87-88 Error ↓

Chapter 4 MOTION UNDER SOME COMMON FORCES

This chapter begins by identifying the differences between mass and weight. Next, we will investigate how Newton's Law is used to describe the behavior of a falling object.

Once we understand and can predict the behavior of falling objects, we will investigate how objects move near the surface of the earth under the influence of earth's gravity. To describe the motion of a body in space, we often draw a picture of the path of the body. Such a path is called a trajectory. We will investigate the trajectories of some objects in motion and how to draw their trajectories. Much emphasis will be placed on predicting time of flight, range (horizontal distance), vertical distance traveled, as well as the horizontal, vertical, and resultant velocity of the object. Learning to do this is mostly a matter of practice, so pay close attention to the exercises in this guide and to the problems in the chapter.

Having studied uniform circular motion in chapter 3, we will now investigate another kind of periodic motion. By 'periodic' we mean the particle retraces its path after a specific amount of time. The periodic motion is called simple harmonic motion. This is a very important concept in physics, for it is used to help describe both very complicated wave motions and vibrating objects.

Finally we will investigate certain motions from different points of view (from different reference frames). This will be done in part by viewing the classic film 'Frame of Reference" which in the opinion of your instructor is the most outstanding physics film ever produced.

CHAPTER 4 PERFORMANCE OBJECTIVES

Upon the completion of this chapter, you should:

1. Be able to differentiate between mass and weight.

2. Using F=ma, be able to calculate the effect of gravity on an object in free fall.

3. Be able to explain that friction is a force that opposes motion.

4. Be able to calculate the frictional effect of air resistance on falling objects, and sliding objects.

5. Be able to resolve projectile motion into its horizontal and vertical components.

6. Be able to mathematically analyze projectile motion.

7. Be able to use $F = mv^2/R$ and $F = m4\pi^2R/T^2$ in analyzing the movement of an object in a circle.

8. By extending the concept of circular motion, be able to relate simple harmonic motion to the projectile of circular motion.

9. Be able to point out how the coordinate system (frame of reference) affects how one analyzes the dynamics of various motions.

Film Law of Falling Bodies

CHAPTER 4 STUDY GUIDE -1-

Film ~~Acceleration~~ Film ch 5 } Mech Univ }

1. Read: Section 4-1 Weight page 65

   a. The term weight will be used to represent pull of earth on object

   b. Weight is expressed in MKS units of Newton.

   c. The mathematical relationship between weight and mass is $w = mg$.

   d. Do you see that w = mg is a special case of F = ma ?

   e. 'g' (near the surface of the earth) is given a value of 9.8 m/sec^2.

   f. Sometimes the value of 'g' = 32 ft/sec^2 will be used.

   g. What is the mass (in kg) of a person weighing: 110 lbs? 220 lbs?

   h. What is the weight (in N) of a person weighing: 110 lbs? 220 lbs?

   i. Your weight is ______ lbs, your mass is ______ kgs and your weight is ______ N.

   j. Ask instructor for tape segment of an astronaut dropping a hammer on the moon. Using a stopwatch, calculate the acceleration of the falling hammer on the moon. Next, predict the time it would take a hammer to fall the same distance on the earth. Using a hammer and stopwatch determine this time. How did your predicted time compare with the measured time?

   k. On the moon your mass is same kg and your weight is ≈ 1/6 W earth N.

   l. Summary: 1 pound = 4.46 Newton(s) 1 Newton = 0.224 pound(s)

2. Problems: page 65: #1 #2

3. Read: Section 4-2 Free Fall page 65

4. Assume that you are standing on a bathroom scale in an elevator which is at ground level. The reading on the scale is 980 Newtons. Describe the reading on the scale under the following conditions. $m = 100\,kg$

   a. The elevator accelerates (up) at 5 m/sec^2. 1480 N

   b. The elevator moves up at a constant speed. 980 N

   c. The elevator slows to a stop at the top with an acc. of -3 m/sec^2. 680 N

   d. The elevator is stopped at the top. 980 N

   e. The elevator accelerates (going down) at 4 m/sec^2. 580 N

   f. The elevator moves downward at constant speed of 4 m/sec. 980 N

   g. The elevator slows to a stop with an acceleration of 2 m/sec^2. 1180 N

   h. Under what conditions would the scale read zero? ________________

   i. What would be your weight when the scale reads zero? 980 N

i. What would be your weight when the scale reads zero? ________

Trouble - see your instructor. If you still have doubts, take a bathroom scale to an elevator and try it, that is..except for conditions discussed in 'h'.

5. For your reading pleasure - 2 NASA Educational Briefs:

   a. CONDITIONS PRODUCING WEIGHTLESSNESS
   b. MECHANICS OF SATELLITES AND WEIGHTLESSNESS

6. Problems: page 67: #4 #5
   page 83: #24 #25 #26

7. Ask instructor for discussion about the effect of frictional forces.

Coefficient of friction (u) = F_f/F_N where F_N = mg

Coefficients of Friction Table

Starting Friction	Sliding Friction	Surfaces
0.74	0.57	Steel on steel
0.94	0.40	glass on glass
0.50	0.30	wood on wood
	0.40	Rubber on asphalt, dry
	0.20	Rubber on asphalt, wet
	0.005	Rubber on ice
0.04	0.04	Teflon on teflon
	1.5	Racing tires

INVESTIGATION: FRICTION

Your task is to determine what factors affect the force of friction.

Using objects that your instructor provides, measure the length, width and height. Next determine the weight of the objects. Use a spring balance to determine the force required to pull the block at a steady velocity.

Determine what variable(s) you wish to investigate and find out how they affect the force of friction.

8. Solve the following problems.

   a. A block weighs 2000 N. If a horizontal force of 100 N is required to keep it in motion with constant speed on a horizontal surface, what is the coefficient of friction?

   b. Why is it easier to stop on a dry road compared to a wet road?

   c. A box having a mass of 60 kg is dragged across a horizontal floor by means of a rope tied on the front of it. The coefficient of sliding friction between the box and the floor is 0.300. If the angle between the rope and the floor is 30 degrees, what force must be exerted on the rope to move the box at constant speed.

86-87

d. An 600-N girl sets on a sled that weights 60-N. A boy pulls at an angle of 40^o above horizontal in order to keep the girl and sled moving over the level ice at constant velocity. What is the coefficient of friction if the boy pulls with a force of 70-N?

9. Film: FREE FALL & PROJECTILE MOTION (27 min) (Film notes provided.)

10. Read 4-4 Idealized Projectile Motion page 69

Note...The equation $y = -gx^2/2v_o2$ has value as indicated in the text. However we will not use it to solve problems. Instead we will use the kinetic and dynamic equations that we are familiar with. Ask instructor for an explanation.

11. Problems: page 72: #9 #10 #11 #12

$d_h =$ $v_h = 800\frac{m}{s}$ $v_i = 0$ $v_f =$

12. A shell is fired horizontally from a powerful gun located 144 meters above a horizontal plane with a muzzle speed of 800 m/sec.

$a = 9.8\frac{m}{s^2}\downarrow$ $d = 144\,m\downarrow$ $t = ?$

$d = v_i t + \frac{1}{2}at^2$ $t^2 = \frac{2d}{a}$

a. How long does the shell remain in the air? $t = 5.42$ sec

b. What is the range (horizontal distance) of the shell? $d_h = v_h t$ $d = 4336\,m$

c. What is the magnitude of the vertical component of its velocity as it strikes the target? $v_f^2 = v_i^2 + 2ad$ $v_f = 53.1\frac{m}{s}\downarrow$

d. With what velocity does it strike the ground? $\vec{v}_R = \vec{v}_h + \vec{v}_v$ $v_f = 801.8\frac{m}{s}$ Horiz 3.8° Down

e. Summarize your procedure. Share with your instructor.

13. A batted softball leaves the bat at an angle of 30 degrees above the horizontal with an initial velocity of 55 m/sec. Calculate:

a. the horizontal velocity of the batted ball.

b. the vertical velocity of the batted ball.

c. the height that the ball will rise.

d. the time the ball was in the air.

e. how far the ball traveled before hitting the ground.

f. How does this problem differ from the previous one?

14. A batter hits a ball to the 3rd base man who throws to the 2nd base man. The batter is 1/2 second from first base when the throw leaves the hand of the 2nd base man on its way to 1st base. In traveling the 90 feet, the ball will rise and fall 1 foot.

a. Based on the information given, is the batter safe or out?

b. Assuming that your instructor made the throw, you as his agent (getting 10%) would ask what salary from the Indians?

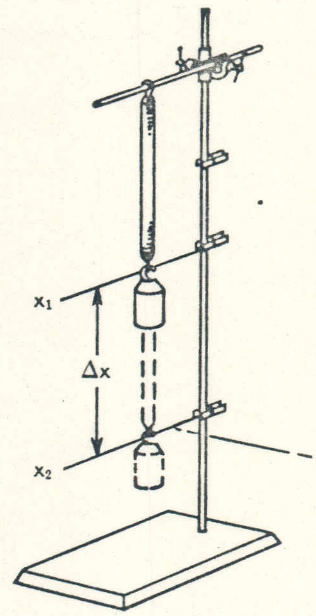
16. Film: PERIODIC MOTION (33 min) (Film notes provided.)

17. Read: Section 4-5 The Force Exerted by a Spring: S.H.M. p-72

18. Complete work sheet titled FREE-FALL AND S.H.M. Then have evaluated.

19. Obtain a spring, support, hooked masses, marker, and a meter stick.

a. Determine the spring constant 'k' for a spring supplied by your instructor. To do so, set up the apparatus as shown and measure the displacement (x) for various masses no greater than 1500 grams. Since it is known that F = kx, graphically determine 'k'. If you think there is a short-cut, try it and compare the two results.



b. Using the spring constant and the information given in the film "Periodic Motion", calculate a predicted value of the period of a 500-gram mass vibrating up and down on your spring.

c. Now place a 500-gram mass on your spring and determine its period. How did the actual value compare with your predicted value?

d. Provide you instructor with data, graph(s) and conclusion.

20. Problems: page 75: #13 #14 #15
page 83: #32

21. Read: Section 4-6 The Simple Pendulum page 75

22. Optional.....Using a pendulum, determine 'g' in this room.

23. Problems: page 77: #17

24. Optional...A uniform meter stick, 100 cm in length is pivoted at one end and allowed to swing free.

a. Predict the period of its swing.

b. Check your predictions.

c. What would be the period if the meter stick was pivoted at the: 90 cm mark? 80 cm mark? 70 cm mark?

d. Check your predictions.

25. Film: FRAMES OF REFERENCE (28 min) (Film notes provided.)

26. Problems: page 83: #33 #34 #35

27. Read: Section 4-7 Experimental Frames of Reference page 77
Section 4-8 Real and Fictitious Forces page 78

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27. Read: Section 4-7 Experimental Frames of Reference page 77
Section 4-8 Real and Fictitious Forces page 78

28. Problems: page 80: #18 #19 #29 #21

29. Read: Section 4-9 Newton's Laws & the Rotation of the Earth page 80
Section 4-10 Newton's Laws & a 'Coasting' Spacecraft page 82

30. Problems: page 81: #22 #23

31. Why is the weight of a 1 kg mass (weight = 9.83 N) at the north pole different from the weight of a 1 kg mass (weight = 9.78 N) at the equator?

32. A Written Exercise is enclosed and awaits your completion.

Thought for the chapter:

28.3495 grams of prevention is worth 0.453 kilograms of cure.

Questions from THE FLYING CIRCUS OF PHYSICAL PHENOMENA by Jearl Walker - CSU

If you are riding a bike around a right-hand turn, you'll be leaning right when in the turn? Why? Also, how did you initiate the turn? What did you do at first to make the bike go into a right hand turn?

Why do hurricanes turn counterclockwise in the northern hemisphere and clockwise in the southern hemisphere? Does the same reasoning apply to the water running out of the bathtub or sink?

How does a boomerang work? For example, must it have that bent banana-like shape? Can you make a left-handed on

Two errors 87-88

ANSWERS Chapter 4

1. (a) the pull (force of the earth on an object) (b) Newton N
   (c) w = mg (e) 9.8 N/kg or 9.8 m/sec^2 (f) 32 ft/sec^2
   (g) using 1-kg = 2.2 lbs, 50 kg, 100 kg
   (h) 490 N, 980 N (j) same as in 'i', weight is 1/6 weight on earth
   (l) 4.46, 0.224

2. (1) 5.00 kg
   (2)(a) 1.1×10^2 N, 6.9×10^2 N (b) 70 kg, 70 kg

4. (a) 1480 N (b) 980 N (c) 680 N (d) 980 N (e) 580 N (f) 980 N
   (g) 1180 N (h) cable cut - elevator undergoing free fall (i) 980 N

6. (4) 7.3 m/sec^2
   (5) (a) 3.2 m/s (b) 10.9 m (c) -7.5 m/s (d) 8.6 m (e) -9.8 m/s^2
   (24) S.A.B.
   (25) $t = h/v_i$
   (26) (a) 1/2 mg (down) (b) 1/2 g (down)

8. (a) 0.05 (b) coefficient friction says .... (c) 203.7 N ok (d) 0.07 0.08

11. (9) examine displacement components
    (10) S.A.B.
    (11) yes
    (12) 3.1 m/sec

12. (a) 5.42 s (b)4336 m (c) -53.13 m/s (d) 801.8 m/s at an angle of horizontal 3.8^o down

13. (a) 47.6 m/s (b) 27.5 m/s (c) 38.6 m (d) 5.6 s (e) 267m

14. (a) You are the umpire.
    (b) No idea! Then - calculate the speed in mi/hr. Does that help?

20. (13) F = -kx for some positive constant 'k'
    (14) points where circle intersects the y-axis
    (15) 0.2 kg
    (32) (a) 20 N (b) 0.016 m

23. (17) (a) $T = \sqrt{2}\, T_{old}$ (b) no effect (c) ~~like projectile motion~~ no noticeable Effect

26. (33)(a) 0.63 m/s (b) 0.74 m/s at 57^o relative to ? (c)(d) S.A.B.
    (34) S.A.B.
    (35)(a) 0.63 m/s perpendicular to A'C' and towards left (b) SAB
    (c) 0.17 N

28. (18) (a) goes straight up and down (b) like projectile motion
    (19)(20)(21) S.A.B.

30. (22) S.A.B.
    (23) no

Questions from THE FLYING CIRCUS OF PHYSICAL PHENOMENA by Jearl Walker-CSU

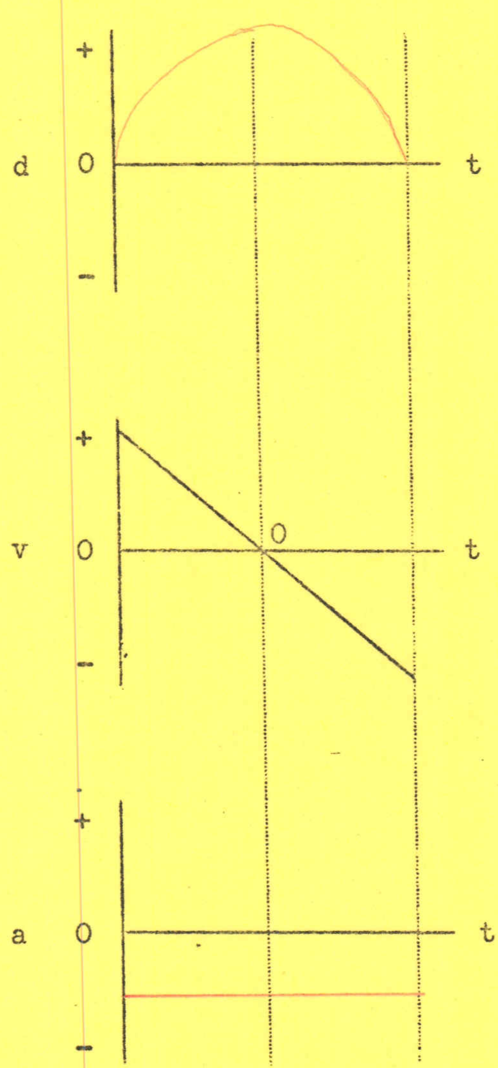
If you must stop your car as quickly as possible, should you lock your brakes? Actually I've heard the answer to this question for years, but I have never done the calculations. Can you?

Free Fall and Sumple Harmonic Motion

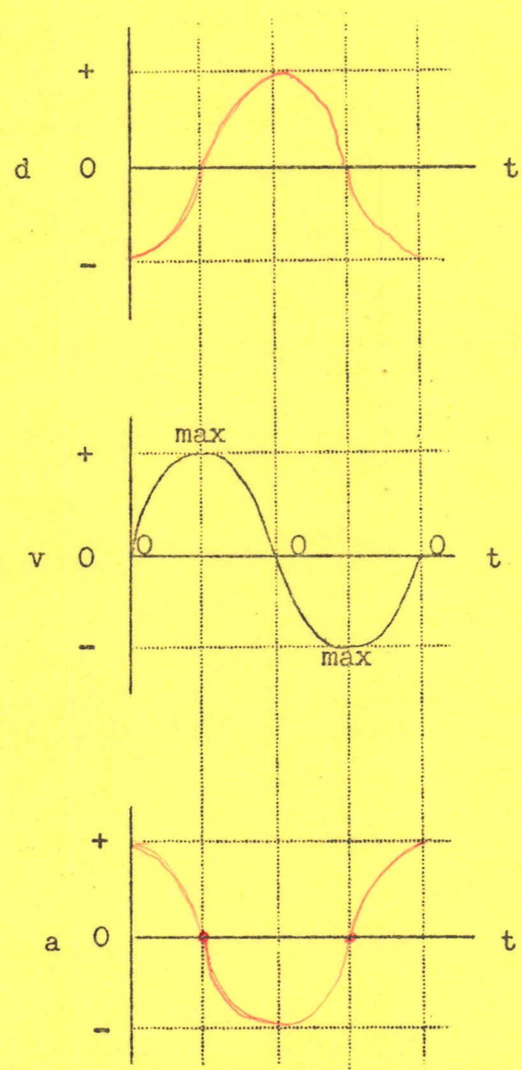
Compare two important and relatively simple motions by constructing displacement-time, velocity-time, and acceleration-time graphs to represent them.

[It will help you to reason out the simple harmonic motion graphs it if you think in terms of a pendulum: remember to be consistent in the meaning you choose to assign to + and −].

a freely falling body – tossed straight up and caught again



simple harmonic motion



What is simple about simple harmonic motion?

FORCES ON A BALL IN FLIGHT

Figure 1, page 41 is a multi-flash photograph of projectile motion. It was made by throwing a small ball into the air at an angle of 27° with the horizontal. The time interval between successive exposures was 1/30 second and the ball moved from left to right in the picture. The ball's trajectory looks like those described in Section 12-4 of the text.

Examine the photograph. Is the horizontal velocity of the ball constant? What can you conclude about the resultant force on the ball if the horizontal velocity is constant? Is not constant?

Our task is to analyze the photograph in detail by finding the changes in velocity caused by the resultant force. In so doing we shall learn more about the forces acting on the ball than we can from a casual examination of the photograph.

[Recall that $\vec{F} = m\vec{a} = m\,\overrightarrow{\Delta v}/\Delta t$. Under what conditions can $\vec{F} \propto \overrightarrow{\Delta v}$ be true?]

Analyze the velocity changes which occur during successive 0.1 second time intervals (three intervals on the photograph) in the following way: Obtain a copy of the photograph from your instructor. First draw straight lines connecting every third point. These lines represent the displacement of the ball during each 0.1 sec and are therefore a measure of the average velocities during these equal time intervals.

Next you are to find the velocity changes between each of these intervals by subtracting each velocity vector from the following velocity vector using the technique shown in Fig. 2a. Note that $\vec{v}_1$ is redrawn as a dashed line so that its tail is connected to the next vector such that subtraction can take place.

Is the direction of the velocity change the same in each interval? Are the magnitudes of the velocity changes the same? What do you conclude about the direction of the resultant force on the ball?

What change in velocity of the ball in each 0.1 sec was caused by the force of gravity? In what direction did it act? To find $\overrightarrow{\Delta v}_g$ we need to know the acceleration of gravity $\vec{a}_g$ and the time interval over which the change is to be calculated. Next, express this velocity change $\overrightarrow{\Delta v}_g$ in meters per tenth of a second. The velocity change due to gravity must also be reduced to the scale of the photograph. (The Scale: 1 to 10) Once the change in velocity due to gravity is determined and then reduced to proper scale, it needs to be subtracted from each of the total velocity changes $\overrightarrow{\Delta v}$ on your diagram. See Fig. 2b.

Do the residual velocity changes $\overrightarrow{\Delta v}_r$ all have the same magnitude? In what direction are they? Describe, qualitatively, the properties of the force that caused them. What do you think was responsible for the force?

What can you conclude about the mass of the projectile?

Plot on your diagram the path the ball in Fig. 1 would have followed if gravity had been the only force acting on it.

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how do you explain the paths followed by the projectile in Fig. 3 and 4?

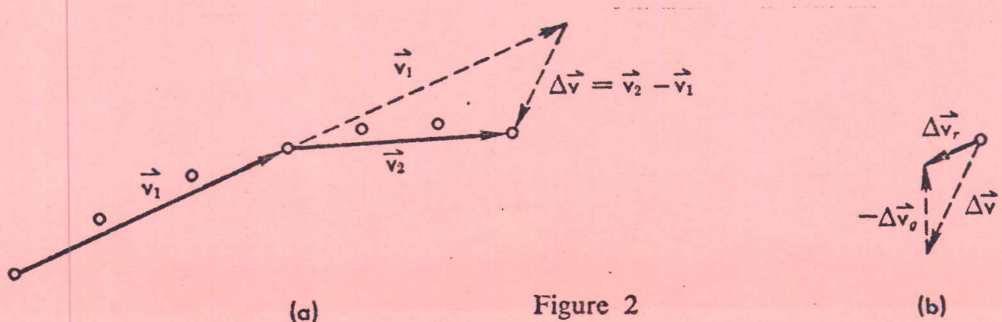
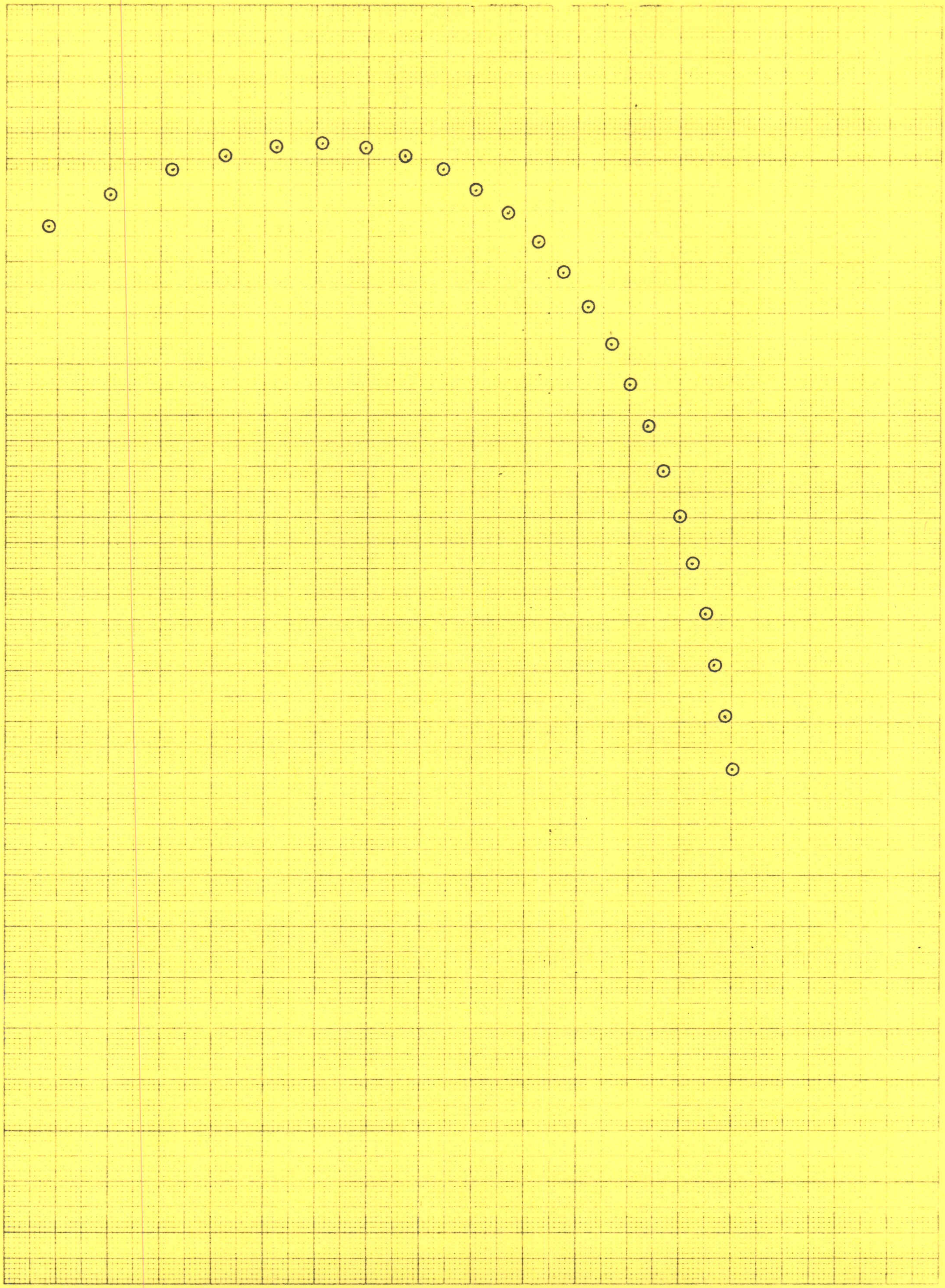


Figure 2

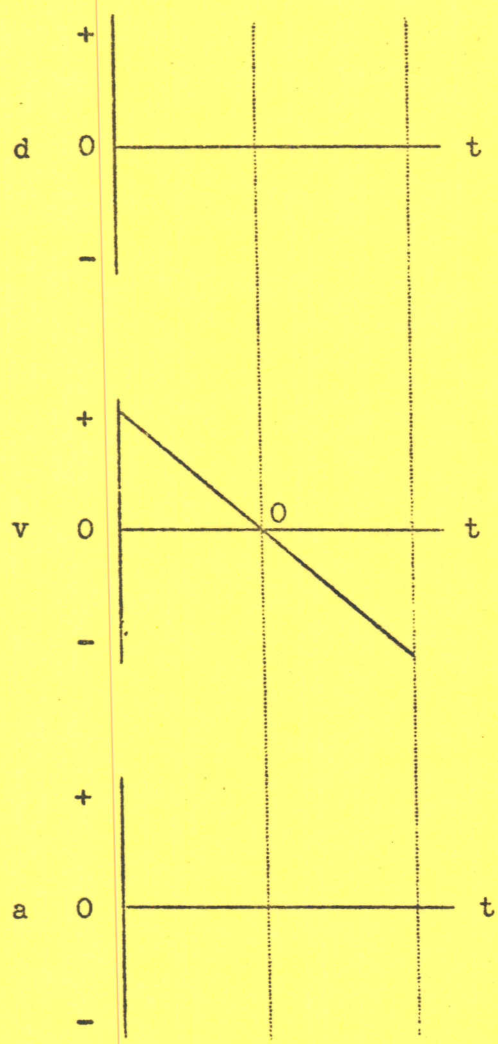


Free Fall and Sumple Harmonic Motion

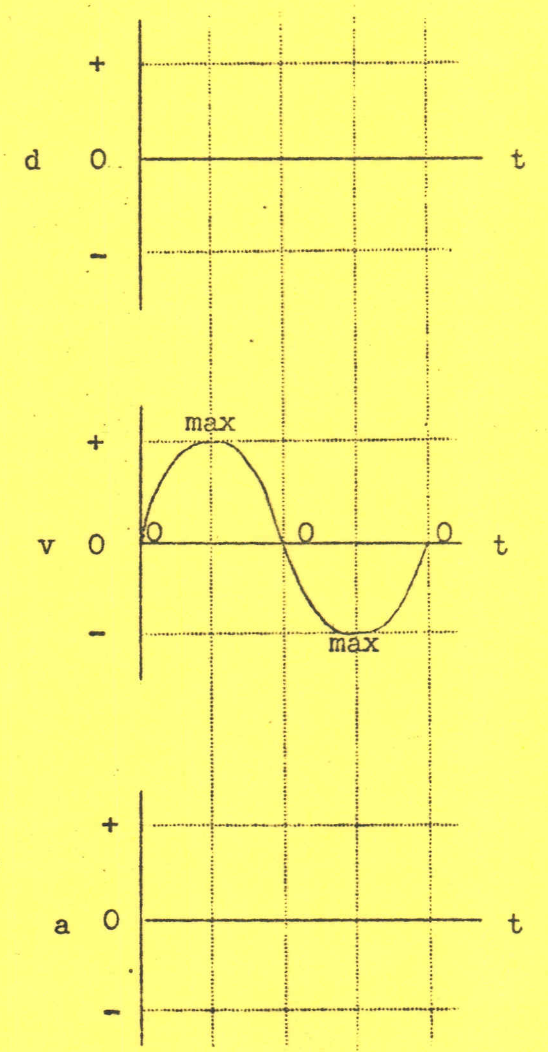
Compare two important and relatively simple motions by constructing displacement-time, velocity-time, and acceleration-time graphs to represent them.

[It will help you to reason out the simple harmonic motion graphs it if you think in terms of a pendulum: remember to be consistent in the meaning you choose to assign to + and –].

a freely falling body – tossed straight up and caught again



simple harmonic motion



What is simple about simple harmonic motion?

1. An upward acceleration of 8.0 m/sec^2 is happening to an elevator. With what force will the elevator floor push upward on a 160-N man?

____

2. A ball is thrown from the top of a building 175 meters high with an initial velocity of 20 m/sec in a horizontal direction. Calculate
a. the time it takes for the ball to reach the earth, and
b. the velocity with which the ball strikes the earth.

a. ____________

b. ____________

3. A football is kicked from the 40 yard line with an initial speed of 64 ft/sec at a projected angle of 45 degrees. A receiver standing on the goal line 60 yards away in the direction of the kick starts running to meet the ball at the instant the ball is kicked.

a. What must be the speed of the receiver if he is to catch the ball just as it is about to hit the ground?
b. Would you be capable of doing it?

a. ____________

b. ____________

4. Calculate the length of a pendulum that has a period of 4 seconds.

____

5. A 3 kg object is swung at 2 revolutions per second at the end of a string which is 3.5 meters long. Calculate:
   a. its linear speed
   b. its tangential acceleration
   c. its centripetal force
   d. the force on the object opposite to the centripetal force.

   a. _______________

   b. _______________

   c. _______________

   d. _______________

6. A 7 kg ball is whirled in a vertical circle at the end of a 1.5 meter string at a speed of 35 m/sec. Find:
   a. the maximum and
   b. the minimum tension on the string.

   a. _______________

   b. _______________

7. An object with a mass of 22 kg stretches a spring 0.55 meters. The same object is then hung on the spring and oscillates up and down. Calculate:
   a. the force constant of the spring, and
   b. the period of the oscillating mass.

   a. _______________

   b. _______________

8. A box that weighs 100 N is being steadily dragged along the floor by a rope that make an angle of 30 degrees above the horizontal. If the tension in the rope is 40 N:
   a. what is the force of friction?
   b. what is the coefficient of friction?

   a. _______________

   b. _______________

~~Chapter~~ Written Exercise 4 TEST

1. An upward acceleration of 8.0 m/sec^2 is happening to an elevator. With what for will the elevator floor push upward on a 160-Nt man?

290.6 NT

$a = 8.0 \frac{M}{sec^2}$

$F_\uparrow = ?$

$W_T = F_g = 160\ NT \downarrow$

$F = ma$

$= \frac{F_g}{g} a$

$= \frac{160\ \cancel{NT}\ sec^2}{9.8\ \cancel{M}} \frac{Kg\ M}{sec^2} \times \frac{8.0\ M}{sec^2} = 130.6\ NT$

$F_{NET\ up} = F_{TO\ ACC} + F_{overcome\ F_g}$

$(130.6 + 160)\ NT$

ok

2. A ball is thrown from the top of a building 175 meters high with an initial velocity of 20 m/sec in the horizontal direction. Calculate (a) the time it takes for the ball to reach the earth, and (b) the velocity with which the ball strikes the earth.

a. 5.98 sec

b. $61.9 \frac{M}{sec}$ Horiz 71.1° down

$d = 175\ M \downarrow$

$V_i = 0$

$V_f =$

$a = 9.8\ M/s^2 \downarrow$

$t = ?$

(a) $d = V_i t + \frac{1}{2} a t^2$

$t^2 = \frac{2d}{a}$

$t = \sqrt{\frac{2 \times 175\ M\ s^2}{9.8\ M}}$

$t = 5.98\ sec$

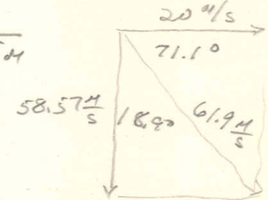
(b) $V_{f_v} = ?$

$V_f^2 = \cancel{V_i}^2 + 2ad$

$V_f = \sqrt{2 \times 9.8 \frac{M}{sec^2} \times 175\ M}$

$V_f = 58.57 \frac{M}{sec}$

ok



3. A football is kicked off from the 40 yd. line with an initial speed of 64 ft/sec at a projection angle of 45°. A receiver standing on the goal line 60 yds. away in the direction of the kick starts running to meet the ball at the instant the ball is kicked.

a. What must be the speed of the receiver if he is to catch the ball before it hits the ground?

b. Would you be capable of doing it?

a. $18.38 \frac{ft}{sec}$

b. most - yes

ok

4. Calculate the length of a pendulum that has a period of 4 seconds.

3.97 m

$T = 2\pi \sqrt{\ell / g}$

$T^2 = 4\pi^2 \frac{\ell}{g}$

$\ell = \frac{T^2 g}{4\pi^2} = \frac{(4\ sec)^2 \times 9.8 \frac{M}{s^2}}{4\pi^2}$

$= 3.97\ M$

ok

5. A 3 kg object is swung at 2 revolutions per second at the end of a string which is 3.5 meters long. Calculate:
   a. its linear speed
   b. its tangential acceleration
   c. its centripetal force
   d. the force on the object opposite to the centripetal force.

a. 44 M/sec
b. 553 M/sec²
c. 1659 N
d. 0

a. $v = ?$
$R = 3.5M$
$T = \frac{1}{f} = 0.5 sec$
$v = \frac{2\pi R}{T}$
$\frac{2 \cdot 3.14 \times 3.5M}{0.5 sec}$
$43.98 \, M/s$

b. $a = \frac{v^2}{R}$
$= \frac{(44 \frac{M}{s})^2}{3.5M}$
$= 553.1 \frac{M}{s^2}$

c. $F = ma$
$= 3kg \times 553 \frac{M}{s}$
$1659 N$

6. A 7 kg ball is whirled in a vertical circle at the end of a 1.5 meter string at a speed of 35 m/sec. Find:
   a. the maximum and
   b. the minimum tension on the string.

a. 5786 N
b. 5648 N

$m = 7kg$
$R = 1.5M$
$v = 35 \frac{M}{s}$

$F = mg = 7kg \times 9.8 \frac{M}{s^2} = 68.6 N$

$F_c = \frac{mv^2}{R} = \frac{7kg \times 35 \times 35 \, M^2}{1.5M \, sec^2}$
$5716.7 = 5717 N$

5717 N − 69 = 5648
5717 + 69 = 5786

7. An object with a mass of 22 kg stretches a spring 0.55 meters. The same object is then hung on the spring and oscillates up and down. Calculate:
   a. the force constant of the spring, and
   b. the period of the oscillating mass.

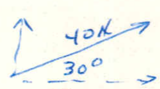
a. 392 Kg/sec²
b. 1.49 sec

$m = 22 kg$
$x = 0.55M$

$K = \frac{F}{x} = \frac{mg}{x} = \frac{22 kg \times 9.8 \frac{M}{s^2}}{0.55 M} =$

$T = 2\pi \sqrt{\frac{m}{K}} = 2\pi \sqrt{\frac{22 kg \, sec^2}{392 \, kg}}$

8. A box that weighs 100 N is being steadily dragged along the floor by a rope that make an angle of 30 degrees above the horizontal. If the tension in the rope is 40 N:
   a. what is the force of friction?
   b. what is the coefficient of friction?



$F_f = \cos 30°$

a. 34.6 N
b. 0.43

$F_f = 40N \cos 30° = 34.6N$
$F_T = 40N \sin 30° = 20$

$W = 100N$
$\theta = 30°$
$F = 40N$

$\mu = \frac{F_f}{F_N} = \frac{34.6N}{100N - 20N}$?
$= \frac{34.6N}{80N}$

HONORS WORKSHEET UNIT 5 Name ________________ mod ______ Cu-4

1. A ball thrown horizontally from the roof of a building with an initial velocity of 40 ft/sec strikes the level street at a distance of 120 ft from the building. What is the height of the building.

$d_v = ?$

2. What is the velocity of the ball in the problem above, just before it strikes the ground?

v_{FINAL}

3. An airplane, flying horizontally at 3600 ft above the ground and at 120 mi/hr, drops a bomb on a target on the ground. How long will it take for the bomb to hit the target?

4. A rifle is aimed horizontally at the bull's-eye of a target 500 m away, and the initial horizontal velocity of the bullet is 1000 m/sec. How far below the bull's-eye will the bullet strike?

5. A stone is thrown horizontally with a speed of 60 ft/sec from the top of a vertical cliff 324 ft. high. How far from the base of the cliff will the stone land?

6. A mortar fires shells with a muzzle velocity of 196 m/sec. If the elevation of the mortar is 30°, find the range of the shell (how far it travels down range from where is was fired.)

. Find the height of the shell at the peak of its trajectory in the problem above.

A. DETERMINE VERTICAL VELOCITY AS FUNCTION OF HEIGHT (d) N/O AIR RESISTANCE

$v_i = 0$ $\qquad V_f^2 = v_i^2 + 2ad$

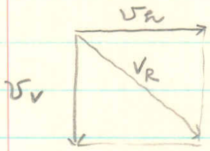
$v_f = ?$ $\qquad v_f^2 = 2ad$

$a = g$

d = variable

~~t~~ =

B. DETERMINE RESULTANT VELOCITY AS FUNCTION OF v_h, VERTICAL DISTANCE FALLEN



$v_R^2 = v_h^2 + v_v^2 \qquad v_v = V_f$

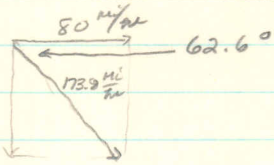
$v_R^2 = v_h^2 + 2ad \qquad \therefore\ v_R = \sqrt{v_h^2 + 2gh}$

C. EXAMPLES : LET $v_h = 80\ \frac{mi}{hr}$ ($117.\bar{3}$ ft/sec) : $g = 32$ ft/sec²

$d = 800\ ft$

$v_V = 226.3\ \frac{ft}{sec} = 154.3\ \frac{mi}{hr}$

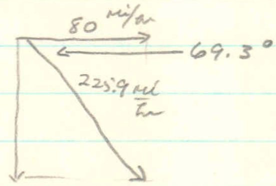
$v_R = 254.9$ ft/sec $= 173.8\ \frac{mi}{hr}$



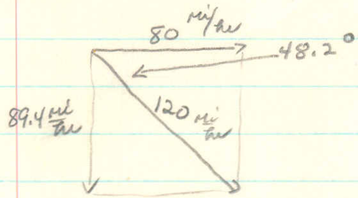
$d = 1500M$

$v_v = 309.83$ ft/sec $= 211.3\ \frac{mi}{hr}$

v_R 331.3 ft/sec = 225.9 mi/hr



D. TERMINAL VELOCITY w/o PARACHUTE $\approx 120\ \frac{mi}{hr} = 176$ ft/sec



MAX $v_V = 89.4\ \frac{mi}{hr} = 131.12$ ft/sec

IF NO AIR RESISTANCE, DISTANCE OF FALL TO ACHIEVE 131.12 ft/sec

$d = ?$ $\qquad V_f^2 = \cancel{V_i^2} + 2ad$ $\qquad d = 268.6\ ft$

$V_i = 0$ $\qquad \frac{v_f^2}{2a} = d$

$V_f = 131.12$ ft/sec

$a = 32$ ft/sec²

$t =$

F_{RETARD} (DUE TO AIR) $= -bv$ (b IS PROPORTIONALITY CONSTANT)

DEPENDS ON SHAPE OF OBJECT

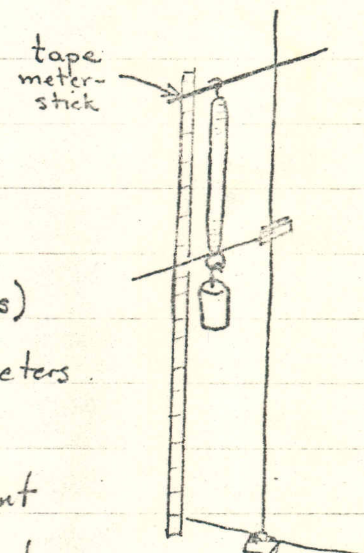
AND ON THE FLUID.

Simple Harmonic Motion

Purpose: 1. To determine the force constant of the spring
2. To predict the period of the simple harmonic motion of the spring with a 1-kg. mass.

Equipment: A spring, a set of standard masses, a meter stick, assorted clamps and poles.

Procedure:
- Set up equipment to measure displacement (x) of spring for 6 masses from 400g to 2000 g.
- Take data. (position, & mass)
- Compute displacement in meters and force in newtons
- Graph force vs displacement
- Compute the spring constant



- Using the spring constant and the information from the film "Periodic Motion", compute (predict) the period (T) for a 1-kg mass.
- Check the calculations with the instructor,

- Actually place a 1-kg mass on the spring, start the motion and time 10 periods.
- Compute the period (T).
- Compare the predicted period to the measured period.

LAB S-___ PERIOD OF A VIBRATING SPRING Name_______________ mod _____

I. PURPOSE: To observe Simple Harmonic Motion (SHM), to isolate the variables affecting the SHM of a spring, and to compare the observed period of a spring in SHM with the calculated period.

II. PROCEDURE: A) Determine the elastic spring constant "K" for each of the springs (reminder: $k = \Delta F / \Delta l$ in nt/m) and record below.

B) Suspend the spring from a support and place a load of 800 g on it. Pull the spring down a small distance so that when released, it vibrates through a small amplitude. Count and record the number of vibrations that occur in 30 seconds. Repeat the procedure with loads of 600 g, 400 g, and 200 g.

C) Change springs and repeat the entire process for the second spring.

D) Turn to the back of the page and complete the table.

III. DATA: Spring #1
Part A Elastic spring constant, k = ________ nt/m

Trial	Load kg	Time sec	Vibrations count
1A			
2A			
3A			
4A			

DATA: Spring #2
Part B Elastic spring constant, k = ________ nt/m

Trial	Load kg	Time sec	Vibrations count
1B			
2B			
3B			
4B			