This exam contains 8 pages and 12 questions: 5 multiple choice (50 pts), 4 single part free response (80 pts), and 3 multi-part free repsonse (120 pts). Your score is graded out of 250 points. This exam is closed-resources, but some reference constants, conversions, and equations have been provided. The use of a **TI 30X IIS** non-graphing, non-programmable calculator is permitted, but cellphones are **not**.

Please use the attached extra paper instead of cramming your work on the pages with problem statements. If I can not read your work, I can not give you credit. Work **must** be explicitly shown to earn full credit including a justification of your methods.

Staple all of your scratch to the exam when you turn it in. A good test taking strategy is to cross out incorrect work instead of erasing it to save some time.

Good Luck!

Physical Constants

$$g \approx 10.0 \, m/s^2$$

Conversion Factors

$$10^3 \, m = 1 \, km$$

$$3600 \, s = 1.0 \, h$$

Physical Relationships

$$\mathbf{v_{ag}} = \mathbf{v_{ab}} + \mathbf{v_{bg}}$$

$$v = 2\pi r/T$$

$$a_c = v^2/r$$

$$v_s = v_o + a_s t$$

$$s = s_o + v_{os} t + \frac{1}{2} a_s t^2$$

$$v_s^2 = v_o^2 + 2a_s(s - s_o)$$

$$\sum \mathbf{F} = m\mathbf{a}$$

$$f_s \leq \mu_s F_N$$

$$f_k = \mu_k F_N$$

Multiple Choice: 50 points

1. (10 points) What is the conversion factor for 1.0 m/s to mi/h?

     A. 1.0 m/s = 0.447 mi/h

     B. 1.0 m/s = 4.47 mi/h

     C. 1.0 m/s = 2.24 mi/h

     D. 1.0 m/s = 22.4 mi/h

2. (10 points) What type of quantity is displacement and how is it defined?

     A. Vector; Distance traveled.

     B. Vector; Change in position.

     C. Scalar; Distance traveled.

     D. Scalar; Change in position.

3. (10 points) Suppose you throw a ball straight up and it reaches height of 50 meters, then falls back down and hits the ground. What would be the total distance it traveled? Choose the upwards direction to be positive.

     A. Distance is 100 meters,

     B. Distance is 50 meters,

     C. Distance is -100 meters,

     D. Distance is -50 meters,

4. (10 points) A car travels a distance of 360.0 km. The first part of the trip is made at a lower speed than the second part. If it takes 6.0 h to complete the trip, what is the average speed of the car during the trip?

     A. 60 km/h

     B. 120 km/h

     C. 240 km/h

     D. 360 km/h

5. (10 points) A 35.0 kg object moves from left to right at a speed of 20.0 km/h. What is the weight of the object?

     A. 700 N

     B. 35 N

     C. 20 N

     D. 0 N

Free-Response: 80 points

1. (20 points) A ball is thrown vertically upward, which is chosen as a positive direction. A little later it returns to its point of release. The ball reaches a maximum height after a time of 20.0 s. What is its initial velocity?

2. (20 points) The captain of a plane flies a plane due west. The cruising speed of the plane is 209 m/s relative to the air when a 38.0 m/s wind starts to blow from the south to the north. How fast does the plane fly relative to the ground due to the cross wind?

3. (20 points) Consider an object that has two applied forces and gravity due to the Earth acting vertically on it. Use a standard x-y coordinate system for this problem where +y means vertically up. It turns out the first force $\mathbf{F}_1 = 4.0\ N$ upward and the mass of the box is 6.0 kg. What must the magnitude and direction of $\mathbf{F}_2$ be to cause no acceleration.

4. (20 points) A car travels with a constant speed around a circular track with a radius of 200 m. The car goes around the track with a centripetal acceleration of 4.60 m/s^2. How much time does it take for the car to complete one full revolution?

Multi-Part: 120 points

1. (40 points) A 25.0 kg crate rests on a level shipping dock. The coefficient of kinetic friction is 0.400. The crate is being pushed such that it has an acceleration of 0.2 m/s^2.

   (a) (10 points) Sketch the dock and crate, and indicate your coordinate system. Then draw a FBD for the box.

   (b) (10 points) Write down the appropriate force equations for the FBD of the crate.

   (c) (10 points) What is the weight of the box and the normal force on the crate from the ramp?

   (d) (10 points) What is the pushing force that causes the acceleration stated above?

2. (40 points) A projectile is launched at an angle of 45.0° from the horizontal and reaches a max height after 23.0 s.

   (a) (10 points) Sketch said projectile being launched, indicate your coordinate system, and write down corresponding kinematic equations.

   (b) (10 points) What is the projectile's launch speed?

   (c) (10 points) What is the max height the projectile reaches before falling back down?

   (d) (10 points) How far horizontally does the projectile travel before landing?

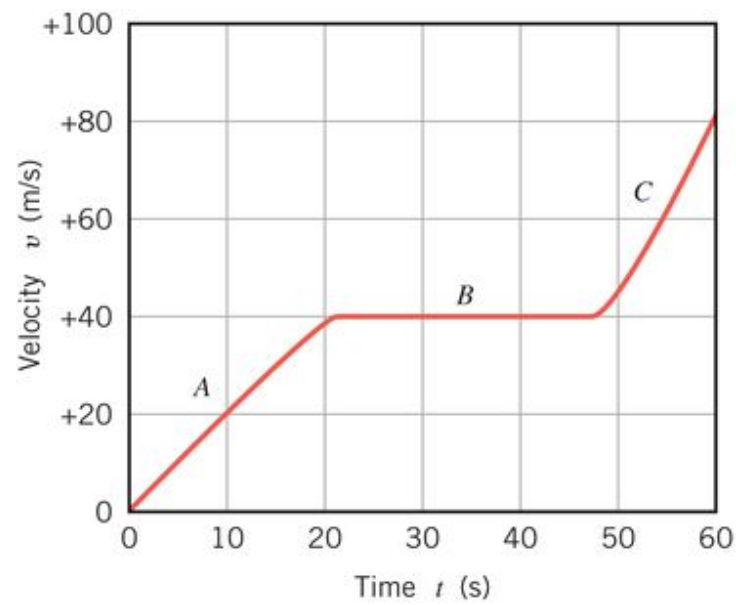3. (40 points) A snowmobile moves according to the velocity–time graph shown in the drawing.

Figure 1: Exam #1 Multi-part Problem 3

Calculate the average acceleration for

(a) (10 points) segment A

(b) (10 points) segment B

(c) (10 points) segment C

(d) (10 points) The whole trip shown.