**Unit 4- Impulse Momentum Derivations**   NAME:_____

Unit 4.1: An explosion in a rigid pipe shoots three balls out of its ends. A ball of mass, *6M* comes out of the right end. A second ball of mass *4M* comes out of the left end with a velocity of *2V* relative to the first ball. From which end, left or right, does the third ball emerge? Derive an expression in terms of *M* and *V* to support your answer.

Unit 4.2: A block of mass M is resting on a horizontal, frictionless table and is attached as shown below to a relaxed spring of spring constant k. A second block of mass 2M and initial speed v_0 collides with and sticks to the first block. Develop expressions for the following quantities in terms of M, k, and v_0.

Before Collision

After Collision
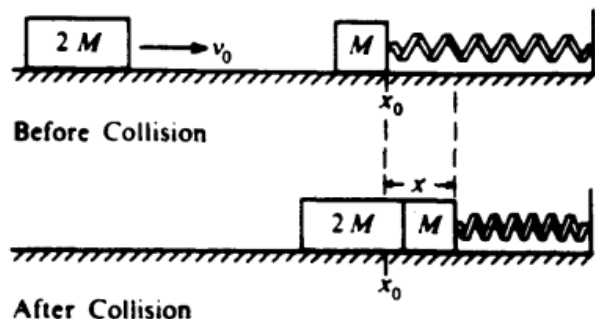
(a). v, the speed of the blocks immediately after impact

(b). x, the maximum distance the spring is compressed

(c). T, the period of the subsequent simple harmonic motion (skip until Unit 7 review)

Unit 4.3: Block A of mass M_A slides along a frictionless surface with a velocity of V_A. Block A collides with block B of mass M_B such that block A stops immediately. Block B slides to the right and collides with block C, initially moving to of mass M_C and sticks. Block C was initially moving to the left with velocity V_C. The block B-block C system moves to the right with a velocity of V_{BC} and up a slope of height, H_1 where it encounters a horizontal spring with a spring constant, K. The spring compresses distance X_1, recoils, and launches the block system horizontally off the slope into projectile motion. While in the air, block C detaches from block B and the center of mass for the system comes to rest at position X_2 to the left of the slope. Block C falls vertically from a height H_2 and lands directly on top of Block A.

(a). Derive an expression for the velocity of block B immediately after the collision with block B in terms of M_A, V_A and M_B.

(b). Using your expression in part (a), derive an expression for the velocity (V_{BC}) of the two-block system immediately after the collision in terms of M_A, V_A, M_B, M_C, and V_C.

(c). Derive an expression for the height (H_1) of the slope. For this question, ignore the spring and assume the block system comes to rest at the top of the slope.