Practice Problems
For Chapter 07

The problems and solutions that follow were designed by students. Although I have checked them, there are very possibly a few errors here and there. If you notice a mistake and turn in a typed correction, you will receive two extra homework points. You may also write new homework problems to add to any chapter and receive between 2 and 5 homework points per problem (see syllabus for details.) Please note: since these problems were written by students, the teacher takes no responsibility for errors – in other words, if there is a mistake and you make the same mistake on a test, you will not get credit for that mistake.

In the problems below, I have highlighted what I feel are the best problems to study prior to tests. The other problems are all ok, but they tend to be very easy problems or repeats of homework problems with slight variations. You may want to start with a few of the regular problems as warm up and then move on to the highlighted problems.

Chapter 7 Questions

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1. What is the velocity of a ball falling through the air that has a mass of 30 kg after 20 seconds? Amish Bhatia '07

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2. One day Sally decided to throw all of her physics papers off of a 200-meter tall building into a fiery pit of doom. Ignore air resistance and friction. (50kg = mass of papers) How long will it take the papers to reach the fiery pit of doom? Find the final velocity of the papers as it enters the pit. Karl Thumm '07

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3. As Karl struts down the street in his Ninja Turtle boxers, he reaches the edge of a swimming pool full of Jell-O. If he jumps straight off the edge and it takes him 3 seconds to reach the surface of the pool, how far above the pool is the street? Annie Matusewicz '07

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4. One day Mr. Laba decided to drop candy off of the walkway in between the two parts of the Cook building. If the distance is approximately 5 meters from the walkway to the ground and the candy has a mass of 1 gram each, at what velocity would the candy hit the ground below? (Assume free fall) John Stevenson '07

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5. After his mud bath, Mr. Laba decides he is in the mood for a dip in his milk pool 10m below his royal patio. After removing his golden robe, revealing his Ninja Turtle swim trunks he dives into the milk pool.

a. What is his speed when he reaches the milky surface?
b. How long did it take him to reach the surface of the pool?

Annie Matusewicz '07

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6. If Moritz can heave a bar of German chocolate 10m straight up, how fast will the bar be going when it hits the ground? Annie Matusewicz '07

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7. One day Steve decided that he was going to drop his car off of the Marriot Hotel's roof (200 ft.). The purpose of this experiment was to check out how long it would take for his car to crash into the concrete ground. Ready with his stopwatch, Steve had his brand new BMW (4000 lb.) all ready to drop. In addition to his car, Steve also wanted to see if a baseball (5/16th lb.) would fall faster than his BMW. Given the objects are dropped from the same height, (200 ft.) which item will reach the ground first? (Ignore air resistance) Karl Thumm '07

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8. Sally drops her purse from her apartment window (she is a very careless person and has no regard or care for anyone who might be standing under her window) if her window is 230 m from the ground?

   a. How long does the purse take to hit the ground?
   b. If Matthew was standing directly under her window and he is 1.9542m tall, how long would the purse take to hit them?

   Karl Thumm ‘07

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9. Vincent was chosen to flip the coin at the beginning of the ESD homecoming football game. If he flips the coin 2 m/s upwards and the coin starts and the height of 1.244m. How long will it take from the time when the coin reaches the peak of the flip to the ground? Karl Thumm ‘07

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10. One day Sarah was awfully curious about what the big deal was in "dropping a penny off the empire state building." So she tried it. The Empire state building is 380m tall. What is the final velocity of the penny? Karl Thumm ‘07

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11. In Labaland, things are pretty crazy. Mr. Laba, supreme deity of the Laba people, can change the force of gravity. One day, he feels especially generous, so he lets money rain on his people. Labaland has no air resistance. A gold coin falls to the earth in 4 seconds from a height of 2,000 meters. It falls on a random duck waddling along the street.

   a. What was the force of gravity at that particular time?
   b. How fast was the coin going when it hit the ground?
   c. Was this a happy day for the duck? Why? Moritz Sudhof ‘07

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12. Mr. Laba and Arnold Schwarzenegger stand on the Leaning Tower of Pisa. Mr. Laba bets Schwarzenegger that if he drops a marble, and then Schwarzenegger drops a hippo a second later, the marble will land before the hippo. Schwarzenegger says, “Ah, what baloney. The hippo weighs more than the marble. A lot more. I will win.” He accepts, and both drop their objects, Mr. Laba first and then Arnold. Why is Mr. Laba so confident he will win? (When Schwarzenegger drops the hippo, he says, “Hasta la vista, baby.”) Moritz Sudhof ‘07

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13. In Labaland, hippopotamuses sometimes randomly fall from the sky (No one knows why. It’s Labaland. It’s a crazy place). The hippo falls from a height of 362 m. When it hits the ground, it comes to a complete stop in 1.2 m, causing pretty sizable indentation in the ground. What was its acceleration as it was stopping? Moritz Sudhof ‘07

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14. If Tom believing that he cannot die then decides to step off a ledge, which is 120m tall, how fast will he be going 10 meters above the cement? Also, if he were able to deploy a parachute, what would his velocity have to change to so that he was going 1 m/s when he finally hit the concrete? Zach Dearing ’08

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15. Lewis and Clark are traveling down a river (refer to one of the practice problems for Chapter 6 for background) with a bear. The bear can only go up to 15 m/s, before it freaks out (and mauls Lewis and Clark). If Lewis and Clark were able to slow the boat to a complete stop right at the beginning of a waterfall, how tall could the waterfall be for the bear to be able to handle it without freaking out? Zach Dearing ’08

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16. One day Mr. Laba is sailing with goats on a boat over the edge of the world. Over the edge of the world there is no air resistance. For how long would they have to fall to reach a velocity where goats combust (goats combust at a velocity of approximately 450 m/sec)? John Wheeler ’08

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17. A goat will not notice a blow to the head by a falling object as long as that object is traveling under 32 m/sec. If Mr. Laba drops a rock from approximately 50 meters above the goat (he is on the mast), would the goat notice and therefore sink the boat (the goat will go crazy and destroy the boat if he notices)? John Wheeler ’08

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18. Mr. Laba jumps off the mast (50 meters above the deck of the ship), and directly below him is a goat. If the goat can teleport instantly, but takes three seconds to notice, will Mr. Laba collide with the goat at the end of his fall? Due to special powers Mr. Laba has no air resistance and freezes the movement of the boat with his mind so that it is still during the entire jump. John Wheeler ’08

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19. Two goats decide to place a wager on who will land last. One goat will fall from the mast (50m) and the other will jump into the air at velocity of 25 m/sec. If Mr. Laba has placed his savings on the first goat, is this a smart financial move? John Wheeler ’08

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20. Mr. Laba, being the good citizen he is, wants to decide if it is worth it to catch Mrs. Oldladies cat after it falls out of a tree. In order to decide he will calculate the speed of the cat when it would reach his arms. The cat’s position in the tree is 25 meters above the ground and Mr. Laba’s arms are 1.6 meters above the ground. He also knows, because he is a physics-of-cats genius, that the cat will first jump straight up with a velocity of 2 m/s before falling. If he is willing to catch any cat falling at less than 10 m/s, will he decide to catch the cat? Colt Power ’08

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21. If a person on the moon (acceleration due to gravity= 1.6 m/s^2) jumps upward with a velocity of 5 m/s, (a) how much longer will he stay off the ground than a person jumping upward with the same velocity on earth? (b) How much longer would he stay in the air than a person jumping upward with the same velocity on Jupiter (acceleration due to gravity= 24.9 m/s^2)? Colt Power '08

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22. The Empire State Building is 381 meters tall. A Klingon on top of the building drops a 2.5 kg bowling ball down towards Mr. Laba who is on the ground below. In order to be strong enough to catch the bowling ball and save an innocent patch of sidewalk from destruction Mr. Laba must do at least 10 pushups before he catches the ball. If it takes him 1 second to do a pushup, will he be able to do enough to muscle himself up to catch the bowling ball? Colt Power '08

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23. If a ball is dropped from a building that is 50m high, how long would it take for ball to reach the ground, and what is the velocity of the ball right before it hits the concrete. Reed Duncan '08

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24. Cindy Lou Who drops a rock off the top of a 2000 m building. If there is no air resistance, how long should it take for the rock to smash into the ground below? If the rock actually falls into a fountain and stops .59 seconds after hitting the water, what is the acceleration of the rock? If instead of a fountain, there was Cindy Lou Who's 5 m tall evil stepmother standing there, what velocity would the rock have when it hit her in her head? What can we assume, then, about how Cindy Lou Who feels about her stepmother? Franci Rooney '08

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25. After a busy day catching butterflies Moritz decides to take a nap on his window ledge. Above, Roland is playing with his Star Wars action figures. While Han Solo and Chewbacca are having an argument, Roland accidentally knocks Luke Skywalker off the window ledge and screams in horror. If Moritz wakes up just as Luke is falling off the windowsill, how much time does he have to wait before sticking his arm out to catch the doll, assuming it takes him .5 seconds to extend his arm and butterfly net out of the window? (The distance between the bottom of Roland's window and the bottom of Moritz's window is 5m.) b. How fast is Luke going when he reaches the rim of Moritz's butterfly net? (assuming the rim of the net is even with the bottom of the window)

Annie Matusewicz '07

Here continues the voyage of the star ship Nickellogan

26. Now that we have off loaded the spice and received a generous bounty of 5,000,000 credits, it looks like we will be able to buy a new gravity drive! The gravity drive allows us to create a miniature black hole that influences the movements of other ships—a technique that is especially useful in battles. (note: since you are too skilled now to worry about simple navigation tasks I will just tell you how we get to new places) After traveling past the Terratator again—which seemed to have lost some weight since the last time we flew by (good for him)—we arrived in the Mirliss system, which is known for their gravity drives (as a side note the Mirliss system is also known for its Margaritas and male Yishuv dancers). As expected the gravity drive we purchased was instilled efficiently and effectively. Now to test it out. Near Planet Juliet (the sixth planet in the Mirliss system) are two communication satellites with useful radar devices. For your first mission with the gravity drives Captain Steve would like you to retrieve the radar devices. If they are 100 meters away and you want them to enter your cargo bay at 15 m/sec what level should you set the gravity drive to (what acceleration is necessary to achieve these results)?
27. Good job Captain ____(insert your name here)____, you have successfully retrieved the communication satellites! But, now you must calculate what negative acceleration the gravity drive should be set to for the satellites to be brought to a stop in 2 seconds (preventing the satellites from crashing into the back of the cargo bay).
28. Now that you have the satellites the Nickellogan can detect small, blockade runners (ships that often carry the most valuable cargo). And sure enough within minutes of bringing the satellites online they have detected a Sisson blockade runner (owned by the vastly wealthy Sir Thomas Sisson, they often are full of riches). This particular vessel could easily outrun the Nickellogan, so to capture it Captain Steve warps the Nickellogan to a location ahead of the Sisson blockade runner's current course. Unfortunately, when the Nickellogan drops her space anchor and activates her cloaking device, a nearby sun begins pulling away from the precise location she must be at. If the ship's telemetries report that the ship is traveling at a rate of 50 m/sec (assume its initial velocity was zero) after having been in the location for 7.5 seconds what acceleration should the gravity drive be set to so that it will counteract the sun's gravity affecting the ship?
29. Congratulations, the gravity drives have counteracted the sun's gravity and by using the main thrusters we have returned to the location the Sisson blockade runner will be passing through. By using a well timed pulse we will be able to knock out the engines on the enemy ship, but it will still be moving away at 500 m/sec (directly away from us and assume that you start the gravity drive right as the ship is zero meters from the Nickellogan). What is the minimum artificial gravity that is required to bring the ship to a stop before the gravity drives targeting system loses the ship (at 30 km)? And if this

gravity continues how long will it take for the Sisson blockade runner to return to the Nickellogan?

30. It should be mentioned that on the Nickellogan we have artificial gravity that strengthens the muscles of our crew members by being stronger than that of Earth's gravity. If a ball is thrown straight up, reaches a height of 3 meters, and then falls to the ground with a final velocity of 9.4868 m/sec, what is the artificial gravity on the Nickellogan?

The story continues in chapter 14

Logan Nickell (class of 2010)

Chapter 7 Solutions

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1. Vf = vi + at
Vf= 9.8 20
Vf = 196 m/s

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2. $\Delta x = \frac{1}{2}$ a t2
200 = ½ 9.8 t2
t = 4.517sec
Vf2 = Vi2 + 2 aΔx
Vf2 = 0 + 2 (9.8) (200)
Vf2 = 3920
Vf2 = 62.609 m/s

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3. Change in distance = .5*a*t^2
Change in distance = .5*9.8*9
44.1m

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4. Vf2=vi2+at
Vf2=0+2(9.8*5)
Vf=9.899494937m/sec

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5. $v^2 = 2*a*\Delta x$
$v^2 = 2*9.8*10$
$v^2 = 196$
v = 14m/s
   a. $\Delta x = \frac{1}{2} a t^2$
      $10 = 4.9t^2$
      $t^2 = 2.04$
      t = 1.43s

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6. $vf^2 = vi^2 + 2a\Delta x$
$vf^2 = 0 + 2*9.8*10$
$vf^2 = 196$
v = 14m/s

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7. The objects will take the same amount of time to reach the ground, because mass is not a factor during freefall.

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8. A.) 230m = (.5)9.8 t2
230m=4.9t2
t=6.8511 seconds

B.) 230m – 1.9542m = 228.0458m
228.0458 = .5 (9.8) t2
t = 6.822 seconds

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9. 0 = 22 + 2 (-9.8))x
-4 = -19.6)x
.204 m =)x
.204m + 1.244 m = 1.448 m
1.448 = 4.9 t2
t= .54 seconds

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10. 380 = .5 (9.8)t2
380 = 4.9 t2
t= 8.806 sec
Vf = Vi + at
Vf = 0 + 9.8 (8.8)
Vf = 86.24 m/s

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11. A. $\Delta y = V_y t + (1/2)gt^2$
2,000 = (1/2)g(16)
gravity = 250 m/s^2
(or negative)
B. $V_f = V_i + at$
V_f= 250(4)
V_f= 1000 m/s
(or negative)
C. It was not a happy day for the duck. He got hit pretty bad. But Mr. Laba felt pity and resurrected the duck.

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12. Mr. Laba knows that gravity affects all objects at the same rate. Both objects will accelerate at the same rate of 9.8 m/s^2. Therefore, the marble will land a second before the hippo. He can ignore air resistance, because neither object is too light or moving too fast.

13. $V_f^2 = V_i^2 + 2a\Delta y$
$V_f^2 = 0 + 2(9.8)(362)$
$V_f^2 = 7095.2$
$V_f = 84.2$ m/s
$V_f^2 = V_i^2 + 2a\Delta x$
$0 = 7095.2 + 2a(1.2)$
$-7095.2 = .2.4a$
$a = -295.63$ m/s^2
(or positive)

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14. $V_f^2 = V_i^2 + 2a\Delta x$
$V_f^2 = 0^2 + 2(-9.8\text{m/s}^2)(-110\text{m})$
$V_f^2 = 2156\ \text{m}^2/\text{s}^2$
$V_f = \sqrt{}(2156\ \text{m}^2/\text{s}^2)$
$V_f = 46.432$ m/s
$V_f^2 = V_i^2 + 2a\Delta x$
$(1\ \text{m/s})^2 = (46.432\ \text{m/s})^2 + 2(a)(-10\text{m})$
$1\ \text{m}^2/\text{s}^2 - 2156\ \text{m}^2/\text{s}^2 = -20\text{m}(a)$
$a = (-2155\ \text{m}^2/\text{s}^2)/-20\text{m}$
$a = 107.75\ \text{m/s}^2$

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15. $V_f^2 = V_i^2 + 2a\Delta x$
$(15\ \text{m/s})^2 = 0^2 + 2(-9.8\ \text{m/s}^2)\ \Delta x$
$(225\ \text{m}^2/\text{s}^2) / (19.6\ \text{m/s}^2) = \Delta x$
$\Delta x = 11.479$ m

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16. $V_f = V_i + at$
450 m/sec = (9.8 m/sec^2) t
t = 45.92 seconds

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17. $V_f^2 = V_i^2 + 2a\Delta x$
V_f = sqr(2a∆x)
V_f = sqr(2*9.8*50)
V_f = 31.3 m/sec, So therefore the goat would not notice and would not sink the boat

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18. $x = V_i t + (1/2)at^2$
x = (1/2)(9.8m/sec^2)(3sec)^2
x = 44.1 meters, so therefore the goat would indeed notice and would teleport away before Mr. Laba falls on him.

19. $x = V_i t + (1/2)at^2$
$50m = (1/2)(9.8 \text{ m/sec^2})t^2$
t = 3.19 seconds to hit the deck for the first goat
$V_f = V_i + at$ (final velocity will be zero because we will just measure the first half of the jump and then multiply it by 2)
0 = 25 m + (-9.8 m/sec^2)(t)
t = 2.55 seconds
Therefore the first goat will hit the deck after the second one, making the first goat the winner of the wager. This makes Mr. Laba's financial move a decision of either extreme knowledge of physics of a lot of luck. Nice move.

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20. Δx=25-1.6=23.4 meters
V_i=2 m/s because an objects speed on the way up is the same at the same position on the way back down
$V_f^2=V_i^2+2a\,\Delta x$
$V_f^2=(2)^2+2(9.8)(23.4)$
$V_f^2=70.64$
V_f= 8.4 m/s
Yes. Because the speed of the falling cat is less than 10 m/s, Mr. Laba will decide to catch the cat.

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21. Moon:
$V_f=V_i+at$
0=5+(-1.6)t
t= 3.13 seconds on the way up
2t=6.26 seconds- total time off the ground

Earth:
$V_f=V_i+at$
0=5+(-9.8)t
t=.51 seconds on the way up
2t=1.02 seconds- total time off the ground

Jupiter:
$V_f=V_i+at$
0=5+(24.9)t
t= .2 seconds on the way up
2t= .4 seconds- total time off the ground
(a) 6.26-1.02= 5.24 seconds more in the air than the person on earth
6.26-.4= 5.86 seconds more in the air than the person on Jupiter

22. $\Delta x = V_i t + (1/2)at^2$

$381 = 1/2(9.8)t^2$

$77.76 = t^2$

t= 8.82 seconds

No. Since it only takes 8.82 seconds for the bowling ball to fall, Mr. Laba will not be able to save the poor sidewalk from the Klingon destruction.

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23. A. $x = ViT + (1/2)at^2$

$50m = 4.9m/s^2 (t^2)$

$50m/4.9m/s^2 = t^2$

$10.2s^2 = t^2$

3.19s=t

B. Vf=Vi+at

$Vf = 9.8(m/s^2)3.19s$

Vf=31.262m/s

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24. $2000 = ½ * 9.8 * t^2$

t = 20.2

0 = 197.98 + a(.59)

a = -332

$Vf^2 = 0 + 2(9.8)1995$

Vf = 197.74

She doesn't like her. She's a giant! And evil

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25. $\Delta x = ½\ a\ t^2$

$5 = ½*9.8t^2$

$5/4.9 = t^2$

t = 1.01

1.01 - .5 = .51s

.51s

$vf^2 = vi^2 + 2a\Delta x$

$vf^2 = 0 + 2*9.8*5$

$vf^2 = 98$

v = 9.9m/s

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26. $V_f^2 = V_i^2 + 2a\Delta x$

$15^2 = (2*100)a$

a=1.125 m/sec^2

27. Vf=Vi+at

0=15+2a

a= -7.5 m/sec^2

28. Vf=Vi+at

50=0+7.5a

a=6.67 m/sec^2

Therefore, the gravity drive should be set to a negative 6.67 m/sec^2 in order to counteract the sun's pull on the Maidenhead.

29. $V_f^2 = V_i^2 + 2a\Delta x$

$0=500^2+2a(30,000)$

a= -4.167

$\Delta x = Vit + \left(\frac{1}{2}\right)at^2$

$30000=(.5*4.167)t^2$

t=120 seconds

30. $V_f^2 = V_i^2 + 2a\Delta x$

$9.4868^2=0+2a(3)$

a= 15 m/sec^2
