Ch4.Q4. If the acceleration is zero, are there no forces acting on it? Explain.

There might be forces acting on an object even if it doesn't accelerate. That $a = 0$ simply implies that the net force is zero.

Ch4.P6. A person has a reasonable chance of surviving an automobile crash if the develeration is no more that $30g$'s. Calculate the force on a 65Kg person accelerating at this rate. What distance is traveled if brought to rest at this rate from 95 km/h?

We have that $a = 30g = 3 \times 9.8\text{m/s}^2 \times 10 = 29.4 \times 10\text{m/s}^2 = 294\text{m/s}^2$.

Since we have that

$$F = ma$$

the unbalanced force a 65 Kg person would feel would be

$$65\text{Kg} \cdot 294\text{m/s}^2 = 19100\text{N}$$

which is a lot. Finally, if we want solve for the distance travelled, we again use our constant acceleration equations, without a time:

$$0 = v_i^2 + 2(-294\text{m/s}^2)\Delta x$$

We have to calculate the initial velocity:

$$\begin{aligned} 95\,\frac{\text{km}}{\text{h}} \times \frac{1\text{h}}{3600\,\text{s}} \times \frac{1000\,\text{m}}{1\text{km}} &= 95\frac{1\text{m}}{3.6\text{s}} \\ &= 26.4. \\ \Rightarrow \Delta x &= \frac{(26.4)^2\text{m}^2/\text{s}^2}{2(294\text{m/s}^2)} \\ &= 1.2\,\text{m}. \end{aligned}$$

Ch4.Q6x. When a golf ball is dropped to the pavement, it bounces back up. (a) Is a force needed to make it bounce back up? (b) If so, what exerts the force?

Ch4.P9x. A 0.140 Kg baseball traveling 35.0m/s strikes the catcher's mitt, which, in bringing the ball to rest, recoiled backward 11.0 cm. What was the average force applied by the ball on the glove.

We have no information about the glove; we only have info on the ball. However, using Newton's Third Law, we can reason about the force on the glove.

We have that

$$\begin{aligned} 0 &= 35^2 + 2a\,(0.11) \\ \Rightarrow a &= -5570\,\text{m/s}^2 \end{aligned}$$

Which corresponds to a force of

$$F = -779\,\text{N}$$

Thus, the force on the glove is 780N.

Ch4.P11x. A 20.0 Kg box rests on a table. (a) What is the weight of the box and the normal force acting on it? (b) A 10.0 Kg box is placed on top of it. Determine the normal force the table exerts on the 20.0Kg box and the normal force the 20.0Kg box exerts on the 10.0 Kg box.

(a)Draw free body diagram, set $ma = 0 = f_n - 20.0\,\mathrm{Kg}g \Rightarrow n = 20.0g = 196\mathrm{N}$.

(b)Draw new free body diagram table, from diagram for each body,

$$\begin{aligned} 20.0\mathrm{Kg}a &= f_{n-\mathrm{table}} - 20.0\,\mathrm{Kg}g - f_{n-\mathrm{box10.0Kg}} \\ 10.0\,\mathrm{Kg}a &= f_{n-\mathrm{box10.0Kg}} - 10.0\,\mathrm{Kg}g. \end{aligned}$$

Since they are still, $a = 0$, so

$$\begin{aligned} f_{n-\mathrm{box10.0Kg}} &= 98\mathrm{N}, \\ \Rightarrow f_{n-\mathrm{tablr}} &= 196\mathrm{N}+98\mathrm{N} \\ &= 294\mathrm{N} \end{aligned}$$

294 N, 20.0Kg box, 98 N.

Ch5. Q13. Does an apple exert a gravitation force on the Earth? If so, how large a force? Consider an apple (a) attached to a tree and (b) falling.

Ch5. P30. At what distance from the Earth will a spacecraft traveling directly fromt eh Earth to the Moon experience zero net force because the Earth and Moon pull in opposite directions with equal force?

We have that at this point

$$\begin{aligned} 0 &= -\frac{GmM_\oplus}{(r)^2} + \frac{GmM_☾}{(R_☾ - r)^2} \\ \Rightarrow \frac{M_\oplus}{r^2} &= \frac{M_☾}{(R_☾ - r)^2} \\ \Rightarrow (R_☾ - r)^2 M_\oplus &= M_☾ r^2 \\ \Rightarrow r^2 - 2R_☾ r + R_☾^2 &= \frac{M_☾}{M_\oplus} r^2 \\ \Rightarrow 0 &= \left(1 - \frac{M_☾}{M_\oplus}\right) r^2 - 2R_☾ r + R_☾^2. \end{aligned}$$

Solve for r. With $R_☾^2 = 3.844 \times 10^8$m, $M_\oplus = 5.972 \times 10^{24}$Kg, $M_☾ = 7.7347 \times 10^{22}$Kg. What follows is a bunch of algebra...I hope you can follow:

$$\begin{aligned} 0 &= (1 - M_☾/M_\oplus) r^2 - 2R_☾ r + R_☾^2 \\ \Rightarrow r &= \frac{2R_☾ \pm \sqrt{4R_☾^2 - 4R_☾^2(1 - M_☾/M_\oplus)}}{2(1 - M_☾/M_\oplus)} \\ &= \frac{2R_☾ \pm \sqrt{4R_☾^2(1 - (1 - M_☾/M_\oplus))}}{2(1 - M_☾/M_\oplus)} \\ &= \frac{2R_☾ \pm 2R_☾\sqrt{(1 - (1 - M_☾/M_\oplus))}}{2(1 - M_☾/M_\oplus)} \\ &= R_☾ \frac{1 \pm \sqrt{1 - 1 + M_☾/M_\oplus}}{1 - M_☾/M_\oplus} \\ &= R_☾ \frac{1 \pm \sqrt{M_☾/M_\oplus}}{1 - M_☾/M_\oplus}. \end{aligned}$$

Using that $M_☾/M_\oplus = 7.7347 \times 10^{22}\mathrm{Kg}/5.972 \times 10^{24}\mathrm{Kg} = 0.012952...$

$$R = 0.8978R_☾, 1.128R_☾.$$

Now, let's envoke some intuition. Obviously, the second number is wrong because it is greater than the distance from here to the moon. Thus, the radius of interest is

$$\begin{aligned} R &= (0.8978)3.844 \times 10^8 \text{m} \\ &\approx 3.45 \times 10^8 \text{m}. \end{aligned}$$

Ch5. Q15x. Would it require less speed to launch a satelite (a) toward the east of (b) toward the west? Consider the Earth's rotation direction and explain your choice.

Earth rotates west to the east, so launching east might be less...

Ch5. P32x. A hypothetical planet has a radius of 2.0 times that of earth but same mass. What is a?

$$\begin{aligned} \frac{GM}{(2r)^2} &= \frac{GM}{4r^2} \\ &= g/4. \end{aligned}$$