Find the velocity, \( v(t) \) as a function of time.

   ii) (3 points) Find the acceleration, \( v(t) \) as a function of time.

   iii) (3 points) Find the maximum velocity reached.

b) A truck on a straight road starts from rest, accelerating at 2 m/s\(^2\) until it reaches a speed of 20 m/s. Then the truck travels for 20 s at constant speed until the brakes are applied, stopping the truck in a uniform manner in an additional 5 s.
   
i) (6 points) How long is the truck in motion?

   ii) (10 points) What is the average velocity of the truck for the motion described?
3. a) Motion diagrams are graphs of position, $x$, vs. $t$, velocity, $v$, vs. $t$ and acceleration, $a$, vs. $t$. Draw the three motion diagrams for:

(i) **(4 points)** an object moving to the right at constant speed

(ii) **(4 points)** an object moving to the right and speeding up at a constant rate

b) The two vectors $\vec{A}$ and $\vec{B}$ are given by $\vec{A} = 10\hat{i} - 2\hat{j} + 5\hat{k}$ and $\vec{B} = 2\hat{i} + 4\hat{j} + 5\hat{k}$

(i) **(5 points)** Find $\vec{C} = \vec{A} + 2\vec{B}$ and $\vec{D} = \vec{A} - \vec{B}$ in terms of the unit vectors. i.e fill in the blanks below:

\[
\vec{C} = \hat{i} \quad \hat{j} \quad \hat{k}
\]

\[
\vec{D} = \hat{i} \quad \hat{j} \quad \hat{k}
\]

(ii) **(5 points)** Find the magnitude of $\vec{D}$.

(iii) **(7 points)** Find the angle between the vector $\vec{D}$ and the x axis.
4. A delinquent high school student constructs a potato gun using plastic drainpipe. The propellant is hair spray ignited by a spark
   a) (2 points) He shoots the gun vertically upward. It takes 15 seconds before the potato returns to earth. How long did it take to reach maximum height?

   b) (5 points) At what speed (muzzle velocity) did the potato leave the gun?

   c) (6 points) What maximum height did the potato reach?

   d) (7 points) Next, the student fires the gun horizontally out of a window 10 m above ground. He uses a different amount of hairspray so that the initial velocity is changed to 40 m/s. Assuming the ground is horizontal and flat, how much time elapses before the potato hits the ground?

   e) (5 points) Measuring horizontally from the point on the ground directly beneath the window, how far away is the potato when it hits the ground?