Week 3 4-2, 5, 7, 16, 52, 54 BONUS 70 (1)

4-2 Ball bouncing off wall. Same speed, bouncing back

a) Yes the momentum vector has changed. (The magnitude remained the same)

b) Yes, a force acted on the ball so as to change the momentum vector (N's 2d law)

c) Yes, a force (by the ball) acted on the wall (N's 3d law)

4-5: No, the body accelerates in the direction of the net force, but the velocity vector is not necessarily in the direction of the acceleration

4-7 Astronaut kicking a ball. Although the ball is weightless, it has a mass. Hence the astronaut exerts a force on the ball and the ball exerts a force back on the foot of the astronaut.

4-16 car hits tree. collision time = 0.14 s, initial speed = $110 \text{ km/h} = 110 \times 10^3 \text{ m}/3600 \text{ s} = \frac{110}{3.6} \text{ m/s} = 30.6 \text{ m/s}$

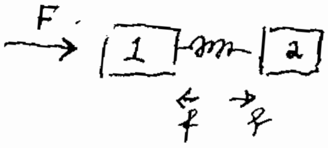
average force on a $m = 60 \text{kg}$ passenger $= \frac{\Delta p}{\Delta t}$

$p_{initial} = m \cdot v_{initial} = 60 \times 30{,}6 = 1{,}83 \times 10^3 \text{ kg m/s}$

$p_{final} = 0$

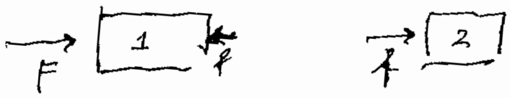
$$\frac{\Delta p}{\Delta t} = \frac{p_{final} - p_{initial}}{\Delta t} = \frac{0 - 1{,}83 \times 10^3}{0.14} = 13.1 \times 10^3 \text{ N} \; !$$

4.52. Two large crates $m_1 = 640\ kg$, $m_2 = 490\ kg$ connected by a spring $k = 8.1 \times 10^3\ N/m$



f = force of spring on either mass

F = external force applied to one of the crates



both masses have the same acceleration (we assume)

$$\therefore \left.\begin{aligned} F - f &= m_1 \cdot a \\ f &= m_2 \cdot a \end{aligned}\right\} \quad F = (m_1 + m_2)\,a \qquad \therefore\ a = \frac{F}{m_1 + m_2}$$

$$f = m_2 a = m_2 \frac{F}{m_1 + m_2} \qquad Eq(1)$$

know f from the compression of the spring

~~known~~ $f = k \cdot (\text{compression}) = 8.1 \times 10^3\ N/m \times \left(\frac{5\ cm}{100\ cm/m}\right)$

$f = 8.1 \times 10^3\ N/m \times \left(5 \times 10^{-2}\ m\right) = 405\ N$

$\therefore$ From $Eq(1)$ $\quad F = \frac{m_1 + m_2}{m_2} \cdot f = \frac{640 + 490}{490} \times 405\ N$

$$\boxed{F = 934\ N}$$

4-54 Rocket of mass m. near earth's surface

a) acceleration downward $= 1.40g$

F_{net} downward $= m \times 1.40g$

weight

F_{net} downward $=$ Rocket thrust $+ mg$

$m \times 1.40g =$ Thrust $+ m \times 1.0g$

Thrust $= m \times (1.4 - 1)g = m \times 0.4g$

b) acceleration upward

F_{net} upward $=$ Thrust $- mg$

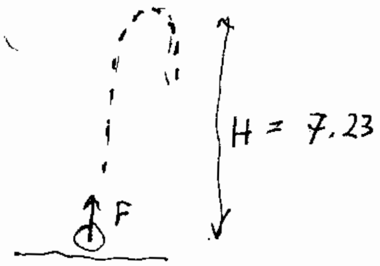
$= m \times 1.40g$

Thrust $= m \times 2.40g$

c) in interstellar space, far from earth

$F_{net} =$ Thrust $= m \times 1.4g$ in direction of a

4-70 Ball thrown upwards. Force (from hand) acts for 0.32 s
Ball rises to max height of 7.23 m (above hand)



F_H = force exerted by hand

$m = 0.20$ kg

net force $= F_{hand} - mg$

accel $= \dfrac{\text{net force}}{m} = \dfrac{F_H - mg}{m} = \dfrac{F_H}{m} - g$

final velocity $= at = \left(\dfrac{F_H}{m} - g\right) \times 0.32\,s = v_{initial}$ of ballistic motion

max height of ballistic motion: $v_f^2 - v_i^2 = -2Hg$

$$0 - \left[\left(\frac{F_H}{m} - g\right) \times 0.32\right]^2 = -2 \times 7.23 \times 9.8$$

$$\therefore \left(\frac{F_H}{m} - g\right) \times 0.32 = (2 \times 7.23 \times 9.8)^{1/2} = (142)^{1/2} = 11.9$$

$$0.32 \ast \frac{F_H}{m} = g \times 0.32 + 11.9 = 15.04$$

$$F_H = \frac{m \times 15.04}{0.32} = \frac{0.20 \times 15.04}{0.32} = \boxed{9.4\,N}$$