Momentum

Or, "How to make Newton's Laws even more complicated without even trying…"

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Nitty Gritty?

- Definitions?
  - ‘member FMA?

$$\Sigma F = ma$$

$$F = ma$$

$$F = m\frac{\Delta v}{t}$$

$$Ft = m\Delta v$$

$$Ft = \Delta mv$$

Impulse

Latin *impulsus*, from past participle of *impellere*, to *impel*
Impel: *See impulse.*

Momentum

Latin *mōmentum*, movement

Nitty Gritty?

- Definitions?
  - P Conservation

$$P_i = P_f$$

$$m_1 v_1 + m_2 v_2 = m_1 v_1' + m_2 v_2'$$

Why?

$$F_1 = F_2$$

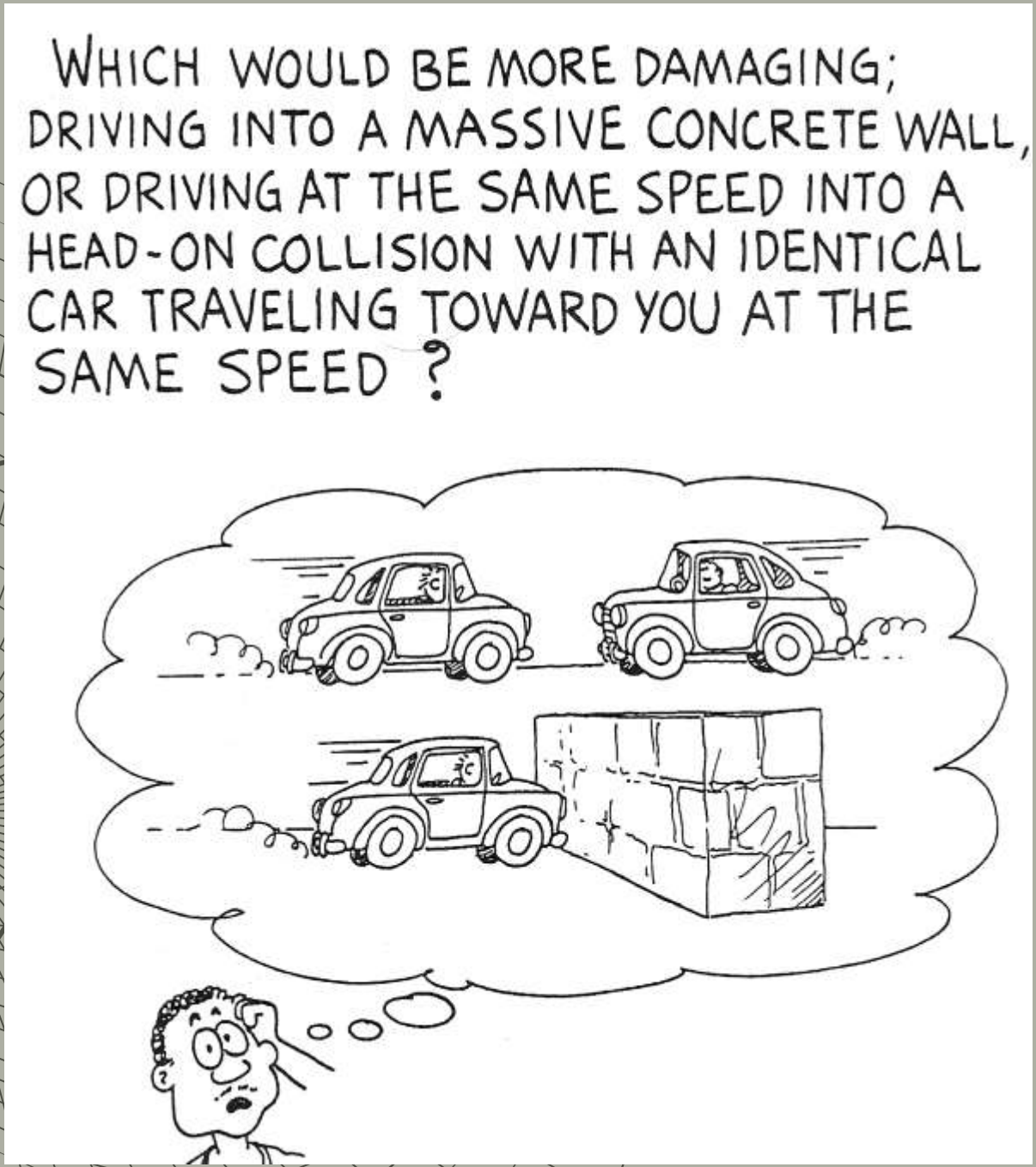
$$m_1 a_1 = m_2 a_2$$

$$\frac{m_1 \Delta v_1}{t} = \frac{m_2 \Delta v_2}{t}$$

$$m_1 v_1 = m_2 v_2$$

POP QUIZ:

#1


WHICH WOULD BE MORE DAMAGING; DRIVING INTO A MASSIVE CONCRETE WALL, OR DRIVING AT THE SAME SPEED INTO A HEAD-ON COLLISION WITH AN IDENTICAL CAR TRAVELING TOWARD YOU AT THE SAME SPEED ?

2-D Momentum

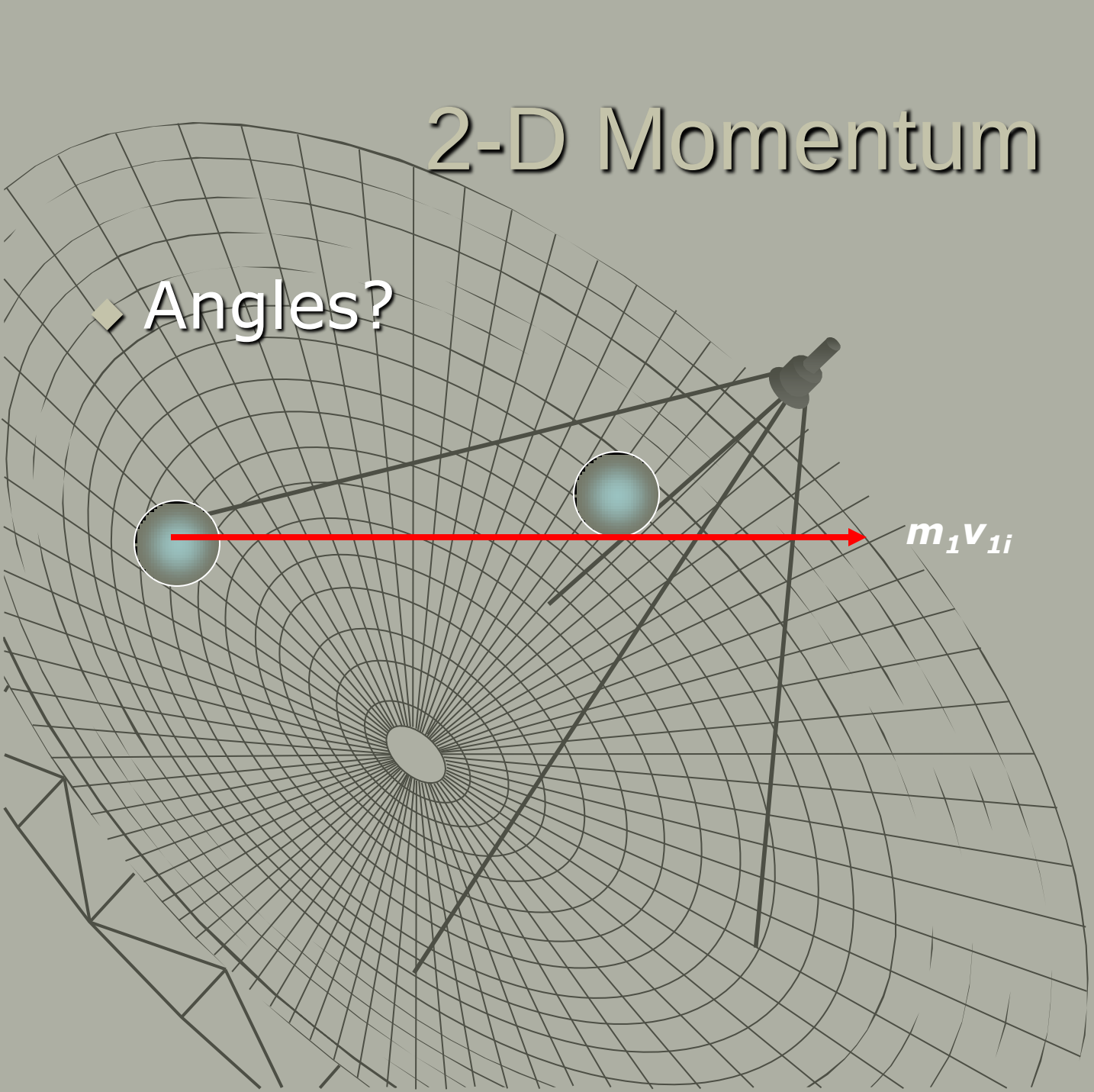
- Momentum is a ***linear vector***

$$\rho_1 = \rho_2$$

$$m_1 v_1 + 0 = 0 + m_2 v_2$$

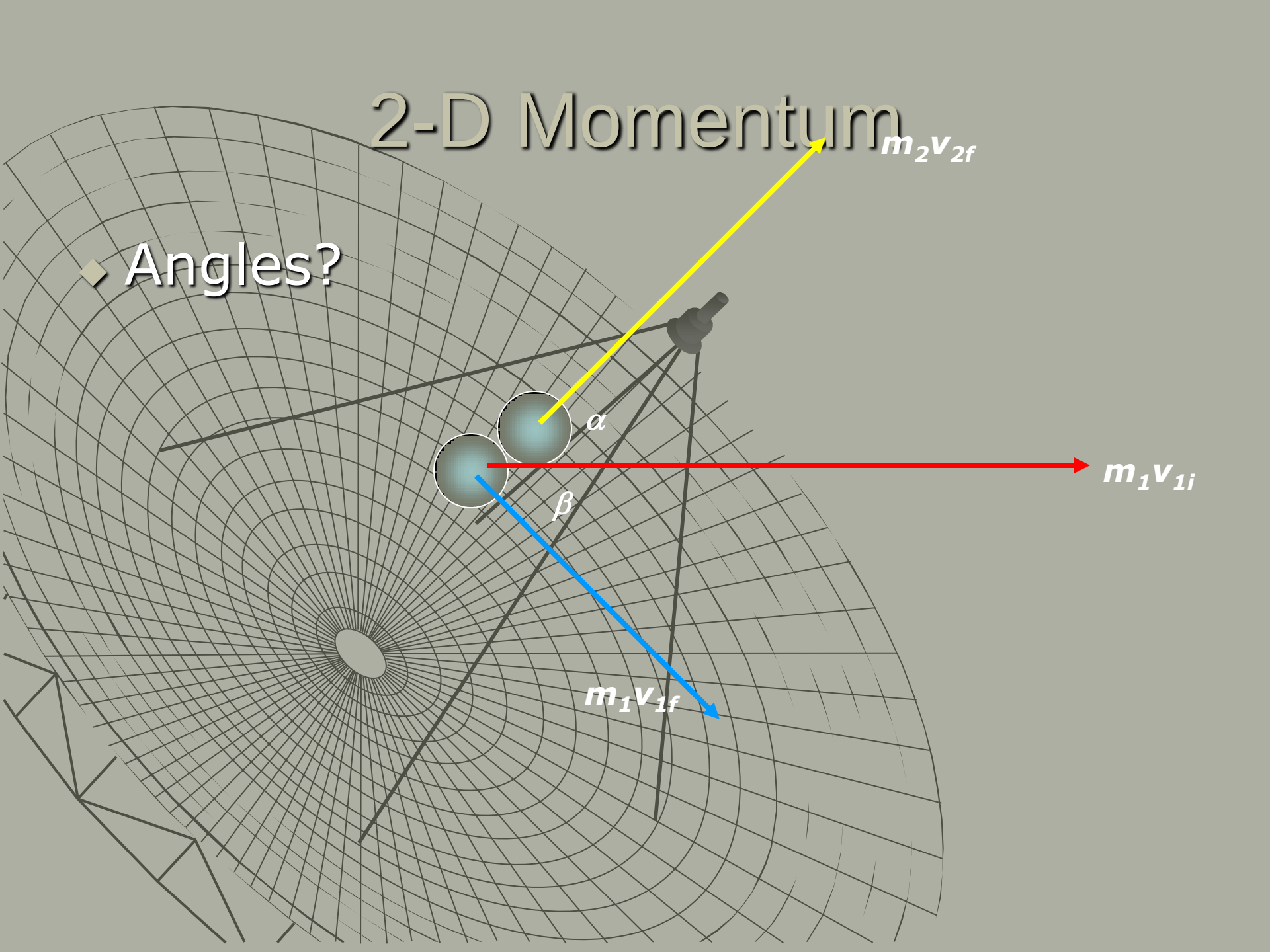
2-D Momentum

- Angles?



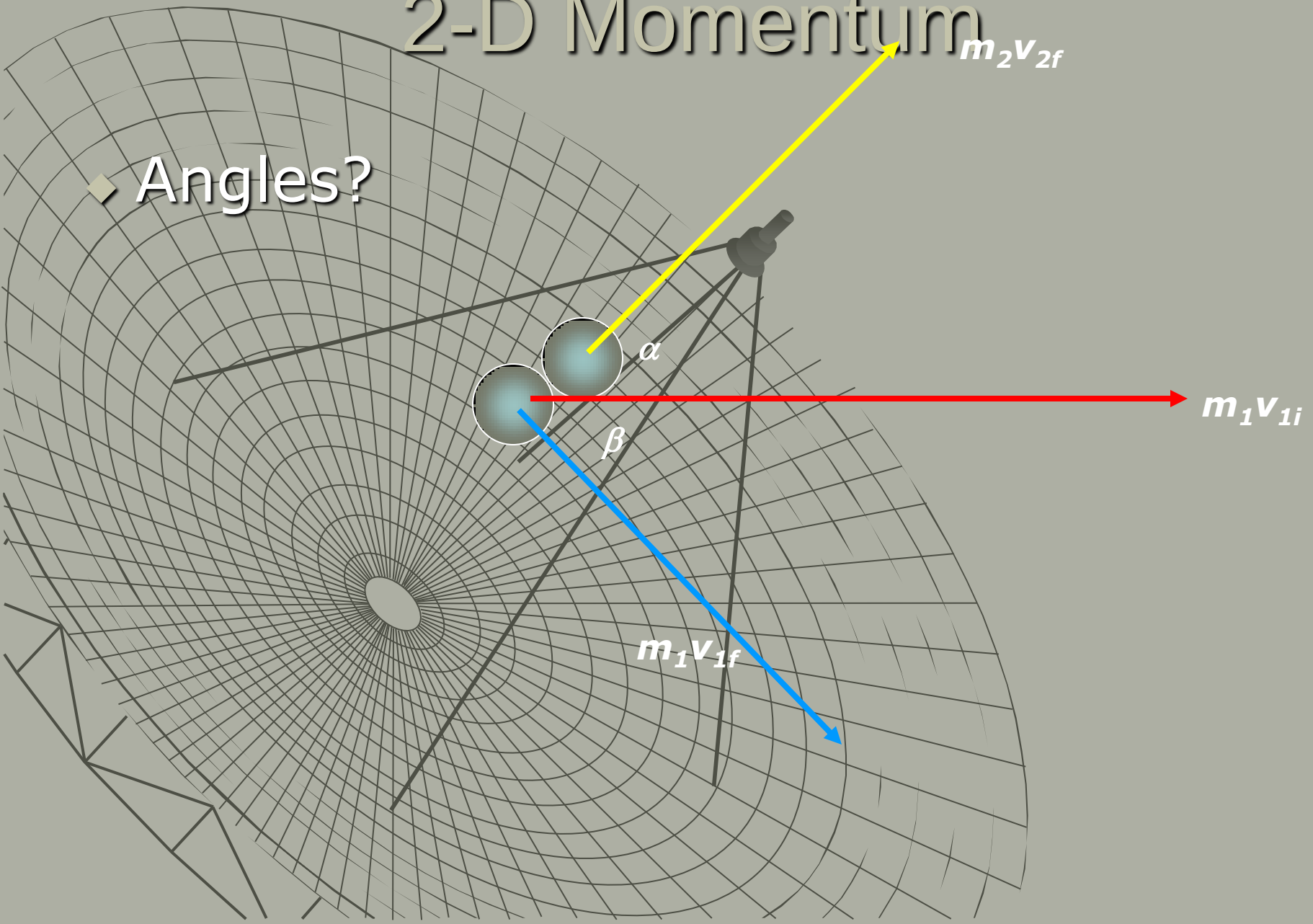
2-D Momentum

- Angles?



2-D Momentum

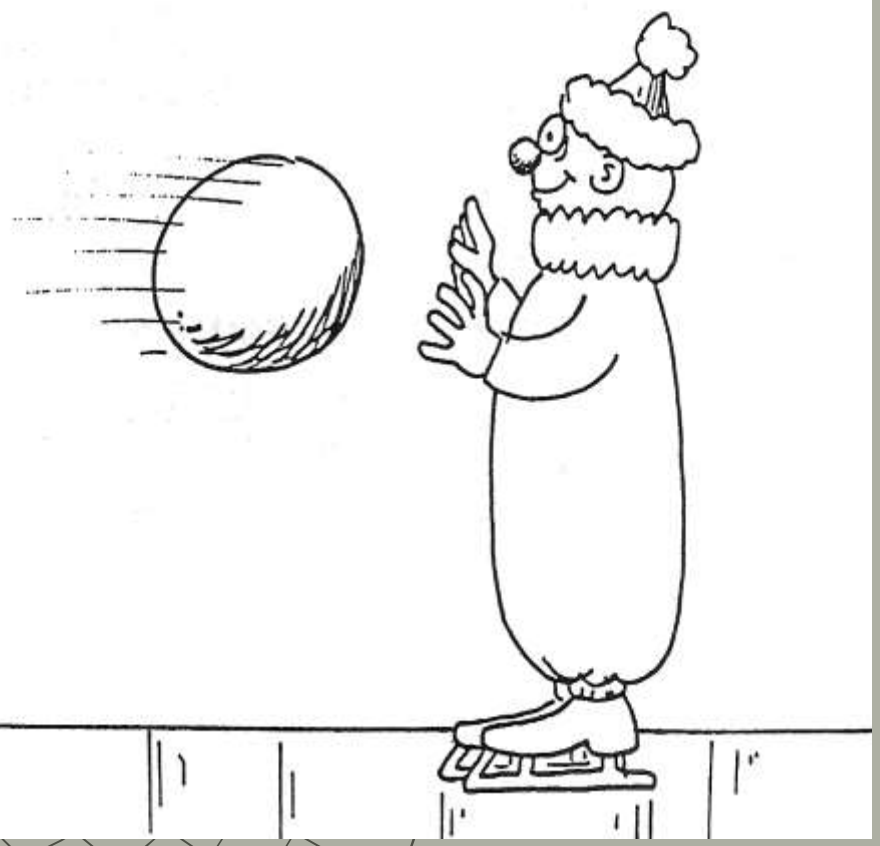
- Angles?



POP QUIZ:

#2

JOCKO, WHO HAS A MASS OF 60 kg AND STANDS AT REST ON ICE, CATCHES A 20 kg BALL THAT IS THROWN TO HIM AT 10 km/h. HOW FAST DOES JOCKO AND THE BALL MOVE ACROSS THE ICE?



2.5 m/s

Types of Collisions;

- Elastic
  - ρ AND KE are conserved

$$\rho_i = \rho_f$$

$$KE_i = KE_f$$

Types of Collisions;

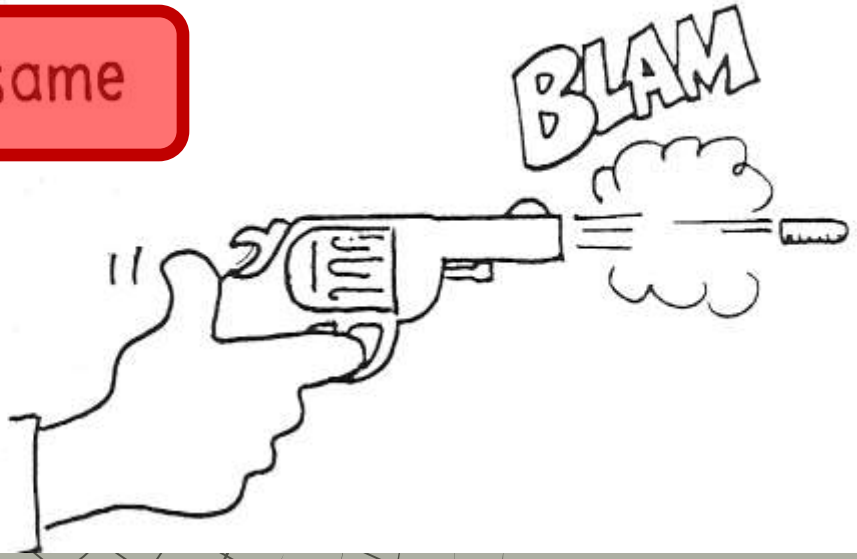
- Inelastic
  - ρ ONLY are conserved

$$\rho_i = \rho_f$$

POP QUIZ; #3

Strictly speaking, when a gun is fired, compared with the momentum of the recoiling gun, the opposite momentum of the bullet is

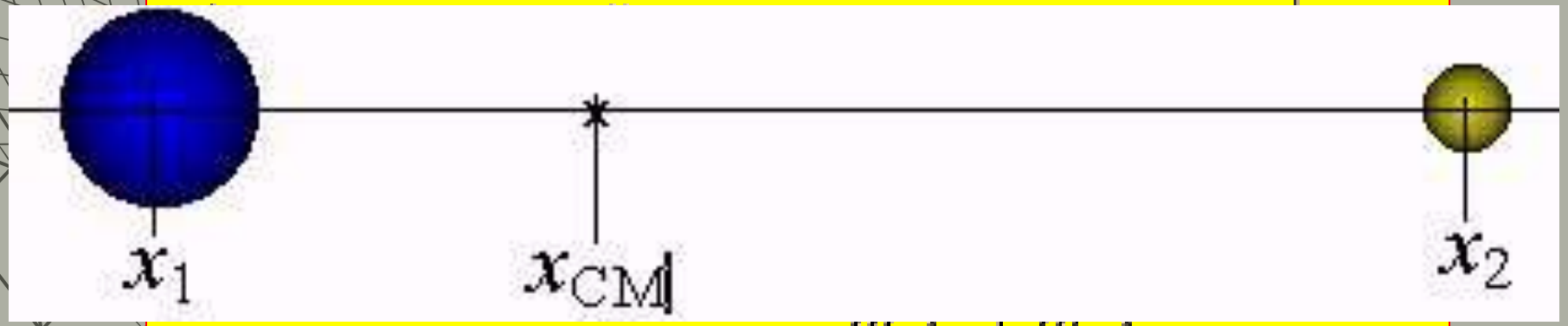
a) less
b) more
c) the same



09 05-15-02 PLAY 000190
FWD10 0000.1890sec
000000 A: 00.0 B: 00.0
1/1000 START 1000FPS

MV & cm

- cm
  - Center of Mass
    - NOT to be confused with Center of Gravity (cg)



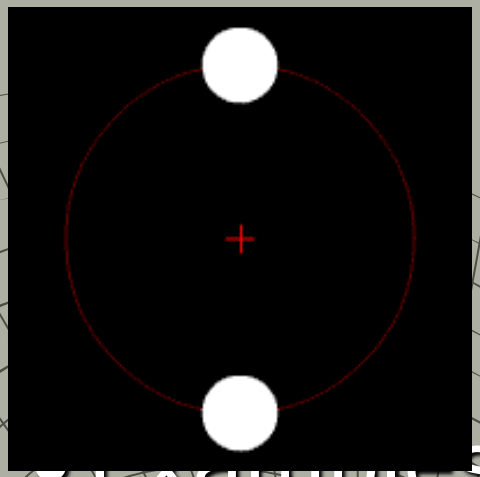
For two masses: $x_{cm} = \dfrac{m_1 x_1 + m_2 x_2}{m_1 + m_2}$

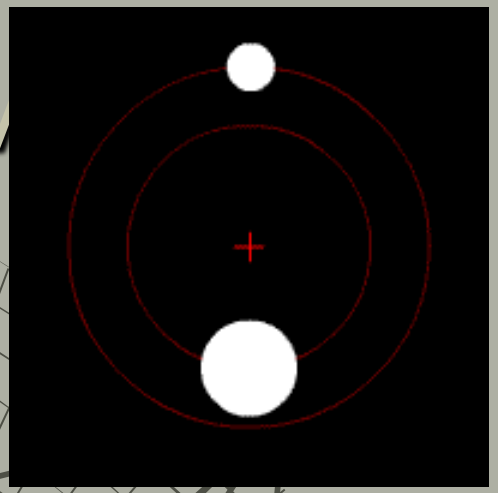
MV & cm

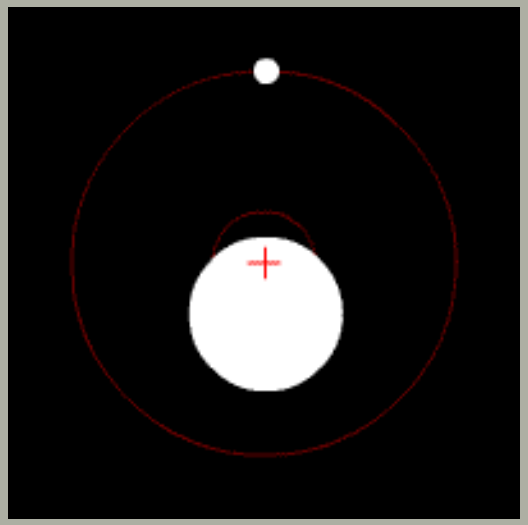
- cm
  - Examples

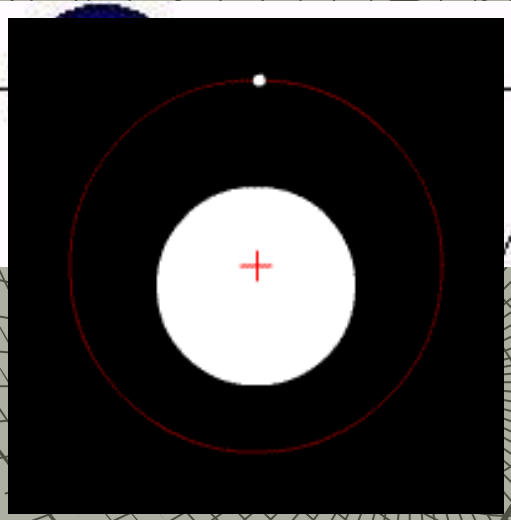
M

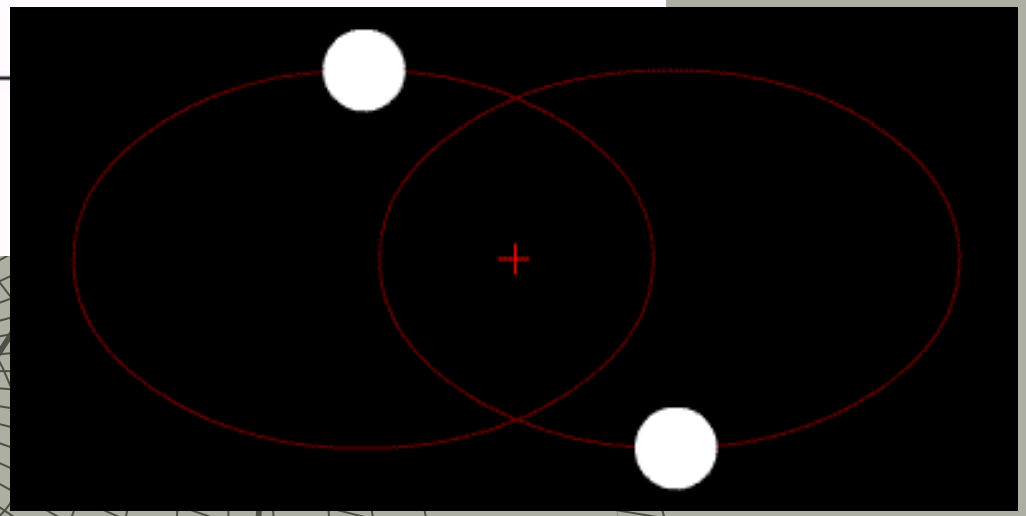
- Examples





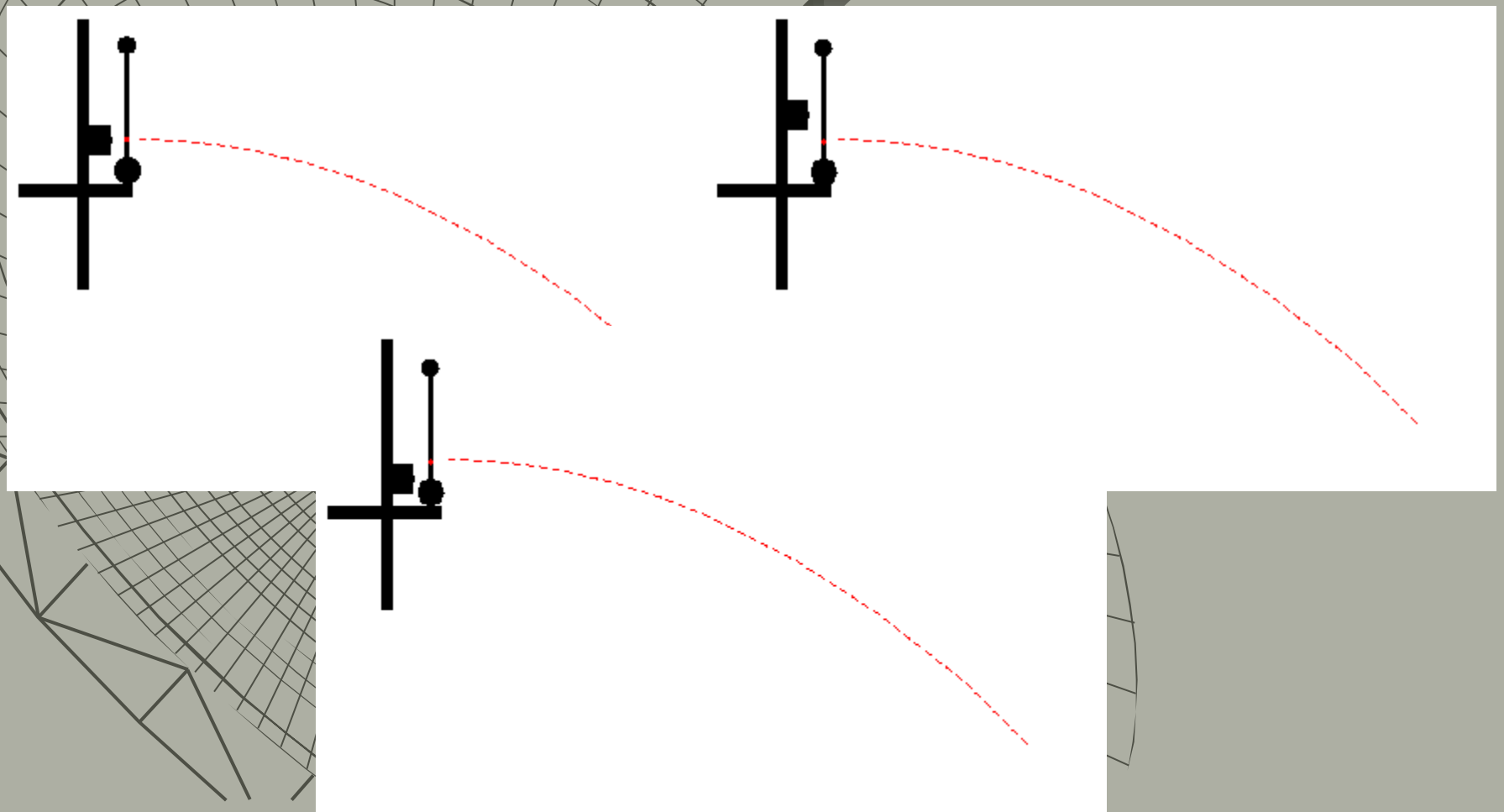






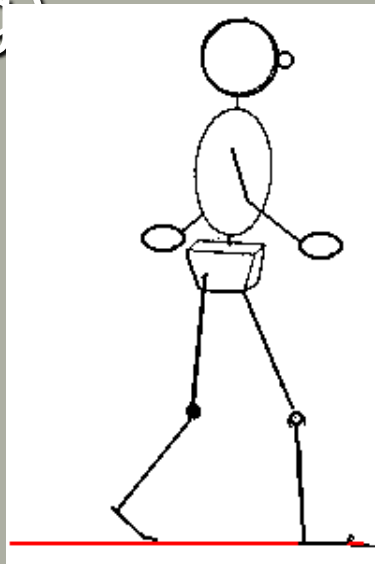
MV & cm

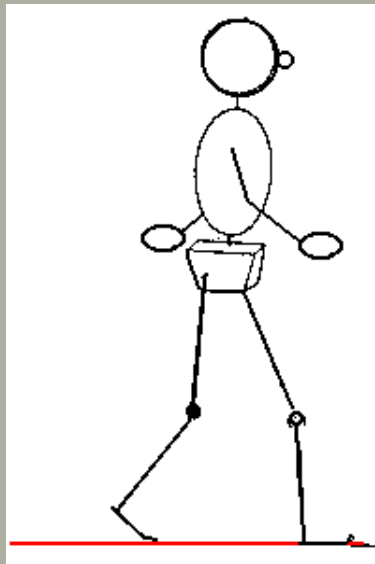
- cm



MV & cm

- Cm – Hume Beans
  - Bending over
  - Sitting
  - Standing
  - Walking
  - One-Leg Lift (Wall & Free-standing)
  - Butt against wall – Touch toes
  - Chair pick-up
  - Babies vs Adults
    - Head size – ¼ vs 1/8



MV & cm

- Cm – Hume Beans
  - Wile E. Coyote Video
  - m-stick and hat
  - Rolling UP HILL demo