

Given the following conditions, solve for these unknowns.

- The weight of the bar is 2500 N
- The length of the bar is 2.0 m
- The weight of the sign is 5000 N
- The sign hangs at a point 1.5 m from the point where the bar pushes against the wall
- The wire is at an angle of  $35^\circ$  above the bar and is attached at a point 1.8 m from where the bar pushes against the wall.

(a). State the three conditions for static equilibrium in two dimensions

(b) Solve for the tension in the wire

(c) Solve for the vertical reaction force

(d) Solve for the horizontal reaction force.

(e) solve for the “net” reaction force

2. A billiard ball travels horizontally with a speed of 27 m/s and strikes a billiard ball of equal mass in a perfectly elastic collision. The first billiard ball then moves off at an angle of  $35^\circ$  above horizontal.

(a) Write an expression for conservation of momentum in the  $\mathbf{i}$  direction

Write an expression for conservation of momentum in the  $\mathbf{j}$  direction

Write an expression for the conservation of kinetic energy.

(b) Move all terms in equation 1 and equation 2 involving  $v_2$  and  $\theta_2$  to the right and all terms involving  $v_1$ ,  $v_1(\text{final})$ , and  $\theta_1$  to the left.

(c) Square equations one and two and add them together. This is equation four

(d) Use equation three to derive an expression for  $v_2^2$ .

(e) Put this expression for  $v_2^2$  into equation four.

(f) Solve for  $v_1(\text{final})$

(g) Solve for  $v_2(\text{final})$

(h) Solve for theta 2.

3. A coal car has a mass of 10,000 kg when it is empty. If it is rolling along a straight smooth track at 80 m/s. how much coal would be need to fall into it in order to slow it down to 50 m/s?

4. A projectile is shot off a cliff at a velocity of 100 m/s at an angle of  $23^\circ$  above horizontal. If the cliff is 300 m high

(a) What are the vertical and horizontal components of its initial velocity?

(b) How long does it take to reach the ground?

(c) What is the range of the projectile (how far does it land from the base of the cliff)?

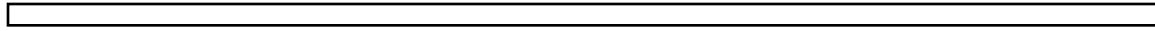
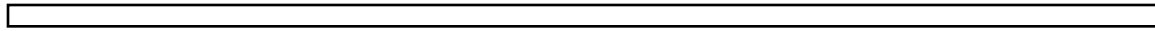
(d) What is its maximum height?

(e) What is its final vertical velocity?

(f) What is its final horizontal velocity?

(g) What is its final "net" velocity?

charged\_particle\_through\_vertical\_electric\_field



Two parallel plates are shown as above. The top plate is connected to the positive terminal of a 30,000 V battery.

The distance between the plates is 7.00 mm

The length of the plate is 12.0 cm

The initial horizontal velocity of the charged particle is  $2.4 \times 10^5$  m/s.

The initial vertical velocity is zero.

The charge is  $4.8 \times 10^{-13}$  C

The mass of the particle is  $3.7 \times 10^{-18}$  kg.

a) Draw the direction of the electric field.

b) What is the strength of the electric field? Give answer in both accepted SI units.

c) What is the force on the particle?

d) What is the acceleration of the particle? Give direction.

e) How long does it take the particle to go through the electric field?

f) What is the final vertical velocity of the particle?

g) What is the magnitude of the final net velocity?

h) What is the direction of the final net velocity?

**6. DON'T YOU WISH YOU WERE GOING TO PHILLY  
WITH THE ROBOT TEAM TOMORROW**

Answers: 1 (a) Sum of forces in x must equal zero, sum of forces in y direction equal zero, sum of torques equal zero (b)  $5.3 \times 10^3 \text{ N}$  (C)  $1.4 \times 10^3 \text{ N}$  (D)  $4.4 \times 10^3 \text{ N}$  (e)  $4.6 \times 10^3 \text{ N}$  at  $18^\circ$  above horizontal

2.  $v_1 = 22 \text{ m/s}$   $v_2 = 15.5 \text{ m/s}$  at  $55^\circ$

3.  $6.0 \times 10^3 \text{ kg}$

4. (a) vert =  $78 \text{ m/s}$  hor =  $183 \text{ m/s}$  (b)  $19.1 \text{ s}$  (c)  $3.49 \times 10^3 \text{ m}$  (d)  $609 \text{ m}$  (e)  $-109 \text{ m/s}$  (f)  $183 \text{ m/s}$  (g)  $213 \text{ m/s}$  at  $-31^\circ$

5. (a) down (b)  $4.3 \times 10^7 \text{ V/m}$  or  $\text{N/C}$  (c)  $2.06 \times 10^{-5} \text{ N}$  (d)  $5.6 \times 10^{12} \text{ m/s}^2$  (e)  $1.6 \times 10^5 \text{ m/s}$  (f)  $-2.9 \times 10^5 \text{ m/s}$  (g)  $-34^\circ$

6. HARMAN, WE HATE YOU!