Exam Study Guide Based on Course Outcomes:

1. Work with Vectors: (chapter 3)
   a. Convert between the component description of a vector and the magnitude and direction
description of that vector.
   b. Add and subtract any two vectors using the graphical (drawing) method.
   c. Using a tabular format, add and subtract any two vectors using the component
(calculation) method.
   d. Understand that position, displacement, velocity and acceleration are vectors. Know how
to manipulate them to find related vector quantities.

2. Work with Forces and Force-diagrams (Free-Body Diagrams, FBDs): (chapters 2-4)
   a. Differentiate between mass and weight.
   b. Identify 3rd Law force pairs.
   c. Draw a FBD for a given physical situation (using the conventions discussed in class).
   d. Write Newton's 2nd Law equations in component form from a FBD.
   e. Translate between motion information represented in different representations (FBD,
Motion Diagram, Equations, Words).
   f. Solve problems involving: Gravitational forces, Tension forces, Normal forces, Friction
forces
   g. Draw FBD’s for objects moving in Curved Paths. Be sure that you can select the correct
directions for your coordinate system.

3. Analyze 2-D Motion: (chapter 3, 4)
   a. Use the kinematic (motion) equations in component form to solve problems.
   b. Solve projectile motion problems given the initial velocity of the projectile.
   c. Understand that position, displacement, velocity and acceleration are vectors. Know how
to manipulate them to find related vector quantities.
   d. Draw kinematic vector diagrams for objects moving in Curved Paths. Be sure that you
can select the correct directions for your coordinate system.

4. Analyze situations involving uniform circular motion. (chapter 4)
   a. Recognize the meaning of the tangential and radial components of the acceleration
vector.
   b. Solve problems involving radial acceleration.
   c. Show the vector subtraction that shows the direction of the “change in velocity vector”
for uniform circular motion.
5. **Analyze motion in terms of momentum change. (chapter 5)**
   a. Describe the quantity, momentum.
   b. Describe the quantity, Impulse and its relationship to Newton’s 2nd Law.
   c. Solve problems involving momentum and impulse in 1-dimensional situations.

**The exam covers:**
- Chapter 3 all
- Chapter 4.1-4, and 5 conceptually
- Chapter 5.1-3
- Labs 4-6

**Policies:**
- **You may Bring and Use:** Calculator (not on a cell phone), ruler, drawing materials
- You must turn off cell phones and place them away from you during the exam.
- Cell phone calculators will NOT be allowed.
- There will be NO BATHROOM breaks. When you leave the room, the exam is finished.
- PHOTO ID required at the time the text is taken.
- You will be asked to explain your answers so be ready
- The exam is a 1 hour exam, you have at least 1 hour 20 min. to complete it. Nothing else is scheduled during the class time so the sooner people settle down and are ready to begin, the more time you will have. You may leave when done.
- You will be asked to spread out so you may not be seated in your usual location.
- I will take off for missing units, no unit analysis (no units in your work), no explanation or work when asked for in the question.
- If you are nervous, relax, breath slow and remember that I’m want to know what you know, tell me.
- Scratch paper and graph paper will be provided.
- An approved equation sheet will be provided. You may get an example online in the Exam 1 folder. You should also have memorized all items covered to date from the “Memorize These” list.
Are You Ready?

Here are some questions that are good practice for checking your understanding. They are here only as sample questions for practice. They are not the same questions that you will see on the exam.

1. Given \( v_1 = 23.9 \text{ m/s} \@ 67 \text{ degrees} \) and \( v_2 = 36.2 \text{ m/s} \@ 100 \text{ degrees} \)
   a. Can you find \( v_1 + v_2 \) graphically (by drawing with protractor and ruler).
   a. Can you find \( \Delta v \) graphically (by drawing with protractor and ruler).
   b. Can you find \( v_1 + v_2 \) by components (putting components into a table).
   c. Can you find \( \Delta v \) by components (putting components into a table).

2. Given an object with forces acting on it, can you:
   a. Draw the FBD
   b. Write Newton’s 2\(^{nd}\) Law in component form.
   c. Solve for all forces and all kinematic unknowns.
   d. Sketch a graph of the motion or draw a motion diagram.

3. A ball is projected from the origin (ground level) with an initial velocity of 52 m/s at an angle of 39\(^{\circ}\).
   a. What is the time that it reaches the top of its flight?
   b. How high does it get?
   c. What is the time that it reaches the ground?
   d. How far to the right does it land?
Solution guidelines for practice questions above:

1a-b. Graphically: Here is a sketch. Remember that a proper drawing will be done with a ruler and protractor and will have a scale. (I’ve used the scale 20 m/s = 1 inch here.)

1c. By components:

<table>
<thead>
<tr>
<th></th>
<th>x-component</th>
<th>y-component</th>
</tr>
</thead>
<tbody>
<tr>
<td>v1 = 23.9 m/s @ 67 degrees</td>
<td>23.9 cos(67) + 9.338</td>
<td>23.9 sin(67) + 22.000</td>
</tr>
<tr>
<td>v2 = 36.2 m/s @ 100 degrees</td>
<td>36.2 cos(80) - 6.286</td>
<td>36.2 sin(80) + 35.650</td>
</tr>
<tr>
<td>Sum: v1+v2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Using Pythagorean equation:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>the magnitude of the sum is 57.7 m/s</td>
<td>+3.052</td>
<td>+57.650</td>
</tr>
<tr>
<td>Using tangent, the angle is:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>+87 degrees</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table

<table>
<thead>
<tr>
<th>Velocity</th>
<th>x-component</th>
<th>y-component</th>
</tr>
</thead>
<tbody>
<tr>
<td>v2 = 36.2 m/s @ 100 degrees</td>
<td>36.2 cos(80) - 6.286</td>
<td>36.2 sin(80) +35.650</td>
</tr>
<tr>
<td>-v1 = 23.9 m/s @ the opposite of 67 deg (which is 247 deg) or (67 SofW)</td>
<td>23.9 cos(67) -9.338</td>
<td>23.9 sin(67) -22.000</td>
</tr>
</tbody>
</table>

**Difference (Δv): v2-v1**

Using Pythagorean equation:

- the magnitude of the sum is 20.7 m/s
- Using tangent, the angle is: +41.1 degrees NofW

### Problem 3.

A ball is projected from the origin (ground level) with an initial velocity of 52 m/s at an angle of 39°.

**Solution example for b: How high does it get?**

First find the initial velocity components:

Use right triangle trig equations. Always draw a picture of the vector to guide your solution.

\[
\begin{align*}
\text{Initial } v_x &= 40.41 \text{ m/s} \\
\text{Initial } v_y &= 32.27 \text{ m/s}
\end{align*}
\]

### Table

<table>
<thead>
<tr>
<th>x-component of motion</th>
<th>y-component of motion</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \bar{v} = \frac{\Delta x}{\Delta t} )</td>
<td>( \bar{v} = \frac{\Delta y}{\Delta t} )</td>
</tr>
<tr>
<td>( \bar{a} = \frac{\Delta \bar{v}}{\Delta t} )</td>
<td>( \bar{a} = \frac{\Delta \bar{v}}{\Delta t} )</td>
</tr>
</tbody>
</table>
Next write all the equations and show what is known (shown in red). The accelerations and initial velocities, and initial position are given. Because the question asks for the maximum height, the final velocity (at maximum height is known also).

One equation is solvable for time. Then, with the value of time now known ($t=3.34$ sec), the height can be determined (54.6 m). Hint: The average vertical velocity is 16.36 m/s. Do you know why?