

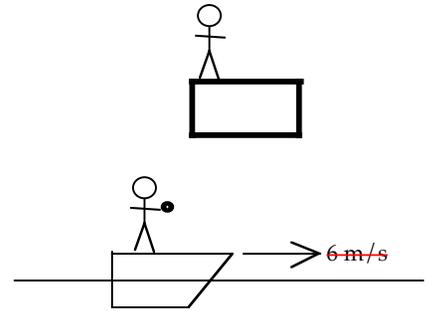
Problem 9

A rocket, initially at rest on the ground, accelerates straight upward with constant **net** acceleration, B , from time $t=0$ until $t=T_1$, at which time the fuel is exhausted. Neglect air resistance and assume that the rocket stays close enough to the ground that the acceleration due to gravity (after the rocket engine stops) is given by g .

- Find the maximum height, H , that the rocket reaches above the ground.
- If the rocket's net acceleration, B , is equal to $1.0g$, find an expression for the total time, T_{\max} , that the rocket is in the air (i.e. from liftoff until it hits the ground) in terms of T_1 . You do not need to solve your expression numerically but simplify it as much as possible.

Problem 10

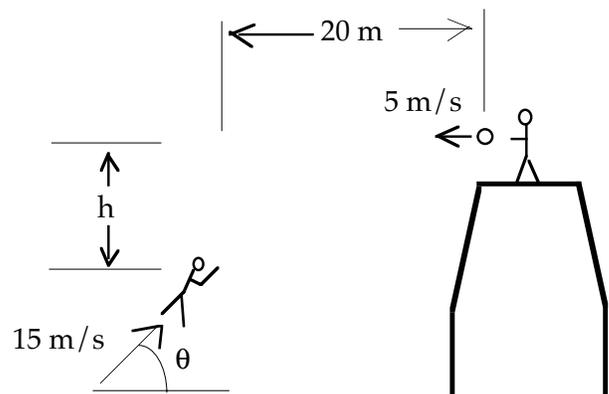
You are standing on the Mass Avenue Bridge watching the boats on the Charles. You see a motorboat pass directly below you, traveling perpendicular to the bridge at a speed of 6 m/s . A person on the boat throws a baseball at an initial speed of v_0 and at an angle of 36.9° from the vertical (Note: both v_0 and the angle are with respect to the boat). Find the value of v_0 necessary for the ball to travel straight up towards you. Show clearly on the drawing the direction the ball is thrown relative to the boat.



Problem 11

A circus acrobat is launched by a catapult at a speed of 15 m/s at an angle of $\theta = 40^\circ$ above the horizontal as shown. At a distance of 20 m away, her partner is standing on a platform at a height of h meters. At the instant that the acrobat is launched, her partner throws a basketball towards her horizontally at a speed of 5 m/s . Ignore air resistance in solving this problem.

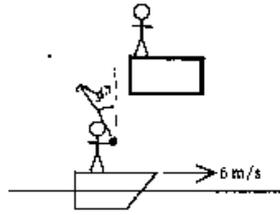
- Write equations for the horizontal and vertical positions as functions of time for both the acrobat and the basketball. Be consistent in your choice of origin.
- When will the performer and basketball be at the same horizontal position?
- Find the value of h for which the acrobat will catch the ball. Assume that she and the ball must be at the same height for her to catch it.
- Find the magnitude of the velocity of the ball relative to the acrobat at the instant that she catches it.



Problem 12

Young & Freedman 5.11 and 5.12 on page 194.

Problem 10



~~Want: $v_{boat,x} + v_{ball,x} = 0$~~

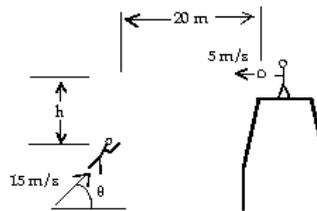
~~$\Rightarrow v_{ball,x}$ must be < 0~~

~~$6 - v_0 \sin(36.9^\circ) = 0$~~

~~$6 - v_0(0.6) = 0$~~

~~$v_0 = 10 \text{ m/s}$~~

Problem 11



a)

Acrobat
 $x = 0 + 15\cos(\theta)t + 0$
 $x = 11.5t$
 $y = 0 + 15\sin(\theta)t - \frac{1}{2}gt^2$
 $y = 9.6t - 4.9t^2$

Basketball
 $x = 20 - 5t$
 $y = h - \frac{1}{2}gt^2 = h - 4.9t^2$

b) $x_1 = x_2$ at $11.5t = 20 - 5t \Rightarrow t = 1.21 \text{ s}$.

c) Acrobat: $y = 4.44 \text{ m}$.

Basketball: $y = h - 4.9t^2 = h - 7.20 = 4.44 \text{ m}$.

$h = 11.6 \text{ m}$.

d)

Acrobat
 $v_x = 11.5 \text{ m/s}$
 $v_y = -2.26 \text{ m/s}$

Basketball
 $v_x = -5 \text{ m/s}$
 $v_y = -11.9 \text{ m/s}$

Relative
 $v_x = -5(-11.5) = -16.5 \text{ m/s}$
 $v_y = -11.9 - (-2.26) = -9.6 \text{ m/s}$
 Mag = 19.1 m/s