Final Exam: Tuesday, May 13th

Time: 8:30-11:00 am (Arrive by 8:15 am)

Room: 107 KUPF (different from Common Exams)

Bring scientific calculators

Covers everything learned in this semester

Some problems will be from Exam 1, 2, 3.

“Impulse” and “Momentum”

Last class...

Motion of system of particles
(Motion of center of mass)

Today...

More explanation on Motion of system of particles

More examples on Impulse and Momentum
More explanation on the motion of center of mass under gravity force

Newton’s second law for C.O.M.: \( \vec{F}_{\text{net,ext}} = M\vec{a}_{\text{com}} \)

Under gravity,
\[
\vec{F}_{\text{net,ext}} = -m_1 \textbf{g} \textbf{j} - m_2 \textbf{g} \textbf{j} - \ldots \\
= -(m_1 + m_2 + \ldots) \textbf{g} \textbf{j} = -M \textbf{g} \textbf{j}
\]

\[
\therefore -M \textbf{g} \textbf{j} = M\vec{a}_{\text{com}}
\]

\[
\therefore \vec{a}_{\text{com}} = -\textbf{g} \textbf{j} \quad \Rightarrow \text{Usual projectile motion}
\]
Example 1

A rocket is fired vertically upward. At the instant it reaches an altitude of 1000 m and a speed of 300 m/s, it explodes into three fragments having equal mass. One fragment moves upward with a speed of 450 m/s following explosion. The second fragment has a speed of 240 m/s toward east right after explosion. What is the speed of the third fragment right after explosion?

Example 2 (related to HW#13)

Two particles, of masses m and 5m, are moving toward each other along the x-axis with the same initial speeds of 3.61 m/s. Mass m is traveling to the left, and mass 5m is traveling to the right. They undergo a head-on elastic collision, and each rebounds along the same line as it approached. Find the final speed of the heavier particle.
Example 3
A 51.5 kg astronaut is on a space walk away from the shuttle when her tether line breaks. She is able to throw her 7.23 kg oxygen tank away from the shuttle with a speed of 11.4 m/s to propel herself back to the shuttle.

Assuming that she starts from rest (relative to the shuttle), determine the maximum distance she can be from the craft when the line breaks and still return within 62.2 s (the amount of time she can hold her breath). Answer in units of m.

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Example 4

Two objects on a frictionless horizontal surface collide as shown above.

(a) Find the velocity of the 1 kg object.
(b) Is this elastic or inelastic collision?
Example 5
A block of mass $m_1=1.6$ kg, initially moving to the right with a velocity $+4.0$ m/s on a frictionless horizontal track, collides with a massless spring attached to a second block of mass $m_2=2.1$ kg moving to the left with a velocity of $-2.5$ m/s. The spring has a spring constant of 600 N/m.
(a) Determine the velocity of block 2 at the instant when block 1 is moving to the right at $+3.0$ m/s.
(b) Find the compression of the spring.

\[ \vec{v}_{1f} = +3.00 \text{ m/s} \quad \vec{v}_{2f} = \text{?} \text{ m/s} \]

\[ k \]

\[ x \]