**Q2.** To anticipate the dip and hump in the road, the driver of a car applies her brakes to produce a uniform deceleration. Her speed is 100 km/h at the bottom A of the dip and 50 km/h at the top C of the hump, which is 120 m along the road from A as shown in Figure Q2. If the passengers experience a total acceleration of 3 m/s$^2$ at A and if the radius of curvature of the hump at C is 150 m, calculate (a) the radius of curvature at A, (b) the acceleration at the inflection point B, and (c) the total acceleration at C.

50 km/h = 13.88 m/s

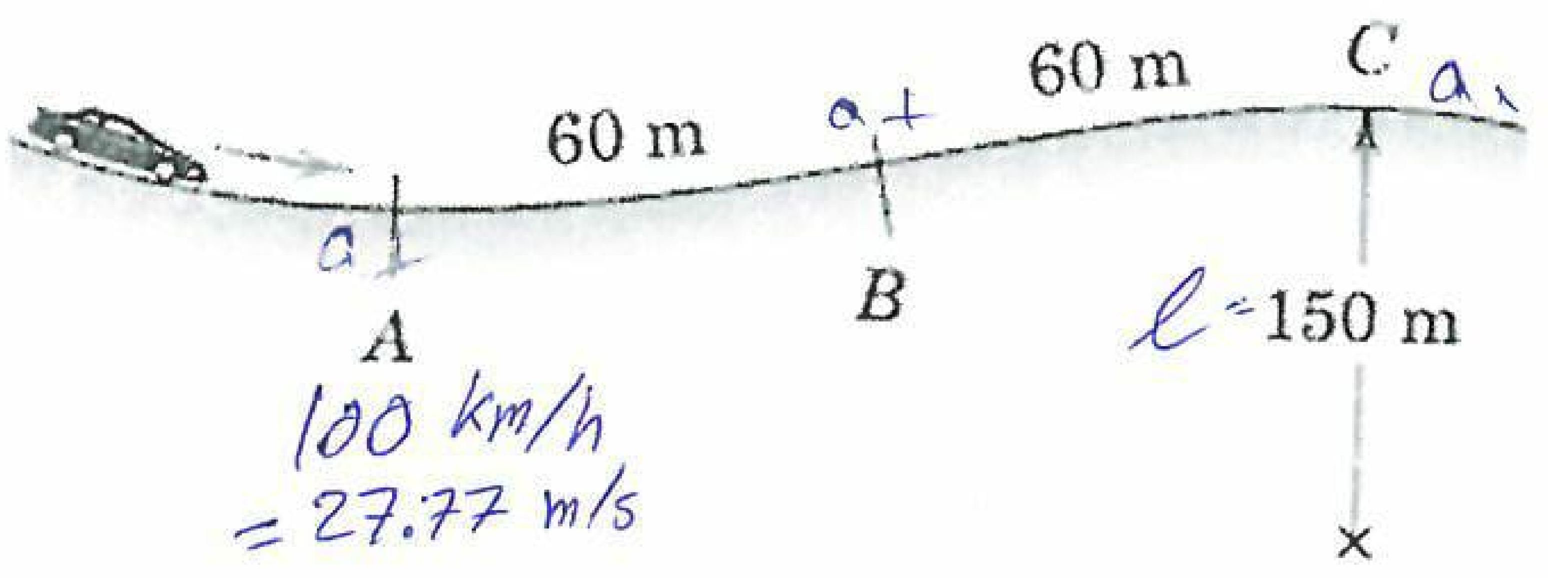



Figure – Q2

total $a = 3\ m/s^2$

(a) $a_t \int_0^{120} ds = \int_{27.72}^{13.88} v\,dv \Rightarrow a_t = \dfrac{13.88^2 - 27.77^2}{2 \times 120}$

$\boxed{a_t = -2.4\ m/s^2}$

$a_{n_A} = a_{n(total)} - a_t = 1.79 - 1.284$

$a = \sqrt{a_n^2 + a_t^2} = 9 = a_n^2 + 5.81$

$\Rightarrow a_n = 9 - 5.81 \Rightarrow a_n = \sqrt{3.19} = 1.79\ m/s^2$

(b) = no $a_n$ because so $= a_t = -2.4\ m/s^2$

(c) $a_t = -2.4\ m/s^2$, $a_n = \dfrac{v^2}{\rho} = 1.284\ m/s^2$

$a = \sqrt{2.4^2 + 1.284^2} = 2.72\ m/s^2$

20

$a_{n_A} = 0.51 \Rightarrow \rho = \dfrac{v^2}{a_n} = \dfrac{27.72^2}{0.51} = 1524.1\ m$

**Q4**. Spring of stiffness k = 500 N/m is mounted against the 10-kg block. If the block is subjected to the force of F = 500 N, determine its velocity at s = 0.5 m. When s = 0, the block is at rest and the spring is uncompressed. The contact surface is smooth.

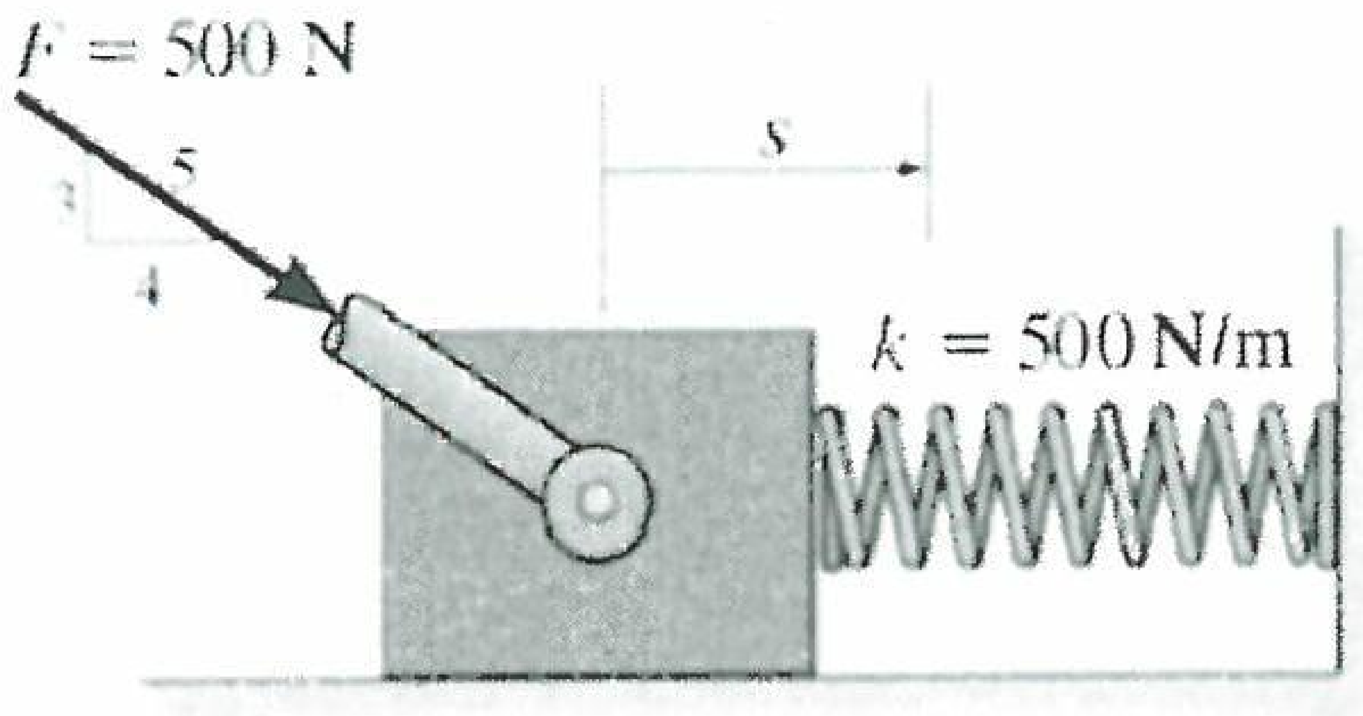



Figure – Q4

$500(\sin(36.87)) = 300N$ $\qquad W = mg$

$500(\cos 36.87) = 400N \qquad F_s = ks \qquad N$

$\Sigma F_x = 400 - \cancel{250}\ 500s = m a_x \Rightarrow s = 0.5$

$\cancel{\Rightarrow 150 = 10(a_x) \Rightarrow a_x = \frac{150}{10} = 15 m/s^2}$

$\cancel{v^2 = v_0^2 + 2a_c(s - s_0)}$

$\cancel{v^2 = 30(0.5 - 0) \Rightarrow v = \sqrt{15} = 3.87 m/s}$

$40\cancel{0} - 50\cancel{0}s = \cancel{10}\, a_x$

$40 - 50s = a_x$

$a_x\, ds = v\, dv \Rightarrow \int_0^{0.5}(40 - 50s)\, ds = \int_0^v v\, dv$

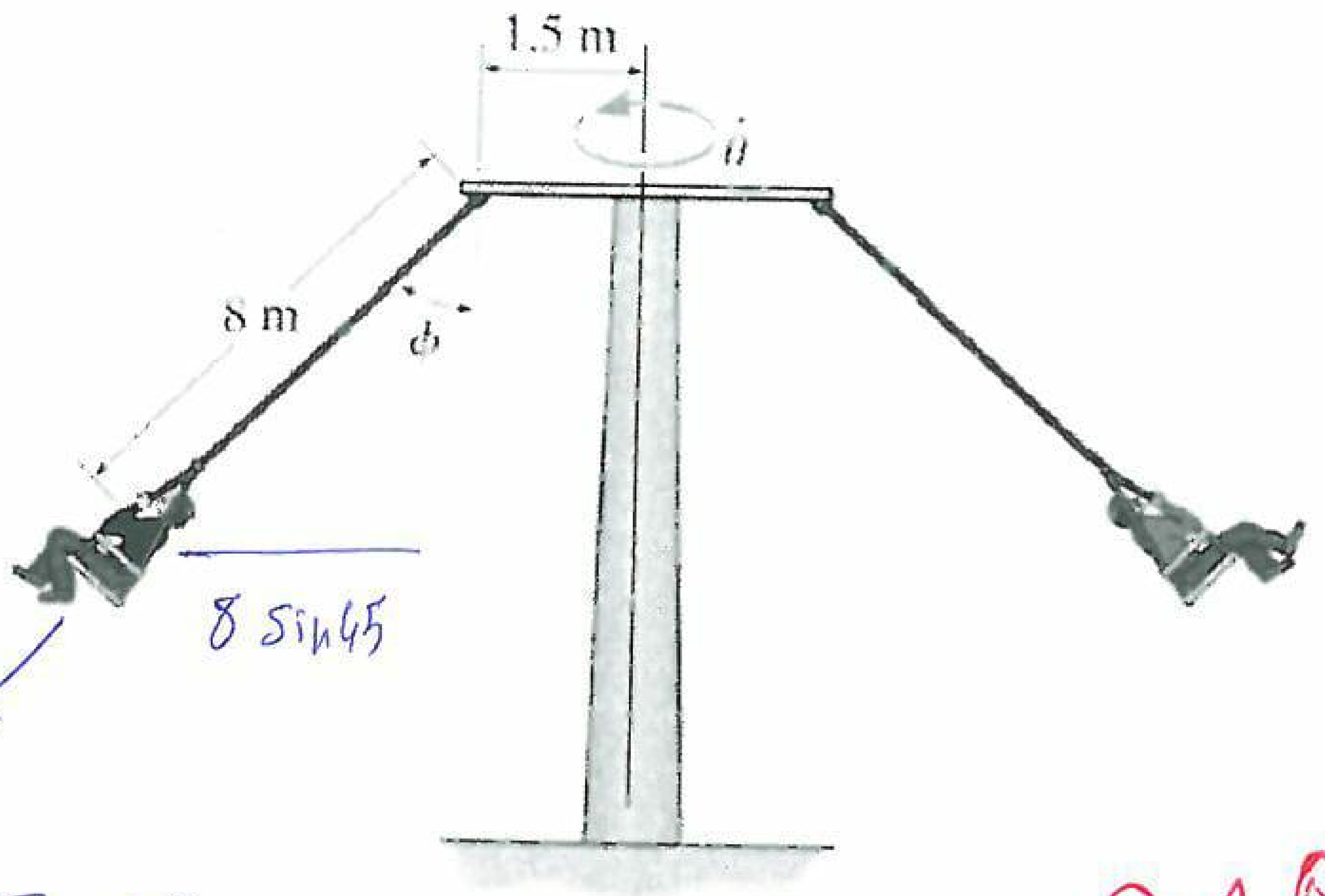
$\left(40s - \frac{50}{2}s^2\right)\Big|_0^{0.5} = \frac{v^2}{2}$

$2(20 - 6.25) = v^2$

$\Rightarrow v^2 = 27.5 \Rightarrow v = 5.24 m/s$

2.5

**Q3**. Determine the constant angular velocity of the vertical shaft of the amusement ride if ø = 45° as shown in Figure Q3. Neglect the mass of the cables and the size of the passengers.




$l = 7.15$

Figure – Q3

$\Sigma F_y = ma_y \Rightarrow T\cos 45 = mg = 9.81m = \cos(45)T$

$\Sigma F_x = ma_x \Rightarrow T\sin 45 = ma_n$

$\cos 45T = \sin(45)T \Rightarrow 9.81\cancel{m} = \frac{\cancel{m}v^2}{l}$

$v^2 = 70.1415\ m/s \Rightarrow v = 8.37$

$\dot{\theta} = \frac{v_\theta \cdot \cos 45}{l}$

$= 0.83\ rad/s$

**Q1.** The basketball was thrown at an angle measured from the horizontal to the man's outstretched arms. If the basket is 10 ft from the ground, make appropriate measurements in the Figure – Q1 and determine if the ball located as shown will pass through the basket.

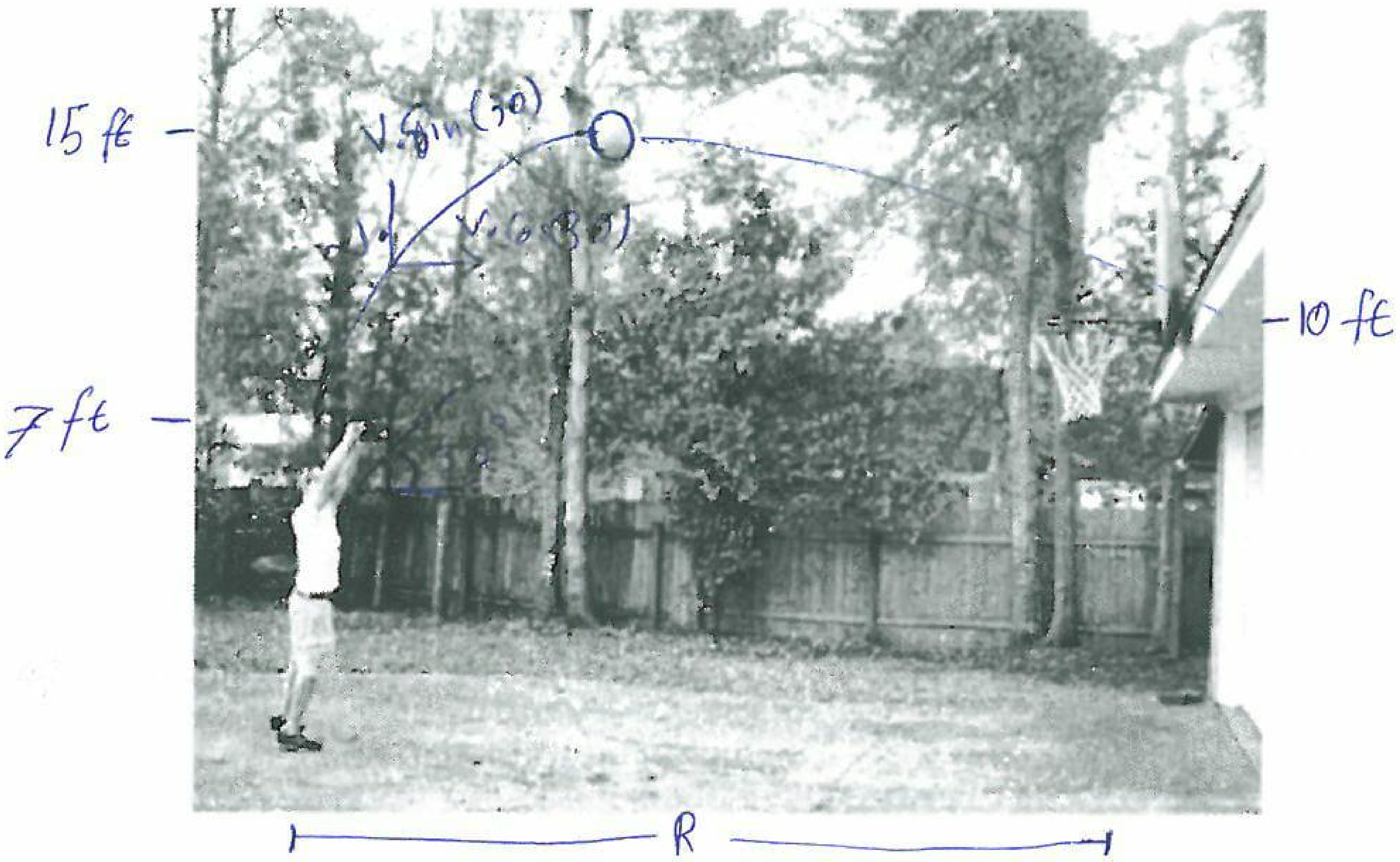



Figure – Q1

$V_0 = \frac{V_{0y}}{\sin(30)} = 45.4$ ft/s

①

$V_y^2 = V_{0y}^2 - 2g(y - y_0) \Rightarrow 0 = V_{0y}^2 = 2g(15-7)$

$V_{0y}^2 = 515.2 = 22.7$ ft/s

$y = y_0 + V_{0y}t - \frac{g}{2}t^2$

$16 = 7 + 22.7t - 16.1t^2$

$16.1t^2 - 22.7t + 8 = 0$

$t_1 = 0.714$ s $\Rightarrow t_1 = 0.7$ s

$t_2 = 0.7$ s

the range is about 18 to 20 $\neq X_1 \neq X_2$ so it won't pass

$V_y^2 = 0 + 2(32.2)(5)$

$V_y = 18$

$y = y_0 + \frac{g}{2}t^2$

$5 = 16.1t^2$

$t_2 = \sqrt{\frac{5}{16.1}} = 0.3$ s

②

$X_1 = X_{0} + V_{0x}t_1$

$V_{0x} = V_0 \cos(30) = 39.32$ ft/s

$X_1 = 0 + 39.32 \times 0.7$

$\boxed{X_1 = 27.5 \text{ ft}}$

2.5

$X_2 = X_{02} + V_{0x}t_2$

$X_2 = 0 + 39.32 \times 0.3$

$\boxed{X_2 = 11.8 \text{ ft}}$