Reading Quiz 4.

1. Impulse is a measure of:

Δmv

a) energy

b) momentum

c) change in energy

d) change in momentum

2. Two masses m_1, m_2 with $m_1 > m_2$ have the same momentum. Which has the greater kinetic energy?

a) Mass m_1

b) Mass m_2

c) Both the same

d) Not enough info. given

[Hint: $p = mv$ so $\frac{1}{2}mv^2 = \frac{p^2}{2m}$]

3. An INELASTIC collision is one in which the following are conserved:

a) kinetic energy

b) momentum

c) relative speed

d) All of the above.

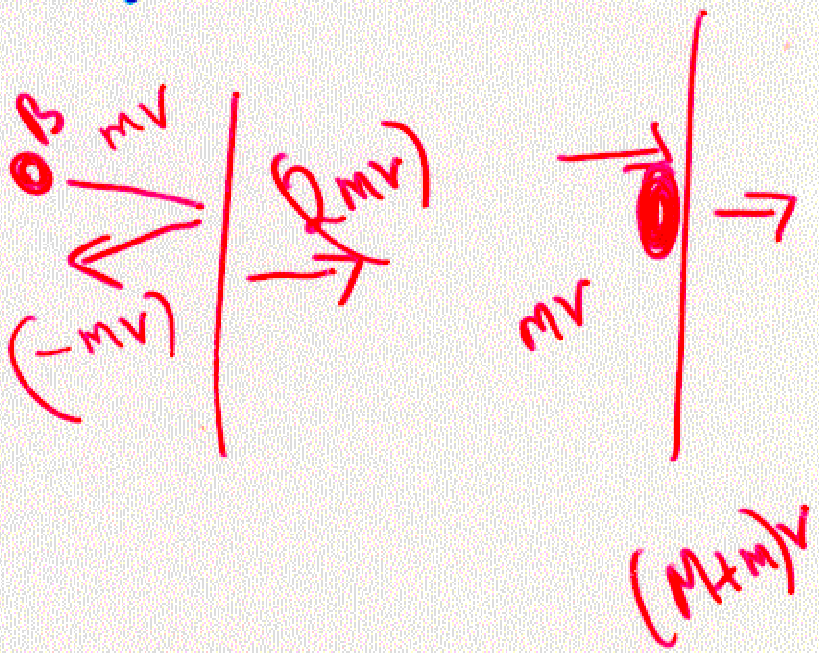
4. A heavy wooden door can be opened by throwing a 0.25kg projectile at it. You can choose a billiard ball or a lump of Playdoh (clay). Which makes the door open faster?

a) billiard ball

b) lump of clay

c) both the same

d) Not enough info.



Momentum and Collisions (Ch 7)

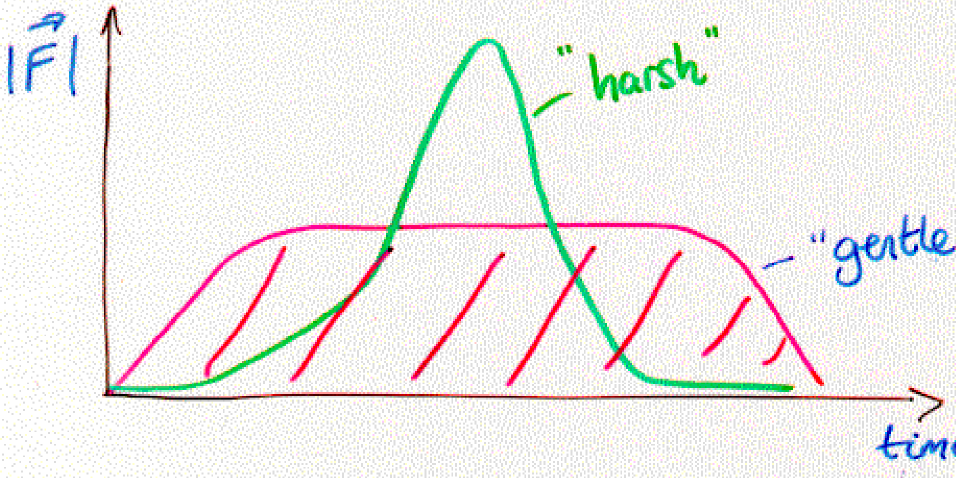
Impulse - change of momentum

From Newton II, $\vec{F} = \frac{d(m\vec{v})}{dt} = \frac{d\vec{p}}{dt}$

So force acting over time changes momentum

i.e. The impulse $\Delta\vec{p} = \int \vec{F}.dt$

e.g. many ways to accelerate golf ball ($m = 0.05kg$) up to $v = 60 m/s$ from rest:



Both cases ⇒ impulse $\int F.dt = \Delta p = 0.05kg \times (60-0)$
$= 3kg\ m/s$

Other examples: catch baseball with hand on table.
For same impulse, if time $\Delta t \downarrow$, $F_{av} \uparrow$ (ouch!)

Newton's 3rd Law and Impulse

e.g. rocket expels gas at rate $\frac{dm}{dt} = 5 kg/s$

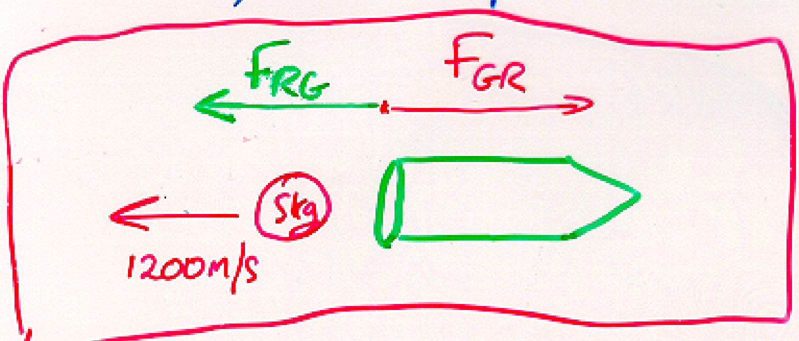
with exhaust speed = 1200 m/s

In time $\Delta t = 1s$, impulse on 5kg of gas

$$F_{av} \Delta t = 5kg \times 1200 \, m/s = 6000 \, kg \, m/s$$

∴ From Newton III, reaction force on rocket $= |F_{av}| = 6000 \, kg \, m/s^2$

$= 6000 \, N.$



∴ In 1s, impulse on rocket = − impulse on gas

$$(\Delta mv)_{rocket} = -(\Delta mv)_{gas}$$

⇒ total momentum change $(\Delta mv)_{rocket} + (\Delta mv)_{gas}$

$= 0.$

Conseration of Linear Momentum

Principle: When no net external fore on system, the momentum $\vec{P}$ of the system is consered (i.e. stays constant, $\Delta\vec{P} = 0$)

$\vec{P} = m_1\vec{v}_1 + m_2\vec{v}_2 + \ldots\ldots$

e.g. Two masses collide

Dwing collision, at any instant $F_{AB} = -F_{BA}$ (Newton III)

and time interal $\Delta t_A = \Delta t_B$

$\therefore$ Impulse on A $= \int F_{BA}\,dt = -$ Impulse on B $\int F_{AB}\,dt$

$\Delta(m_A v_A) \quad = \quad -(\Delta m_B v_B)$

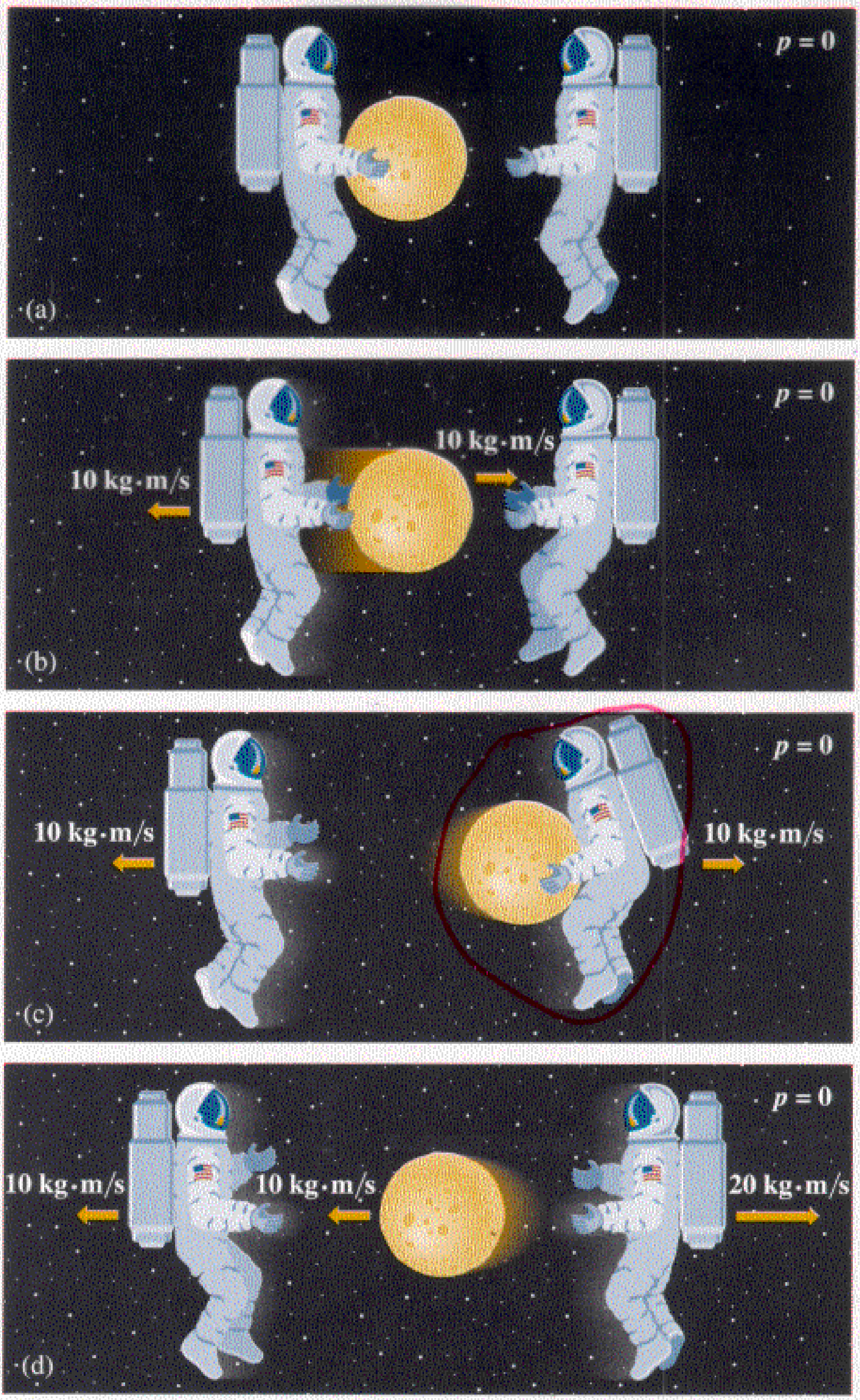
$\Rightarrow \quad \Delta P = \Delta(m_A v_A) + \Delta(m_B v_B) = 0$

Note: Add friction $\Rightarrow$ net external fore on system

$\Rightarrow$ momentum no longer consered.

Figure 7.9

Conservation of linear momentum



Same result as long as $\int F.dt = 10$ kg m/s
– "gentle" or "harsh" throw or catch makes no difference