You must show all your work to get full credit on a problem. Partial credit is given for work that is solid but fails to yield the correct answer.

1) Two balls 6 cm in diameter are placed 200 m apart on a frictionless horizontal plane at 65N. If the balls are impulsively propelled directly at each other with equal speeds, at what speed must they travel so that they just miss each other?

2) Neglecting the latitudinal variation in the radius of the Earth, calculate the angle between the gravitational force and gravity vectors at the surface of the Earth as a function of latitude.

3) Calculate the altitude at which an artificial satellite orbiting in the equatorial plane can remain above the same spot on the surface of the Earth.

4) So long as it is shallow, water is a fluid with constant density. Use this fact to help solve the following problem.

   a) Develop a relationship for the horizontal pressure gradient force in terms of depth (h) of water in a shallow container.

   A cylindrical tank of water is set on a turntable. The radius of the tank is \( r_0 \) and the depth of the water is \( z_0 \).

   b) The turntable is turned on (with rotation rate, \( \omega \)) and the system is allowed to equilibrate. Derive an expression for the height of the water surface, \( h \), as a function of radius.

   c) Express \( h(r) \) in terms of \( z_0 \) (Hint: consider the volume of fluid in the container).

   d) If \( r_0 = 1 \text{m} \), what rotation rate is required to raise the water level on the outer edge of the tank to \( h = 2z_0 \)?