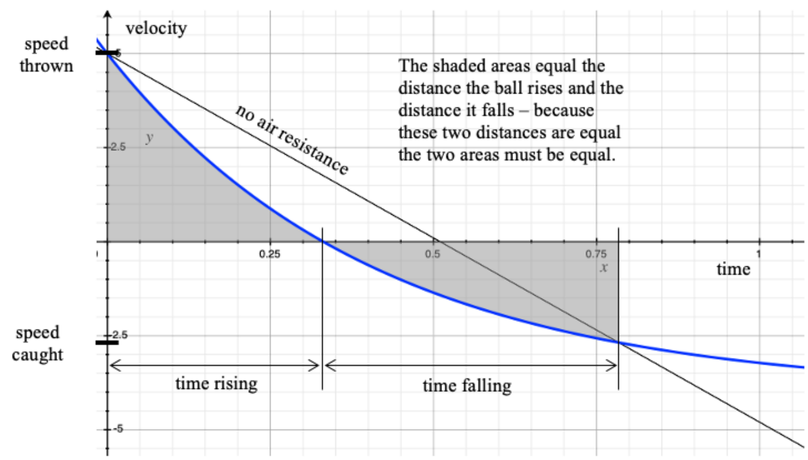
Answers to Selected Homework Problems

1. According to the 2nd Law it requires force to accelerate the bike from rest, but the bike's inertia will carry it forward at constant velocity by the 1st Law.
2. By shaking the jar downward you set the salsa into motion but then stop the jar. The inertia of the salsa will cause it to continue moving downward by 1st Law.
3. The spacecraft continues to move at high speed because there is no force to prevent or change this state of motion as stated in 1st Law
4. a. The head is has tendency to remain at rest in absence of force (1st Law) and the body is forced to accelerated forward relative to the head (2nd Law). The person's head snaps backward relative to their body.
   b. The headrest applies a force to the head to accelerate it along with the rest of the body.
5. Acceleration is proportional to net force, which increases as gravity and air resistance both get less but upward force remains constant. It is also inversely proportional to mass, which decreases as rocket fuel is burned and expelled in the exhaust.
6. 125 kg
7. 3700 N
8. a. 8.2×10^{-5} m/s^2
   b. 4700 m/s
9. a. 6.70 m/s^2, 270.0°
   b. $50\underline{0}$ N, 90.0°
   c. Air resistance is greater by $50\underline{0}$ N.
10. $F = \dfrac{4md}{t^2}$
11. a. It requires less force to lift the rock on the Moon because there is less gravity opposing the lifting.
    b. It requires about the same force to throw the rock because there is no opposing horizontal force, only the rock's mass and acceleration would determine the required force and neither of these factors would be different on the Moon.
12. a. 95.0 kg
    b. 929 N
    c. 95.0 kg
    d. 934 N
    e. A balance would give more consistent results.
13. $25\underline{0}$ kg
14. 53 kN, $9\underline{0}$°
15. 5.0 m/s^2, $9\underline{0}$°
16. 3400 N, $9\underline{0}$°
17. a. $F_{\text{net}} = T - W$
    b. $a = \left(\frac{T}{W} - 1\right) g$, upward
18. 22.0 m/s^2, 33.4°
19. The equal and opposite forces act on two separate things. A 3rd Law pair of forces never act on the *same* object. The force that the cart pulls back on the mule does not affect the cart but the force of the mule on the cart does.
20. a. 6.6×10^{-25} m/s^2
    b. 6.7×10^{-26} m (~ 1/10-billionth the width of a single proton!)
21. a. 173 N, 0.0°
    b. 173 N, 180.0°
    c. 76.6 mm/s^2, 180.0°
22. a. 1.96 N, 90.0°
    b. 22.0 N, 90.0°
    c. 22.0 N, 270.0°
    d. 18.0 N
23. a. 1.2 m/s^2, $9\underline{0}$°
    b. 0.63 m/s^2, $27\underline{0}$°
    c. Most of the time the elevator has a constant speed and does not accelerate. Therefore the two forces balance and net force is zero.
24. a. 2.2 m/s^2, 90.0°
    b. 24.0 N, 90.0°
    c. 24.0 N, 270.0°
    d. As expected by 3rd Law, the force of top box actin on the bottom box is exactly equal and opposite the force of the bottom box acting on the top box. These internal forces do not affect the acceleration of the two-box system. Only the external forces of gravity and the applied force influence the "overall" motion of the two-box system.
25. a. 276 N
    b. 354 N

26. a. 490 N
    b. 150 N
    c. 49 N
    d. 200 N
27. a. 10 N
    b. 0.20
28. 5.3 m/s^2
29. a. 0.599 m/s^2, 0.0°
    b. 0.520 m/s^2, 180.0°
    c. 0.018 m/s^2, 0.0°
30. a. 2.0 m/s^2
    b. 1.5 m/s^2, 0.0°, 2.5 m/s^2, 180.0°
31. a. 0.47 m/s^2
    b. 480 N
32. a. 1360 N, 0.0°
    b. 462 kg
33. Terminal velocity involves a balance between only two forces: gravity and air resistance. The bat is a third force that can cause acceleration beyond terminal velocity.
34. The time falling is greater than time rising and speed thrown is greater than speed caught. Because air resistance works with gravity during the ascent (instead of opposing gravity during the descent) the rate of acceleration is greater on way up than on way down. Graph:



35. a. 8.71 m/s^2, 270°
    b. 30.0 m/s
36. a. 2.2 m/s^2, 0.0°
    b. 340 N, 270°
37. a. 51°
    b. 140 N
38. a. 150 N
    b. 220 N
    c. 170 N, 184 N
39. $T_A = \dfrac{mg}{\sin\theta}, \quad T_B = \dfrac{mg}{\tan\theta}$
40. a. 284 N, 90.0°
    b. 113 N, 0.0°
    c.1.9 m/s^2, 180.0°
41. a. 8.0 m/s^2
    b. 3.2 m/s^2
    c. 3.8 N
42. a. $t = \sqrt{\dfrac{2L}{g(\sin\theta - \mu\cos\theta)}}$
    b. Such an angle would make the expression undefined for real numbers (can't divide by zero or take square root of negative number). The significance is that the object will not slide down the ramp (ever) if the coefficient of friction is great enough and or the angle of incline is small enough.
43. a. 0.176
    b. 0.867 m/s^2
44. 139 km/h
45. a. A force of 18 N pushing upward along the surface is less than the sum of the parallel component of gravity and the maximum static friction (9.8 N + 10.2 N = 20.0 N) and therefore the object would remain at rest.
    b. 0.71 m/s^2, 30.0°
    c. 0.38 N, 210°
46.
47.