PhyzLab Springboard:
Fun with the Eyewash

Felix

1. How long does it take the eyewash to fill a 5-gallon bucket?

   50 seconds

2. Determine the flow rate of water from the eyewash in m^3/s.

   $$\frac{5\ gal}{50\ s} \quad \frac{3.786\ L}{gal} \quad \frac{1\ m^3}{1000\ L} \qquad 0.00038\ m^3/s$$

3. When aimed at a 45° angle, what is the height of the eyewash's water fountain (above the nozzle)?

   5 cm = 0.05 m

4. Determine the speed of the water as it emerges from the eyewash nozzle.

   $v_y = v\sin\theta$

   $y = 0.05\ m$ $v_y^2 = v_{y0}^2 + 2ay$

   $v_{y0} = ?$ $v_{y0} = \sqrt{(-2ay)}$

   $v_y = 0$ $v_{y0} = \sqrt{(-2 \cdot -9.8\ m/s^2 \cdot 0.05\ m)}$

   $a = -9.8\ m/s$ $v_{y0} = 0.99\ m/s$

   $t = ?$

   $v_y = v\sin\theta$

   $v = 0.99\ m/s\ /\ \sin 45°$

   $v = 1.4\ m/s$

5. What is the total area of all the holes in the eyewash nozzle?

   $V\ /\ t = Av$

   $A = (V/t)/v = 0.00038\ m^3/s\ /\ 1.4\ m/s = 2.7\ E{-}4\ m^2$

6. Estimate the cross-sectional area of the inside of the eyewash hose/pipe after measuring its outer circumference.

   $C = 4.0\ cm = 0.04\ m$

   $OD = 0.04\ m\ /\ \pi = 0.013\ m$

   $ID = OD - 4\ mm = 0.013\ m - 0.004 m$

   $ID = 0.009\ m$

   $A = \pi(d/2)^2$

   $A = \pi(0.009\ m\ /\ 2)^2$

   $A = 6.4E{-}5\ m^2$

7. If the eyewash head were removed and the water were allowed to shoot straight up out of the hose, how high would it rise above the opening?

   $A_1v_1 = A_2v_2$

   $v_2 = A_1v_1/A_2$

   $v_2 = 3.8E{-}4\ m^3/s\ /\ 6.4E{-}5\ m^2$

   $v_2 = 5.9\ m/s$

   $y = ?$

   $v_0 = 5.9\ m/s$

   $v_y = 0$

   $a = -9.8\ m/s$

   $t = ?$

   $v_y^2 = v_{y0}^2 + 2ay$

   $y = -v_{y0}^2/2a$

   $y = -(5.9\ m/s)^2\ /\ 2 \cdot -9.8\ m/s^2$

   $y = 1.8\ m$