Taylor adds up the forces on all bits of a body with N pieces. If all forces are internal, he gets

$$\dot{P} = \sum_{\alpha=1}^{N} \sum_{\beta \neq \alpha} F_{\alpha\beta}$$

If you wrote out all the terms in this double sum, how many would there be?

A) N
B) N^2
C) N(N-1)
D) N!
E) Other/not really sure

1

(Assume below that N-II is an experimental fact)

We just showed that we can then use N-III to *derive* the law of conservation of momentum for systems of particles.

Is the converse true? i.e.:

If the law of conservation of total momentum of a system (of two particles) holds, can you *derive* that it MUST be the case that $\mathbf{F}_{12}=-\mathbf{F}_{21}$?

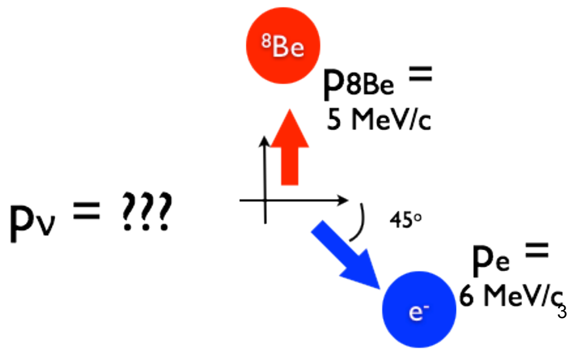
A) Yes
B) No
C) Maybe *one* could, but *I* can't...

2

A ^{8}Li nucleus at rest undergoes β decay transforming it to ^{8}Be, an e^- and an (anti-) neutrino.
The ^{8}Be has $|p|$=5 MeV/c at 90°,
the e^- has $|p|$= 6 MeV/c at 315°, what is $|p_v|$?

$^{8}Li \rightarrow {}^{8}Be + e^- + \overline{\nu}$

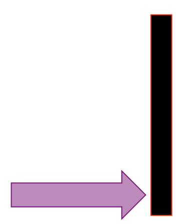
A) (4.2, 4.2)
B) (-5,0)
C) (-5,-1)
D) (-4.2, 0.8)
E) (-4.2, -0.8)
MeV/c



3

If you push horizontally (briefly!) on the *bottom* end of a long, rigid rod of mass m (floating in space), what does the rod initially do?

A) Rotates in place, but the CM doesn't move
B) Accelerates to the right, with a_{CM}<F/m
C) Accelerates to the right, with a_{CM}=F/m
D) Other/not sure/depends...

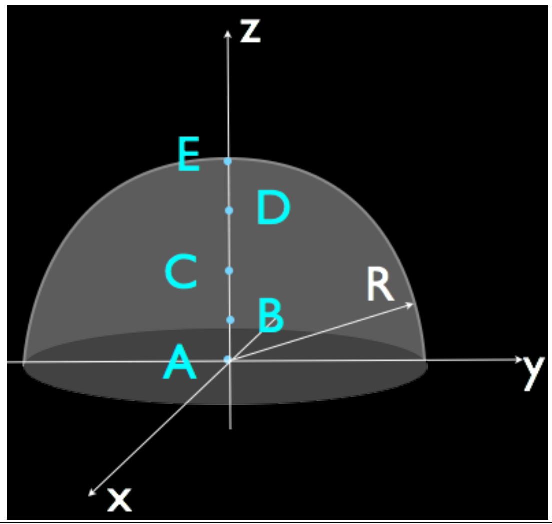


F(external)

4

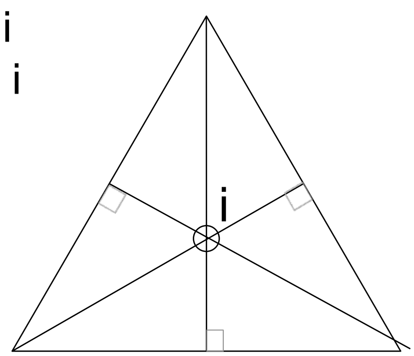
Consider a solid hemisphere of uniform density with a radius R.
Where is the center of mass?

A) $z=0$
B) $0<z<R/2$
C) $x=R/2$
D) $R/2<z<R$
E) $z=R$

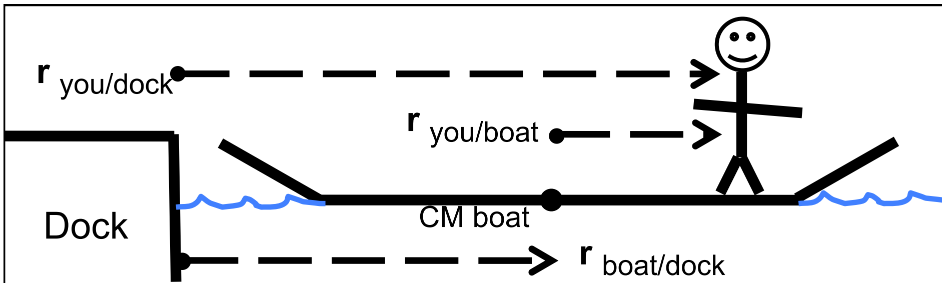


Consider a flat "isosceles triangle".
Where is the CM?

A) Precisely at the point i
B) A little ABOVE point i
C) A little BELOW point i



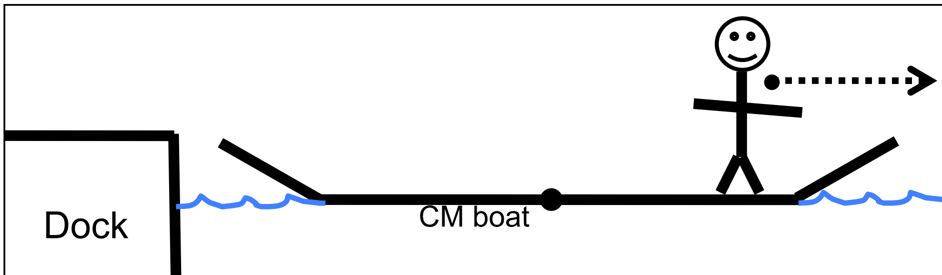
6



You are walking on a flat-bottomed rowboat.
Which formula correctly relates position vectors?
Notation: $\mathbf{r}_{a/b}$ is "position of a with respect to b."

A) $\mathbf{r}_{you/dock} = \mathbf{r}_{you/boat} + \mathbf{r}_{boat/dock}$
B) $\mathbf{r}_{you/dock} = \mathbf{r}_{you/boat} - \mathbf{r}_{boat/dock}$
C) $\mathbf{r}_{you/dock} = -\mathbf{r}_{you/boat} + \mathbf{r}_{boat/dock}$
D) $\mathbf{r}_{you/dock} = -\mathbf{r}_{you/boat} - \mathbf{r}_{boat/dock}$
E) Other/not sure

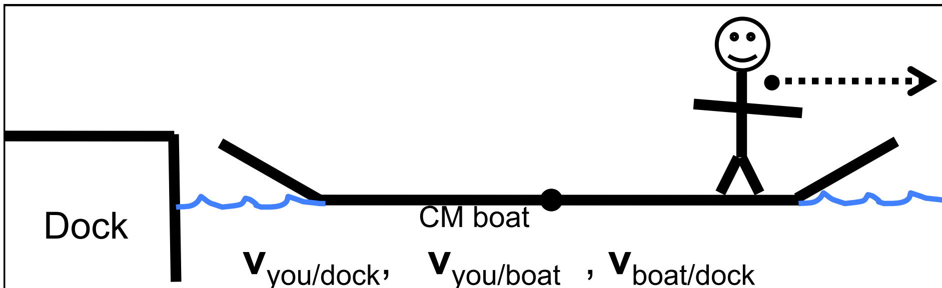
7



You are walking on a flat-bottomed rowboat.
Which formula correctly relates velocities?
Notation: $\mathbf{v}_{a/b}$ is "velocity of a with respect to b."

A) $\mathbf{v}_{you/dock} = \mathbf{v}_{you/boat} + \mathbf{v}_{boat/dock}$
B) $\mathbf{v}_{you/dock} = \mathbf{v}_{you/boat} - \mathbf{v}_{boat/dock}$
C) $\mathbf{v}_{you/dock} = -\mathbf{v}_{you/boat} + \mathbf{v}_{boat/dock}$
D) $\mathbf{v}_{you/dock} = -\mathbf{v}_{you/boat} - \mathbf{v}_{boat/dock}$
E) Other/not sure

8

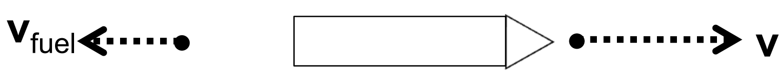


If you are walking in the boat at what feels to you to be your normal walking pace, $\mathbf{v_0}$, WHICH of the above symbols equals $\mathbf{v_0}$?

A) $\mathbf{v}_{you/dock}$ B) $\mathbf{v}_{you/boat}$ C) $\mathbf{v}_{boat/dock}$

D) NONE of these...

9



A rocket travels with velocity $\mathbf{v}$ with respect to an (inertial) NASA observer. It ejects fuel at velocity $\mathbf{v}_{exh}$ *in its own reference frame.*

Which formula correctly expresses the velocity $\mathbf{v}_{fuel}$ of a chunk of ejected fuel with respect to an (inertial) NASA observer?

A) $\mathbf{v}_{fuel} = \mathbf{v}_{exh} + \mathbf{v}$

B) $\mathbf{v}_{fuel} = \mathbf{v}_{exh} - \mathbf{v}$

C) $\mathbf{v}_{fuel} = -\mathbf{v}_{exh} + \mathbf{v}$

D) $\mathbf{v}_{fuel} = -\mathbf{v}_{exh} - \mathbf{v}$

E) Other/not sure??

10