Choose any three from the group 1, 4, 6, 7, 8 and do all others. Show your work to receive credit. Sketch relevant diagram, list known and unknowns and write formula before plugging in numbers. Show algebraic steps systematically with equal signs in proper places. Remember a vector has both magnitude and direction.

1. (14 points) Suppose force $\vec{A}$ is 4.0 N, force $\vec{B}$ is 6.0 N and angle between them is 60.0°. What is the magnitude and direction of $\vec{A} + \vec{B}$?

2. (8 points) What is the weight of a 100 kg astronomer at the orbit 300 km above the surface of the Earth?

3. (12 points) A brick of mass 1.0 kg slides down a smooth wooden roof inclined at 30.0° with respect to the horizontal. If the coefficient of friction between wood and brick is 0.20, what is the acceleration of the brick?

4. (14 points) Two blocks are connected by an ideal cord that passes over an ideal pulley that is fixed as shown in figure. If $m_1 = 2.0$ kg and $m_2 = 4.0$ kg, what is the tension on the cord?

5. The results of Doppler echocardiography for one person show that the blood in aorta begins at a speed of 0.10 m/s and undergoes constant acceleration for 38 milliseconds, reaching a peak speed of 1.29 m/s. (a) (5 points) What is the acceleration? (b) (5 points) How far does blood travel during this period?

6. A ball player standing at home plate hits a baseball that is caught by another player at the same height above the ground from which it was hit. The ball is hit with an initial velocity of 22.0 m/s at an angle of 60.0° above the horizontal. (a) (11 points) How much time will elapse from the ball leaves the bat until it reaches the fielder? (b) (3 points) At what distance from home plate will the fielder be when he catches the ball?

7. A car is travelling in a highway curve that is banked and has a radius of 825 m. (a) (3 points) Draw a free body diagram of the car on the road. (b) (11 points) At what angle should the road be banked so that the car travelling at 26.8 m/s has no tendency to skid sideways on the road?

8. A metallic ball ($m = 500$ g) initially at rest slides down a track as shown in figure. Ignore friction and air resistance. The loop has radius of 5 m and the initial vertical position of the ball is 20 m above from the bottom of the loop. (a) (7 points) At what speed does the ball reach the top of the loop? (b) (7 points) What is the force exerted on the ball by the track at the top of the loop?

9. (8 points) A box of mass 0.25 kg slides along a horizontal frictionless surface with a speed of 3.0 m/s. The box encounters a spring with $k = 200$ N/m. How far is the spring compressed when the box is brought to rest?

\[ g = 9.80 \text{ N/kg} = 9.80 \text{ m/s}^2, \quad G = 6.67 \times 10^{-11} \text{ Nm}^2/\text{kg}^2, \quad M_E = 5.97 \times 10^{24} \text{ kg}, \quad r_E = 6370 \text{ km} \]