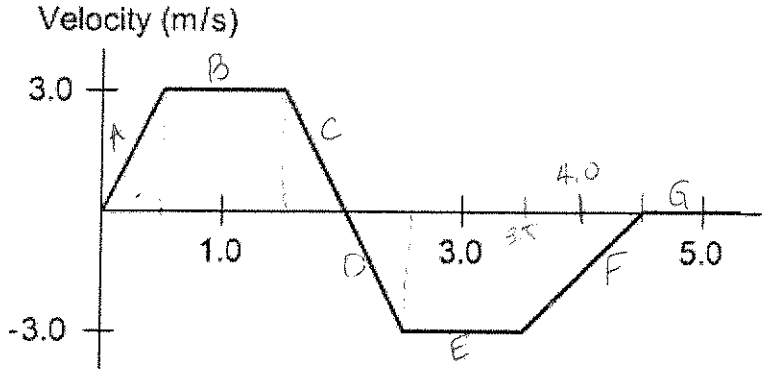
Displacement, velocity, and acceleration graphs

Use the graph below to answer questions #1-5.



accel:

$A = \frac{3.0\ m/s}{.5s} = 6\ m/s^2$

$B = 0\ m/s^2$

$C = \frac{3.0 - -3.0\ m/s}{1.5s - 2.5s}$

$C = D = -6\ m/s^2$

$E = 0\ m/s^2$

$F = \frac{0\ m/s - -3\ m/s}{4.5 - 3.5s}$

$= 3\ m/s^2$

$G = 0\ m/s$

1. Determine the acceleration for each segment of the graph.
2. Determine the displacement for t = 0s to t = 2.0 s.
3. Determine the displacement for t = 2.0 s to t = 3.5 s.
4. Determine the total displacement for the entire graph.
5. Describe the motion of the ball. Use velocities and accelerations in your description!

6. Determine the *average* velocity for t = 0 s to t = 3 s for figure 3-12. Determine the *instantaneous* velocity for t = 2 s.

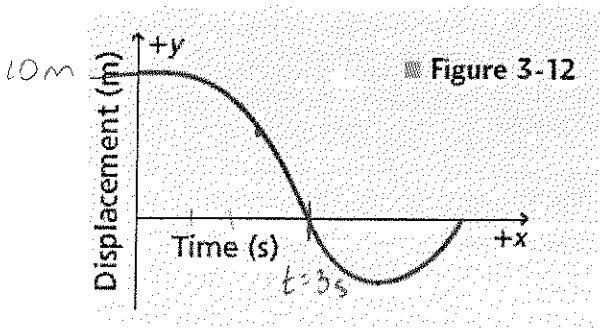
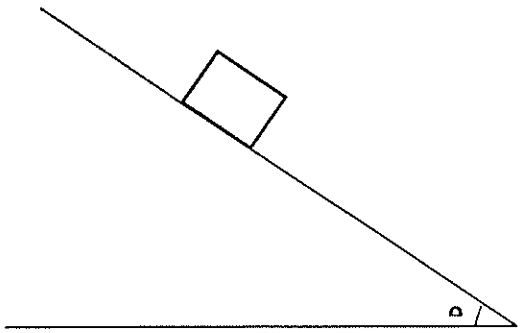


Figure 3-12

Friction

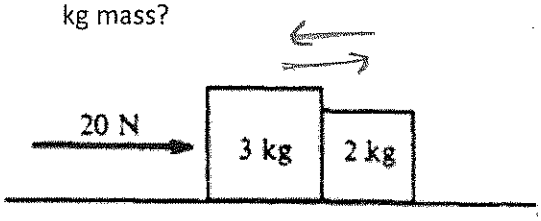
7. A block weighing 300. N is being moved *at constant speed* over a horizontal surface by a force of 50.0 N applied parallel to the surface. Draw a free body diagram for the block. What is the coefficient of kinetic friction? *(0.167)*
8. A 100. N force is applied horizontally to a 50.0 kg crate resting on a level floor. The coefficient of kinetic friction is 0.150. What is the acceleration?
9. A 250.0 kg box is on a 45° angle. If the coefficient of static friction is 0.25, does the box slide down the incline?



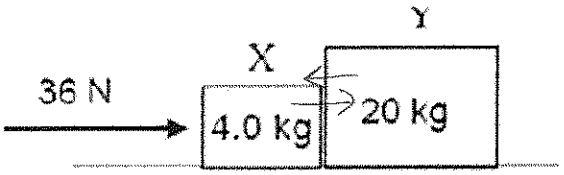
10. For the incline above, what is the acceleration of the box if the coefficient of ~~static~~ kinetic friction is 0.20?
11. A different box is accelerating down an incline at an angle of 24°. The box has a mass of 10.0 kg. The box has an acceleration of 2.5 m/s2 down the incline. What is the coefficient of kinetic friction on the slope?

Newton's third law

12. What is the force of the 3 kg mass on the 2 kg mass? What is the force of the 2 kg mass on the 3 kg mass?



13. What is the force of Y on X?



Force and motion

14. A model rocket is accelerating upward at 105 m/s^2. The thrust force is 2940 N. What is the mass of the rocket? *(25.6 kg)*
15. A hot-air balloon is hovering over a country-fair when a passenger drops a camera. If a camera is 45.0 m above the ground when it is dropped, how long does it take for the camera to reach the ground?
16. A ball is thrown horizontally at 10.0 m/s from the top of a hill 50.0 m high. How far from the base of the cliff would the ball hit the ground?
17. Susan drops a ball, and 4 seconds later the ball has a speed of 40 m/s. What is the ball's acceleration?

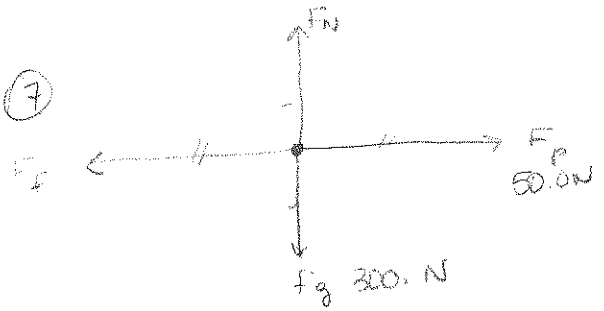
(5) Describe motion.

Ball starts at rest + accelerates at 6 m/s². when v = 3.0 m/s, the ball has traveled .75 m. Ball then maintains constant v, traveling 3.0 m in 1 s. Velocity then decreases at rate of -6 m/s² until ball comes to a halt. Ball then accelerates in ⊖ direction at -6.0 m/s² reaches -3.0 m/s, maintains for 1.0 s slows down (a = 3.0 m/s²) until it comes to a stop.

(6) average velocity: $\frac{10\text{ m} - 0\text{m}}{0\text{ s} - 3\text{ s}}$, $= \frac{10\text{m}}{-3} = -3.1\text{ m/s}$

instantaneous velocity - slope of tangent line at t = 2 s

(7)



$F_N = F_g$

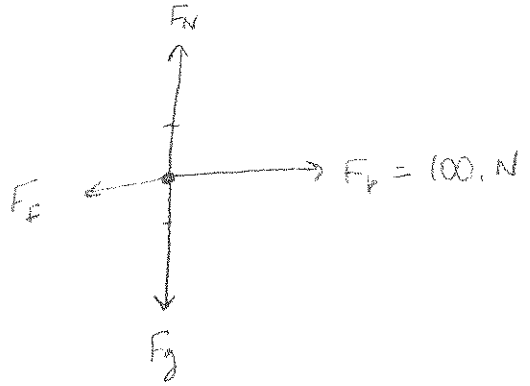
$f_p = F_f$ because a = 0

$\mu_K F_N = F_p$

$\mu_K F_N = F_p$

$\mu_K = \frac{f_p}{F_N} = \frac{50.0\text{ N}}{300.\text{ N}} = \boxed{.167}$

(8)



m = 50.0 kg

μ_K = .150

$F_N = F_g$

$F_N = mg = (50.0\text{ kg})(9.80\text{ m/s}^2)$

$= 490.\text{ N}$

$F_{net} = F_p - F_f$

$ma = F_p - \mu_K F_N$

$a = \frac{F_p - \mu_K F_N}{m} = \frac{100.\text{ N} - (.150)(490.\text{ N})}{50.0\text{ kg}}$

$= \boxed{.530\text{ m/s}^2}$

① Acceleration = slope of v vs t

section A: slope = $\frac{3.0\,m/s - 0\,m/s}{.5\,s - 0\,s} = 6\,m/s^2$

B: slope = $0\,m/s^2$

C + D: slope = $\frac{-3.0\,m/s - 3.0\,m/s}{2.5\,s - 1.5\,s} = -6.0\,m/s^2$

E: slope = $0\,m/s^2$

F: slope = $\frac{0\,m/s - -3.0\,m/s}{4.5\,s - 3.5\,s} = 3.0\,m/s$

G: slope = $0\,m/s^2$

② Displacement = area under v vs t

section A: area = $\frac{1}{2}bh = \frac{1}{2}(.5\,s)(3.0\,m/s) = .75\,m$

section B: area = $b \cdot h = (3.0\,m/s)(1.0\,s) = 3.0\,m$

C: area = $\frac{1}{2}b \cdot h = \frac{1}{2}(.5\,s)(3.0\,m/s) = .75\,m$

D: area = $\frac{1}{2}b \cdot h = \frac{1}{2}(.5\,s)(-3.0\,m/s) = -.75\,m$

E: $b \cdot h = (1.0\,s)(-3.0\,m/s) = -3.0\,m$

F: $\frac{1}{2}b \cdot h = \frac{1}{2}(1.0\,s)(-3.0\,m/s) = -1.5\,m$

G: area = $0\,m$

Displacement $t = 0$ to $t = 2.0\,s$

$A + B + C = .75m + 3.0m + .75m = \boxed{4.50\,m}$

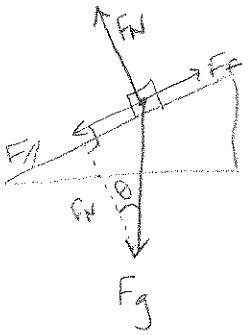
③ Displacement $t = 2.0\,s$ to $t = 3.5\,s$ =

$D + E = -.75m + -3.0m = \boxed{-3.75\,m}$

④ total displacement

$A + B + C + D + E + F + G = \boxed{-.75\,m}$.

(9)



$m = 250.0\ kg$

$\theta = 45°$

$\mu_s = .25$

$F_g = mg = (250.0\ kg)(9.80\ m/s^2)$

$= 2450\ N$

$F_N = mg\cos\theta = (2450N)(\cos 45°)$

$= 1730\ N$

$F_{//} = mg\sin\theta = (2450N)(\sin 45°)$

$= 1730N$

$F_{f,s} = \mu_s F_N = (.25)(1730N)$

$= 433\ N$

box slides because $F_{//} > F_{f,s}$

(10) same diagram as above

$\mu_k = .20$

$F_g = 2450N$

$F_N = 1730N$

$F_{//} = 1730N$

$F_{f,k} = \mu_k F_N = (.20)(1730N)$

$= 346N$

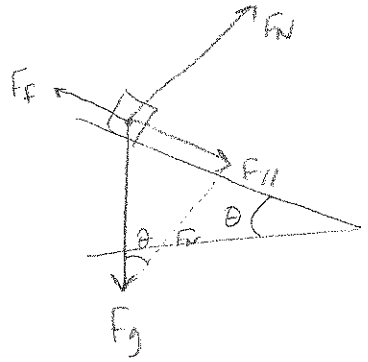
$F_{net} = F_{//} - F_f$

$ma = F_{//} - F_f$

$a = \frac{F_{//} - F_f}{m} = \frac{1730\ N - 346N}{250.0\ kg}$

$= \boxed{5.54\ m/s^2}$

(11)



$\theta = 24°$

$m = 10.0\ kg$

$a = 2.5\ m/s^2$

$\mu_k = ?$

$F_g = mg = (10.0\ kg)(9.80\ m/s^2)$

$= 98.0\ N$

$F_N = mg\cos\theta = (98.0\ N)(\cos 24°)$

$= 89.5\ N$

$F_{//} = mg\sin\theta = (98.0\ N)(\sin 24°)$

$= 39.9\ N$

$F_{net} = ma = (10.0\ kg)(2.5\ m/s^2)$

$= 25.0\ N$

$F_{net} = F_{//} - F_f$

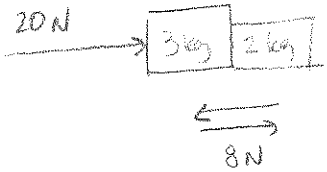
$F_f = F_{//} - F_{net} = 39.9\ N - 25.0\ N$

$= 14.9\ N$

$F_f = \mu_k F_N$

$\mu_k = \frac{F_f}{F_N} = \frac{14.9\ N}{89.5\ N} = \boxed{.17}$

(12)



acceleration of both masses:

$F = ma$

$a = \frac{F}{m} = \frac{20\ N}{(3\ kg + 2\ kg)} = 4\ m/s^2$

acceleration of 2 kg = $4\ m/s^2$

pushed by 3 kg

$F = ma = (2\ kg)(4\ m/s^2)$

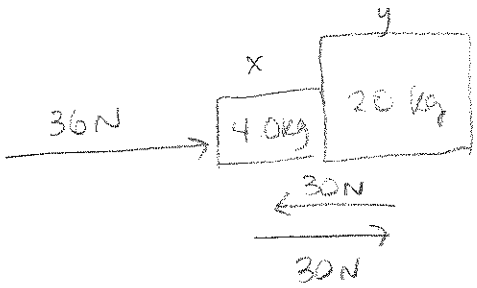
$= 8\ N$

2 kg pushed by $F = 8\ N \rightarrow$

produces equal + opposite force

$\boxed{F = 8\ N \leftarrow}$

(13)



acceleration of both masses:

$$F = ma$$

$$a = \frac{F}{m} = \frac{36\,N}{(20\,kg + 4\,kg)} = 1.5\,m/s^2$$

F from 4 kg causes 20 kg to accelerate

$$F = ma$$
$$= (20\,kg)(1.5\,m/s^2)$$

$$\boxed{F = 30\,N}$$

(14)

$m = ?$

$a = 105\,m/s^2$

$F_{thrust} = 2940\,N$

$$F_{net} = F_{thrust} - F_g$$

$$ma = F_{thrust} - mg$$

$$ma + mg = F_{thrust}$$

$$m(a + g) = F_{thrust}$$

$$m = \frac{F_{thrust}}{a + g}$$

$$= \frac{2940\,N}{105\,m/s^2 + 9.8\,m/s^2}$$

$$\boxed{= 25.6\,kg}$$

(15)

$\Delta y = -45.0\,m$

$a = -9.80\,m/s^2$

$t = ?$

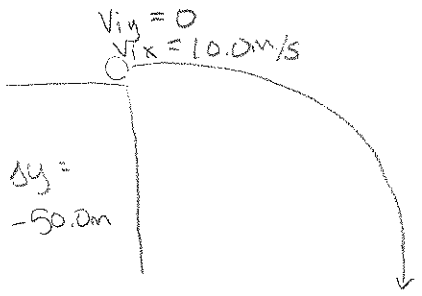
$$\Delta y = v_i t + \tfrac{1}{2} a t^2$$

$$\Delta y = \tfrac{1}{2} a t^2$$

$$t = \sqrt{\frac{2\Delta y}{a}} = \sqrt{\frac{2(-45.0\,m)}{-9.80\,m/s^2}}$$

$$\boxed{= 3.03\,s}$$

(16)



$\Delta y = v_i t + \frac{1}{2} a t^2$

$\Delta y = \frac{1}{2} a t^2$

$t = \sqrt{\frac{2\Delta y}{a}} = \sqrt{\frac{2(-50.0\ m)}{9.80\ m/s^2}}$

$= 3.19\ s$

$\Delta x = v_i t + \frac{1}{2} a t^2$

$\Delta x = v_i t = (10.0\ m/s)(3.19\ s)$

$= \boxed{31.9\ m}$

(17)

$t = 0\ s$
$v = 0\ m/s$

$v_f = v_i + at$

$a = \frac{v_f - v_i}{t} = \frac{40\ m/s - 0\ m/s}{4\ s} = \boxed{10\ m/s^2}$

$t = 4\ s$
$v = 40\ m/s$

$a = ?$