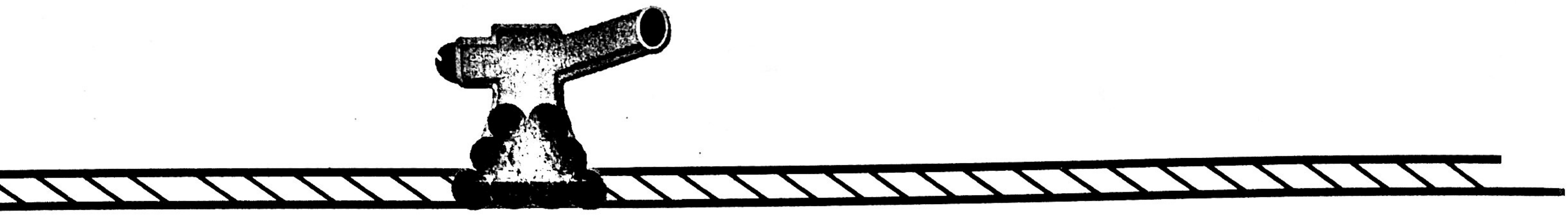
Name(s): ______________________ Date: ______________ Period: ____________

AP Physics 1

Year in Review Problem

A 600kg canon sits on train tracks with a coefficient of friction of μ=0.41. The cannon is fired, causing the 50kg cannon ball to accelerate at 6410m/s^2 down the 0.78m long chute.



a. What is the velocity of the cannon ball as it leaves the chute?

$V_i = 0$ m/s $\Delta d = 0.78$m $V_f^2 = V_i^2 + 2a\Delta d$
$a = 6410$ m/s^2 [$V_f = 100$ m/s]

b. How long will it take the cannon ball to reach the end of the chute?

$V_i = 0$ m/s $\Delta d = 0.78$m $\Delta d = V_i t + \frac{1}{2}at^2$
$a = 6410$ m/s   [$t = 0.016$s]

c. What is the force exerted on the cannonball by the cannon?

$F = ma = (50kg)(6410$ m/s$^2) = $ [320500N]

d. What is the force exerted on the cannon by the cannonball?

Equal + opposite [-320500N]

e. What is the velocity of the cannon just after it fires the cannonball?

I | F
(650)(0) = 600(V) + 50(100)   [V = -8.3 m/s]

f. What is the acceleration of the cannon when the cannonball is being fired?

$F = ma$
320500N = (600)(a)   [$a = -534.17$ m/s^2]

g. What is the acceleration of the cannon *after* the cannonball is fired?

F_N, F_F, F_g

$\Sigma F_x = F_F = m \cdot a$ $\mu \cdot m \cdot g = ma$
$\mu F_N = m \cdot a$ [$a = -4.02$ m/s^2]

h. How long does it take the cannon to come to rest? (t)

$V_i = 8.3$ m/s $a = 4.02$ m/s^2 $V_f = V_i + at$
$V_f = 0$ m/s   [$t = 2.06$ s]

i. How far does the cannon travel before coming to rest? (d)

$V_i = 8.3$ $a = -4.02$ m/s^2 $V_f^2 = V_i^2 + 2a\Delta d$
$V_f = 0$ $\Delta d = ?$ [$\Delta d = 8.57$m backwards]

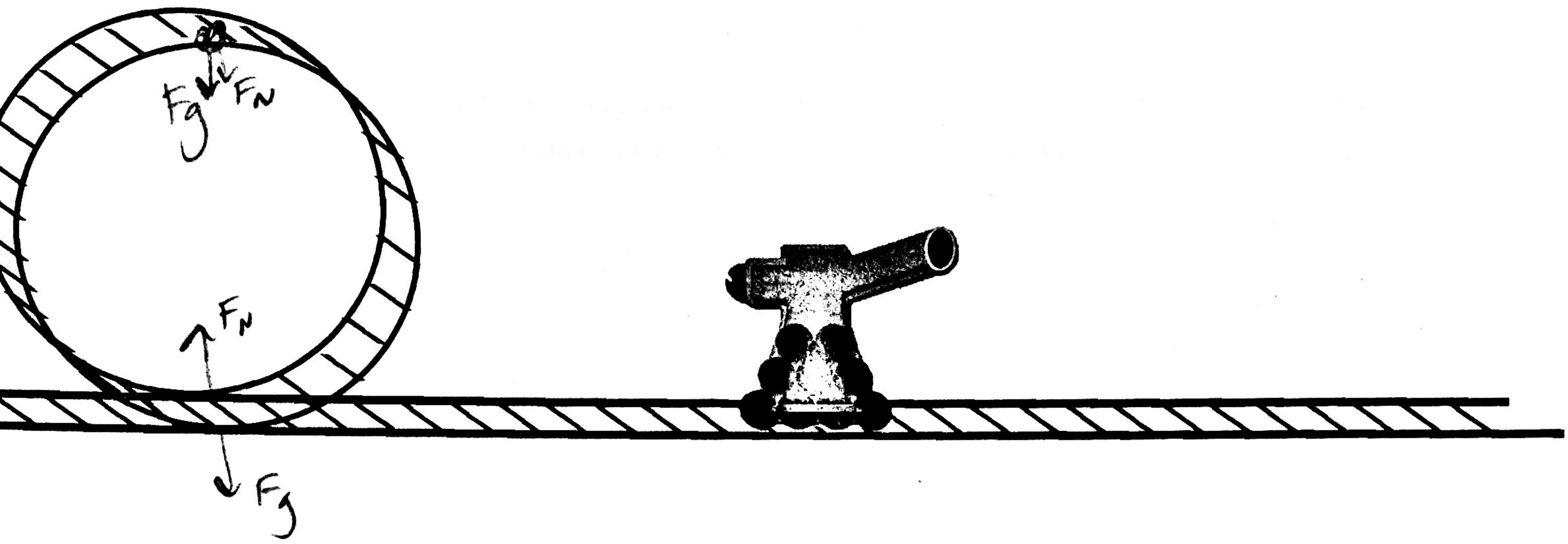
j. What is the magnitude of the force of friction acting on the cannon when it slides on the tracks?

$F_F = \mu \cdot m \cdot g = $ [2410.8N]

Each question is worth 1/2 of a summative point. The total amount of points received will be divided between all group members (ex 6 summative points, group of 2 = 3 points each)

Name(s): ______________________________ Date: ________________ Period: ______________

The same cannon-cannonball system is now placed on a flat frictionless track with a loop of radius 5m.



a. What is the minimum velocity the cannon will need at the top of the loop to make it around the loop without falling off? min $a_c = 9.8 m/s^2$ (only F_g)

$9.8 m/s^2 = \frac{V^2}{5}$ $V = 7 m/s$

b. What velocity does the cannon need on the ground to make it around the loop?

$ME_{loop} = (600)(9.8)(10m) + \frac{1}{2}(600)(7^2) = ME_{ground} = \frac{1}{2}(600)v^2$

$V_{ground} = 15.65 m/s$

c. What is the minimum final firing velocity of the cannonball (when it leaves the chute) that will cause the cannon to go all the way around the loop?

I	F
0	$(600)(15.65) + (50)(v)$

$V = 187.8 m/s$

d. What is the new acceleration of the cannonball down the chute?

$V_i = 0 m/s$ $V_f = 187.8 m/s$ $V_f^2 = V_i^2 + 2a\Delta d$

$\Delta d = 0.78 m$

$a = 22608.23 m/s^2$

e. What is the new acceleration of the cannon when it fires the cannonball?

$F_{cannon} = -F_{cannonball}$ $F_{cannonball} = (50)(22608.23) = 600 \cdot a$

$a = 1884 m/s^2$

f. What is the centripetal acceleration of the cannon at the bottom of the loop?

$a_c = \frac{15.65^2}{5}$ $a_c = 48.98 m/s^2$

g. What is the centripetal acceleration of the cannon at the top of the loop?

$a_c = 9.8 m/s^2$

h. What is the Normal force acting on the cannon at the top of the loop?

$F_N = 0 N$

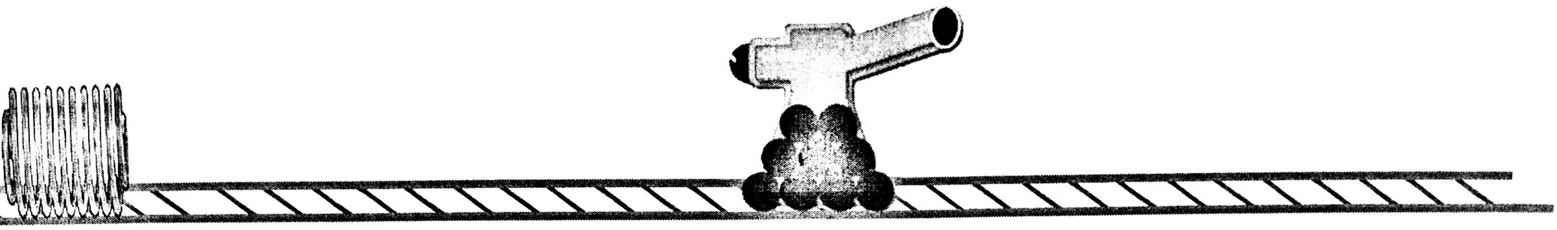
i. What is the Normal force acting on the cannon at the bottom of the loop?

$\Sigma F_y = F_N - F_g = m \cdot a_{c\,bottom}$ $F_N = 17{,}638{,}680 N$

Each question is worth 1/2 of a summative point. The total amount of points received will be divided between all group members (ex 6 summative points, group of 2 = 3 points each)

Name(s): ______________________ Date: ______________ Period: ______________

The cannon/cannonball system is now placed on a frictionless track that ends with a spring with a maximum compression of 3m. The cannon is fired with the same initial stats as on page one.



a. What is the minimum K value where the spring will be completely compressed and absorb all energy from the cannon? $\frac{1}{2}(600)(8.3)^2 = \frac{1}{2}k(3^2)$

$K = 4629.63\ N/m$

b. What is the force of the spring on the cannon?

$F_s = -kx = 13{,}778\ N$

c. What is the force of the cannon on the spring?

$-13{,}778$

d. What is the acceleration of the cannon once it hits the spring?

$v_i = 8.3$ $\Delta d = 3$
$v_f = 0$

$a_{avg} = -11.48\ m/s^2$ OR $F = ma$, $13778 = 600 \cdot a$ → $a = 23.1\ m/s^2$ ↑max acceleration

e. Imagine the cannon sticks to the spring once it strikes it. What is the period of the spring/cannon system? $T = 2\pi\sqrt{m/k}$

$T = 2.26\ s$

f. What will be the compression/extension of the spring after 10 seconds?

$x(t) = A\cos 2\pi f t$ where $f = \frac{1}{T}$

$x(10) = 3\cos 2\pi(\frac{1}{2.26})(10)$ IN RADIANS

$x(10) = -2.629\ m$

g. How would doubling the K value of the spring affect the period of the spring/cannon system? (give exact #'s) decrease by 30%, 70% of original

$T_{new} = \frac{1}{\sqrt{2}} T_{old}$

h. Imagine the spring sticks to the cannon after being struck and is torn away from the wall on the left. The cannon compresses the spring and then moves away to the right, trailing the spring. Once the spring/cannon system is moving away at a constant velocity, what is the force of the cannon on the spring?

0N (not being squished or stretched)

i. In the above scenario, what is the compression of the spring?

0 m (no force anymore)

Each question is worth 1/2 of a summative point. The total amount of points received will be divided between all group members (ex 6 summative points, group of 2 = 3 points each)