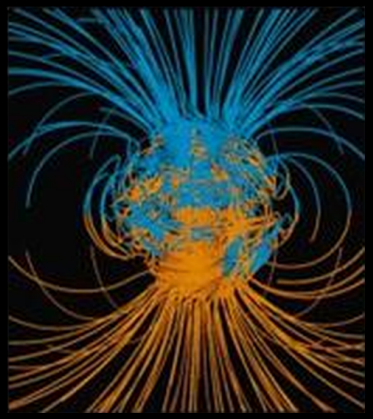


Phy2005
Applied Physics II
Spring 2018

Announcements: Top Hat quizzes start Wednesday
BW office hours T7th R7th NPB 2079
or by appt.

Last time: Math review

Today: Mechanics review I

Motion

Equations for uniformly accelerated motion:

$$a = const.$$

$$v = v_I + at$$

$$x = x_I + v_I t + \frac{1}{2} a t^2$$

Force and Motion

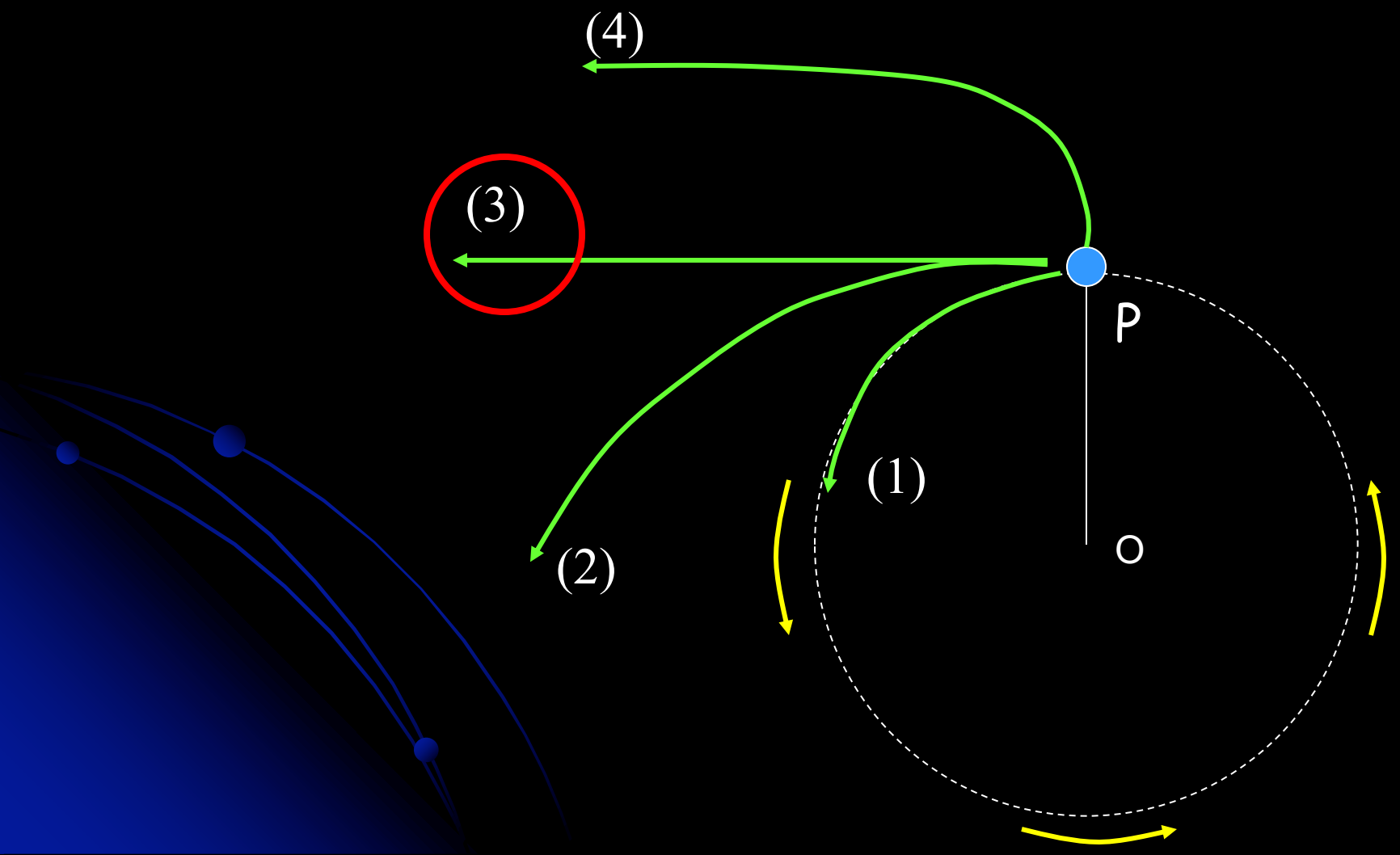
Newton's 1st Law of Motion

An object at rest remains at rest and an object in motion remains in a uniform motion in a straight line unless acted on by an unbalanced external force.

If an object is in non-uniform motion and/or in a motion not in a straight line, then there must be an unbalanced external force acting on the object.

If an object remains at rest or in a uniform motion in a straight line even when an external force is applied on that object, there must be an extra force acting on the object with equal strength and in the opposite direction

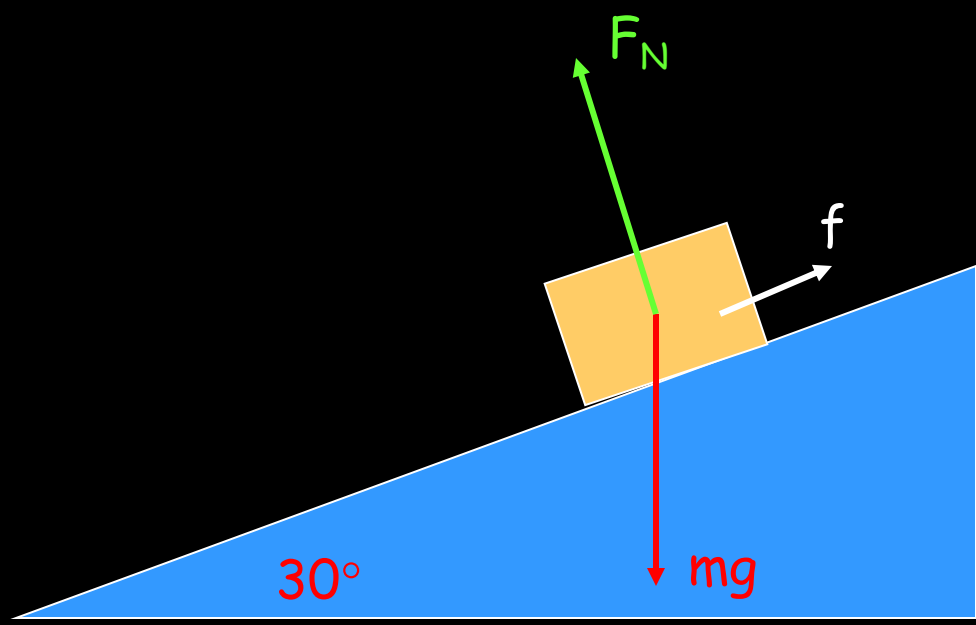
Ex 3-1 Which of the following trajectories would the ball most closely follow after it is released at P during the circular motion on a frictionless table top?



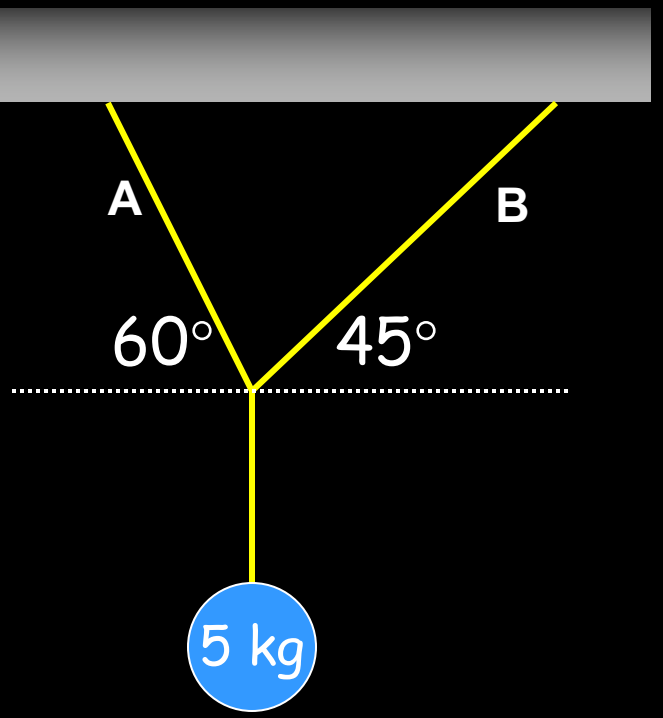
Ex 3-2 A 1-kg block is resting on a 30 inclined plain. What forces are acting on the block. Indicate all the forces acting on the block. How big is the friction?

$f = 4.9$ N

$F_N = 8.49$ N



Ex 3-3 A 5-kg mass is hanging on a string as shown in the figure. What are the magnitudes of the tensions on two strings, A and B?



$F_A = 25.5$ N
$F_B = 36.0$ N

Newton's 2nd Law of Motion

$$\vec{F} = m\vec{a}$$

The first law says that an unbalanced external force causes change in motion.

Using the second law, you can quantitatively understand how its motion changes.

$$\vec{a} = \frac{\Delta \vec{v}}{\Delta t} = \frac{\vec{v}(t_f) - \vec{v}(t_i)}{t_f - t_i}$$

Once you know acceleration, game over!

Ex 3-4 Consider the following trajectory of an object. The velocity Of the object at the given points P and Q are represented by two vectors. Which of the following vectors represent the direction of the average acceleration between two points?

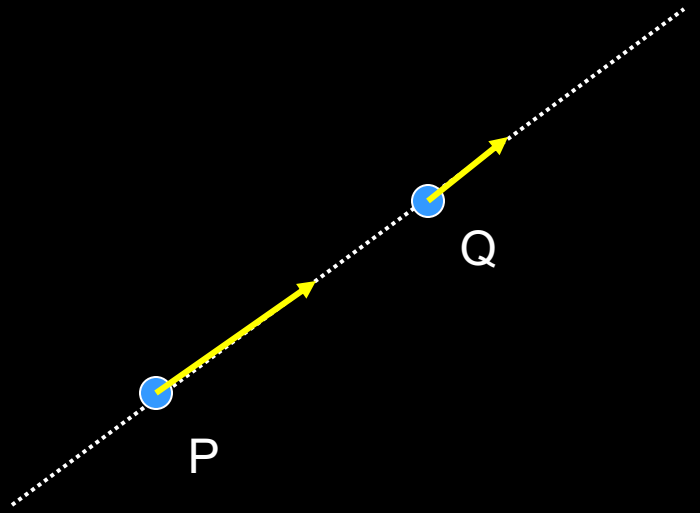
(1) 

(2)

(3)

(4) 

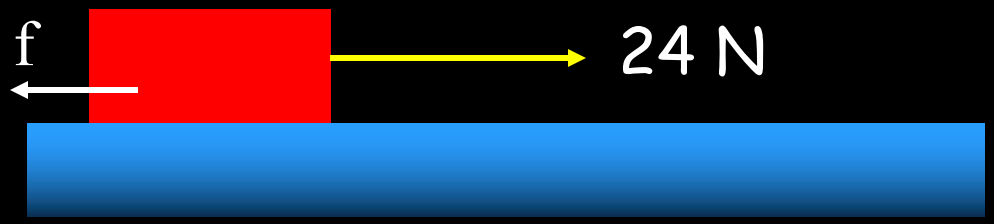
(5) need to know time



Ex 3-5 A 9-kg block is pulled with a 24 N force as shown in the figure. Katie found the block moving with an acceleration of 2.0 m/s^2. From this observation, can you tell if there is friction between the block and the table surface? If there is, what is the magnitude of the friction?

If no friction, $a = 2.67\ m/s^2$.

$a = 2.0\ m/s^2 \rightarrow f = 6$ N (opposite direction)

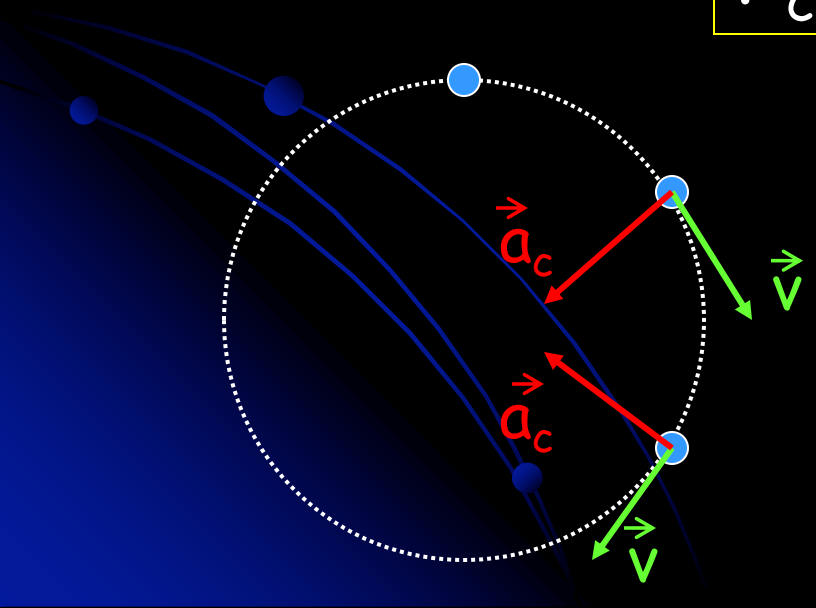


Constant Speed Circular Motion

acceleration (constant magnitude) toward the center of the circle
centripetal acceleration (a_c)

$F = ma_c$: centripetal force

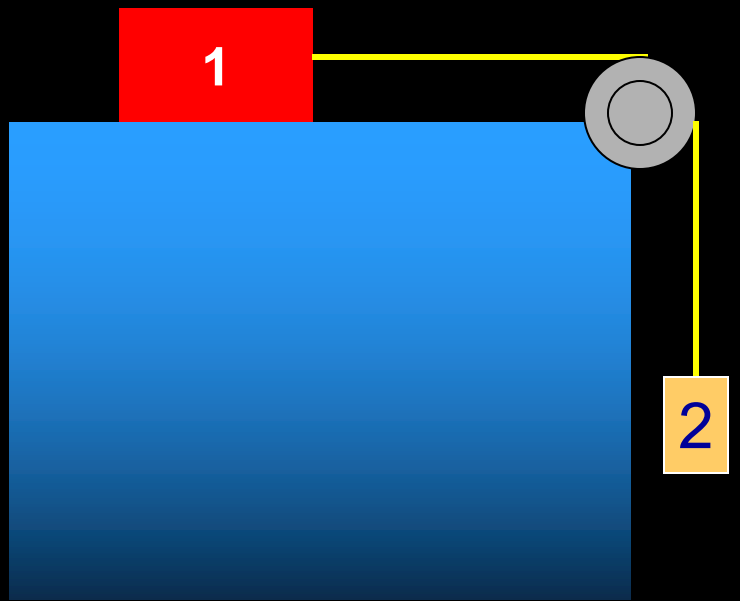
$$a_c = v^2/r$$
$$F_c = mv^2/r$$



Ex 3-6 A 5-kg block (1) rests on a frictionless table top. A cord attached to it is connected to a 1.28 kg mass (2) over a frictionless pulley. The system accelerates at x m/s^2.

Both mass 1 and 2 accelerate at the same rate. What external force causes the mass 1 accelerate? What <u>forces</u> cause the mass 2 to accelerate? (1) Write down eq. of motion for 1 and 2 separately. Both 1 and 2 are moving together and should have the same accel.

$x = 2.0\ m/s^2$



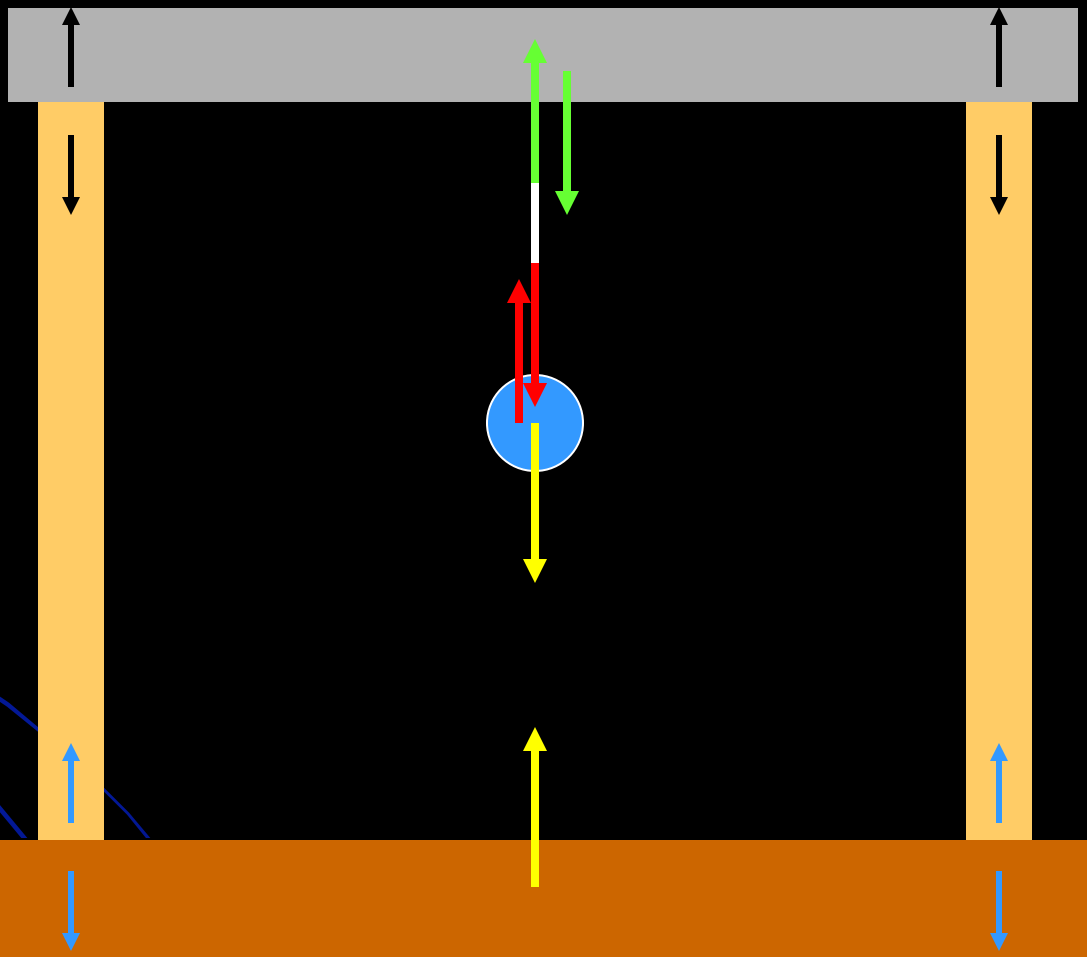
Newton's 3rd Law of Motion

Action and Reaction

Whenever an object exerts a force on a second object, the second object exerts a force on the first one with the same strength but in the opposite direction

Key to understand net external force!

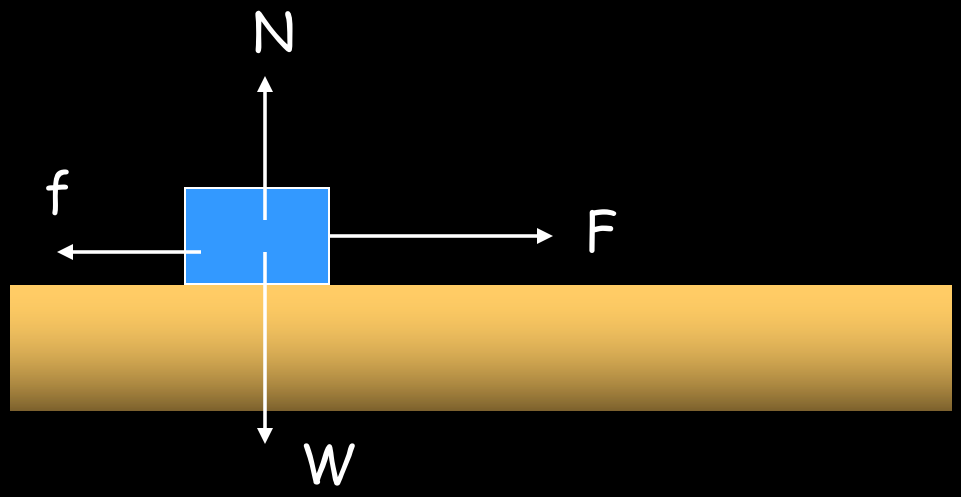
Ball hanging by string from ceiling.
Same color vectors are action-reaction pair.
Pay attention to the acting points of these vectors.



For every action there is an equal and opposite reaction,
but the forces in an action-reaction pair don't act on same mass!

Q1 A person pulls a block on a rough surface at a constant speed by a force F. The arrows in the figure correctly indicate the directions of F, friction (f), normal force (N), and weight (W). Which of the following relations among the force magnitudes must be true?

(1) We have to know the speed of the block.
(2) F > f and N = W
(3) F = f and N > W
(4) F > f and W > N
(5) F = f and W = N



Film: The Mechanical Universe

15. Conservation of Momentum

Remark: ignore the brief discussion of calculus $d \sim \Delta$

Momentum $p=mv$

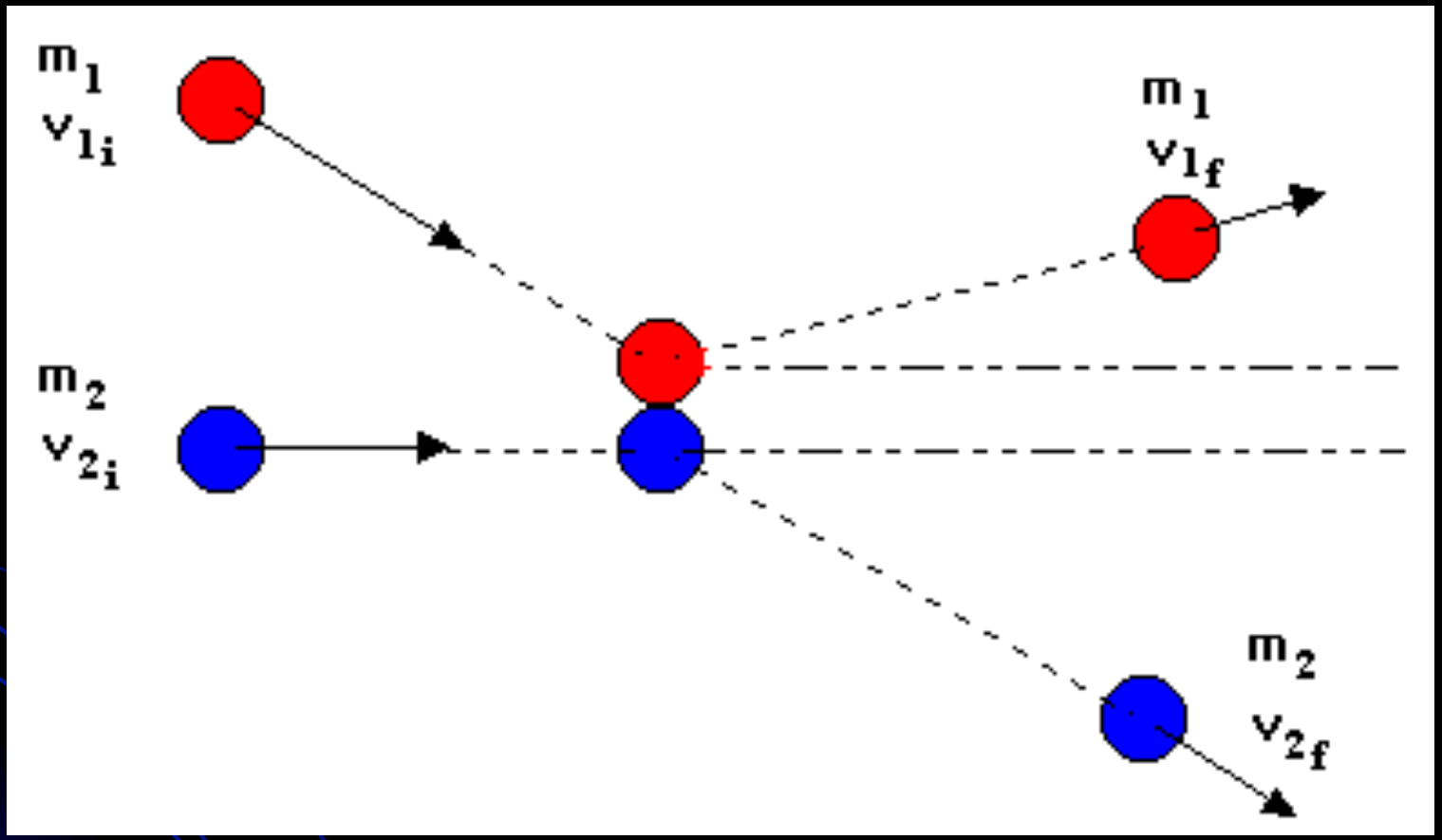
Newton's 2nd law: $F = \Delta p/\Delta t$

An external force causes a change in total momentum

So if there is no external force, total momentum is conserved

NB Films available for free at Caltech youtube site

Momentum conservation



Since no external force acts on the two balls, momentum is conserved:

$$p_{1i} + p_{2i} = p_{1f} + p_{2f}$$