

Multiple Choice:

- Describe the 9 types of motion in both of these types of language:
 - Acceleration and velocity (e.g. positive acceleration with negative velocity)
 - Direction and change in speed (e.g. moving leftward, getting slower)
- The strict difference between average velocity and average speed, and how they are both calculated.
- Matching graphs of motion to one another (position, velocity, and acceleration)
- Free-fall
 - Net force acting on an object in free-fall.
 - What it means to be in free-fall.
- Why all objects fall at the same rate, regardless of their mass. (assuming no air resistance)
- Head-to tail vector addition for a 3 vector system
 - Finding a component, given the resultant and a component
 - Finding the resultant, given two components
 - Comparing the magnitudes of the vectors
- Resolve a vector into x and y components, given the starting vector's magnitude and direction (angle).
- Add an x and a y component vector to produce a resultant. Give the magnitude and direction (angle) of the resultant.
- Given an initial launch speed, find the speed (v) of an object that is launched horizontally from a cliff at any time during its flight.
- Consider a projectile traveling straight up and down through the air. Be able to draw force diagrams (individual and net force) at any point in the object's flight. You must be able to indicate the direction of each force.
- Identify 3rd law action/reaction forces. Distinguish them from other balanced forces.
- Know and apply Newton's 3rd law.
- Find the forces acting on an object by first identifying the known forces and then writing and solving the equation $ma = \text{vector sum of individual forces}$.
- Find the normal force acting on an object that is supported by a stationary surface. Be able to do this for a surface at any angle.
- When an object is kept moving in a vertical circle by either tension or normal force, be able to compare the magnitudes of weight (mg) and normal force or tension at the top or the bottom of the circle (e.g. – "at the bottom of the circle, which is greater, mg or F_N ?")
- Draw a force diagram showing all of the forces acting on a mass hanging from a string that is inclined at an angle. Resolve those forces into x and y components.
- Know why objects travel in circular motion.

Problems:

General Problems

- Direction of acceleration – how can you tell?
- Graphing motion – acceleration, velocity, and displacement (distance) – relating these graphs to one another.
- Kinematics – apply all of the formulas in 1D
- Draw a force diagram. Name and calculate forces:
 - individual forces acting on an object
 - Friction, weight, normal force, tension, other
 - Resolve forces
 - On a slope

b. Net Force

5. Problem-solve by writing two equations for net force.
6. Identify forces that are in the same dimension vs different dimensions
7. In terms of forces, what are the conditions that lead to constant velocity?
8. How does normal force relate to weight and perpendicular weight in various situations? When are they equal and when are they not? How do we know?
9. Apply the friction formula to a slope
10. Use friction to explain propulsion (not just slowing down)
11. Identify and describe 3rd Law action/reaction pairs of forces.

Projectile Motion

1. Show v , v_x , and v_y at multiple points in a projectile's trajectory.
2. Use kinematics to solve projectile problems by applying kinematics to the x and y dimensions independently
 - a. X dimension -- only 1 equation and 3 variables
 - b. Y dimension -- all equations and variables; $g = 9.8\text{m/s}^2$
3. Graph x and y velocity, acceleration, and displacement.
4. What vector to add to give something a new and specific velocity.

River problems:

1. Identifying components and resultants in river problems.
2. Knowing the three typical types of vectors -- object velocity (R), speed and heading (C), velocity of "current" (C)
3. Drawing head-to-tail diagrams
 - a. Given two components
 - b. Given one component and one resultant
4. Mathematical problem-solving with triangles
 - a. Pythagorean theorem
 - b. Inverse functions to find angles
5. How to determine and communicate vector direction on a map

Multibody Problems:

1. Define (or identify) a system, and identify all forces acting on that system
2. Draw and label forces
3. Identify forces that cancel
4. Calculate friction
5. Determine the direction in which friction will act.
6. When necessary, identify which direction will be considered positive, and which will be considered negative, for purposes of calculation. Follow this convention carefully.
7. Find the acceleration of a system by writing two equations for net force (using $\Sigma F = ma$ and $\Sigma F =$ vector sum of forces), setting them equal, and solving.
8. Solve for an internal force (like tension) by analyzing a smaller system for which that force does not cancel.

Circles and Gravity:

1. Be able to apply Newton's Law of Gravitation and $\Sigma F_c = mv^2/r$
2. Be able to solve a "regular" circle problem (vertical, horizontal, or in space) or a "planetary" circle problem.
3. Understand how to make yourself travel in a circle (with a fire extinguisher, on a hovercraft, on ice).
4. Deeply understand what causes circular motion.