1. (25) A baseball player throws a ball with the initial velocity shown in the figure. Determine the radius of curvature of the trajectory \((a)\) just after release, and \((b)\) at the maximum height. For each case, calculate the rate of change of speed.

2. (25) The barrel of a rifle is rotating in a horizontal plane about the vertical \(z\)-axis at a constant angular velocity \(\dot{\theta} = 0.5 \text{ rad/s}\) when a 60-g bullet is fired. If the velocity of the bullet relative to the barrel is \(\dot{r} = 600 \text{ m/s}\) just before it reaches the muzzle \(A\), determine the resultant horizontal side force exerted by the barrel on the bullet just before it emerges from \(A\).

3. (25) A toy train has magnetic couplers whose maximum attractive force is 0.9 N between adjacent cars. What is the maximum force \(P\) with which a child can pull the train and not break the train apart at a coupler? If \(P\) is slightly exceeded, which coupler fails? Neglect friction at the wheels.

4. (25) For a given value of \(y\), determine the upward velocity of \(A\) in terms of the downward velocity of \(B\).

**Useful equations**

\[ v = \frac{dx}{dt}, \quad a = \frac{dv}{dt} = \frac{d^2 x}{dt^2} = \nu \frac{dv}{dx} \]

Uniform rectilinear motion: \(x = x_0 + vt\)

Uniformly accelerated rectilinear motion: \(v = v_0 + at\), \(x = x_0 + v_0t + \frac{1}{2}at^2\), \(v^2 = v_0^2 + 2a(x - x_0)\)

Velocity components (radial and transverse): \(v = r \dot{e}_r + r \dot{\theta}e_\theta\)

Acceleration components:

- **Tangential & normal** \(a_r = \frac{dv}{dt}, \quad a_\theta = \frac{v^2}{\rho}\)
- **Radial and transverse** \(a_r = \ddot{r} - r \dot{\theta}^2, \quad a_\theta = r \ddot{\theta} + 2\dot{r} \dot{\theta}\)