PHYS 1401
Homework #1 Solutions

1. For each of the following, tell whether nm, μm, mm, m, or km is the most appropriate unit. Explain your answer
a. The distance from Greeley to Denver *km comparable to mi*
b. A sprint in track and field *m sprints range from 100 m to 800 m*
c. The thickness of a piece of paper *mm is probably best. Things on the size of μm need a microscope to be seen*
d. The size of an atom *nm atoms are sub nm in size*
e. The size of a letter on this page *mm A fraction of an inch, mm is probably best*

2. List the fundamental units in the SI system.
kg, m, s, K, A, cd, mole

3. a) Describe the process for converting 15 yd to m. b) Carry out the conversion.
a) *To carry out a conversion convert a conversion factor or factors to 1 and multiply such that the unwanted units are replaced with the desired units*
b) *Using the conversion factors in front of the text*
15 yd (3ft/1 yd) (.3048 m/ 1 ft) = 14 yd

4. a) Explain whether you prefer to change metric prefixes by powers of 10 or conversion factors. b) Explain why. c) Carry out the following conversions i) Convert 25.4 m to km ii) Convert 1.65 km to m iii) Convert 25.4 μm to nm.
a) and b) *Your opinion*. c) i) 25.4 m = 25.4 x 10^{-3} km (using that 1 m = 10^{-3} km)
ii) 1.65 km x 1000 m / km = 1650 m
iii) 25.4 nm (10^{6} μm/10^{9} nm) = 25.4 x 10^{-3} μm

5. a) How many seconds are there in a year? b) Explain your reasoning.
a) and b) *To find the seconds in a year multiply seconds in minute time minutes in hour by hours in day by days in year*
1 y = 60 s/ 1 min x 60 min/ 1 hr x 2h hr/ 1 day x 365 day/ 1 y =

6. a) Make a conversion factor from m/s to mph b) Describe a "rule of thumb" for converting m/s to mph.
a) 1 m/s x 1 km /1000 m x 1 mi/1.602 km x 3600 s/ 1 hr = 2.25 mi/hr. b) A "rule of thumb" would be to take the velocity in m/s and double it to get an approximate value in mi/hr.

7. a) Explain how you have to do unit conversions which include exponents on the units. b) Convert the following i) 25 cm^3 to mm^3 ii) 50 m^2 to yd^2
a) The conversion factors need to be raised to the same power as the exponents on the units being converted. b) i) 25 cm^3 × (10 mm/ 1cm)^3 = 25000 mm^3
ii) 50 m^2 × (3.28 ft/m × 1 yd/3 ft)^2 = 60 yd^2

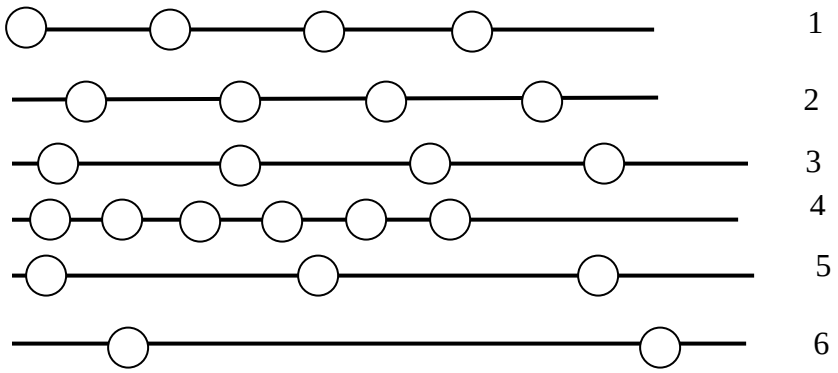
8. The wavelength of the major component of a sodium lamp is 589 nm. Convert this to inches.
589 nm = 589×10^{-9} m × 39.37 in/1m = 2.31×10^{-5} in

9. Write a problem corresponding to the following unit conversion.

$$10\frac{\text{mi}}{\text{hr}}\frac{1\,\text{hr}}{3600\,\text{s}}\frac{5280\,\text{ft}}{1\,\text{mi}}$$

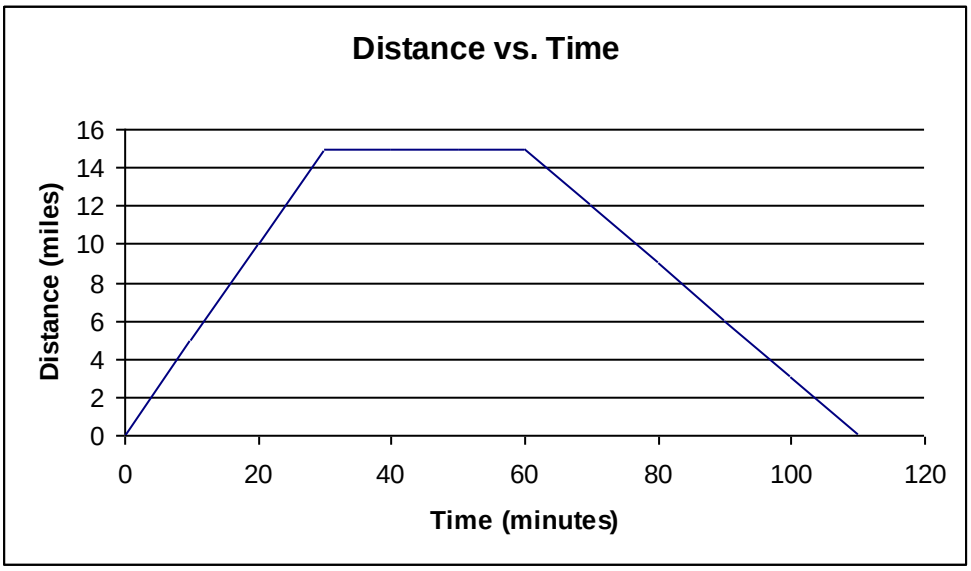
A bicycle rider is traveling at 10 mi/hr. How fast is she traveling in ft/s?

10. a) Rank the motion diagrams shown below from the lowest to the highest speed. If two diagrams have the same speed, give them the same ranking. Assume that in each diagram the dots are evenly spaced. b) Explain your reasoning.



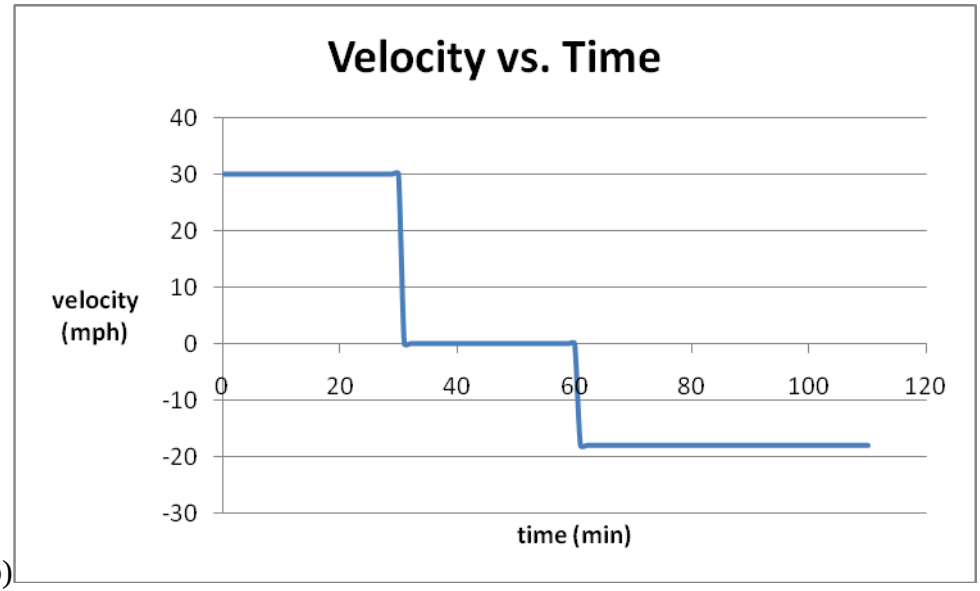
6 is the fastest, 5 is next fastest, 3 is next fastest, the spacing is the same for 1 and 2 so they are at the same speed, and finally 4 is the slowest. b) The larger the displacement in the same time interval, the faster the object is moving. The dots in the motion diagram being further apart indicate that a greater displacement occurred.

11. a) Write a story corresponding to the graph of distance versus time shown below.

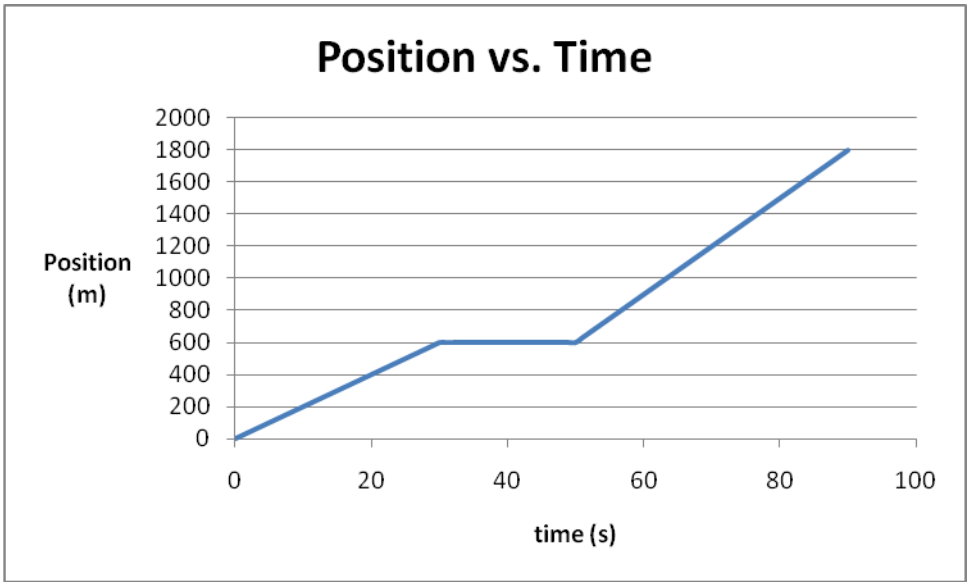


b) Sketch a graph of velocity versus time for the distance versus time graph shown.
c) Sketch a graph of position vs. time for the following situation. A car moves east at a constant speed of 20 m/s for 30s, comes to a stop for 20 s, and then heads east again at 30 m/s for 40 s.
a) A driver starts from home and drives down a city street at an average speed of 30 mph until he gets to a favorite store located 15 miles away. The driver spends 30 minutes at the store and then returns him. Since it is rush hour it takes 50 minutes to get home.

b)



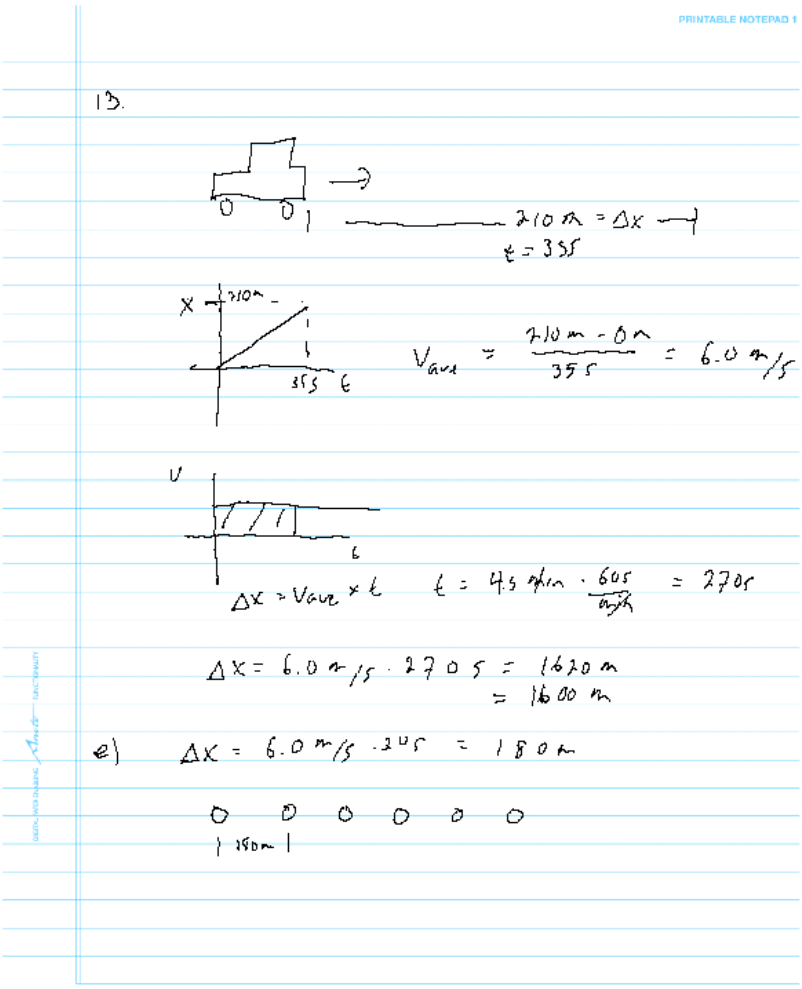
c)



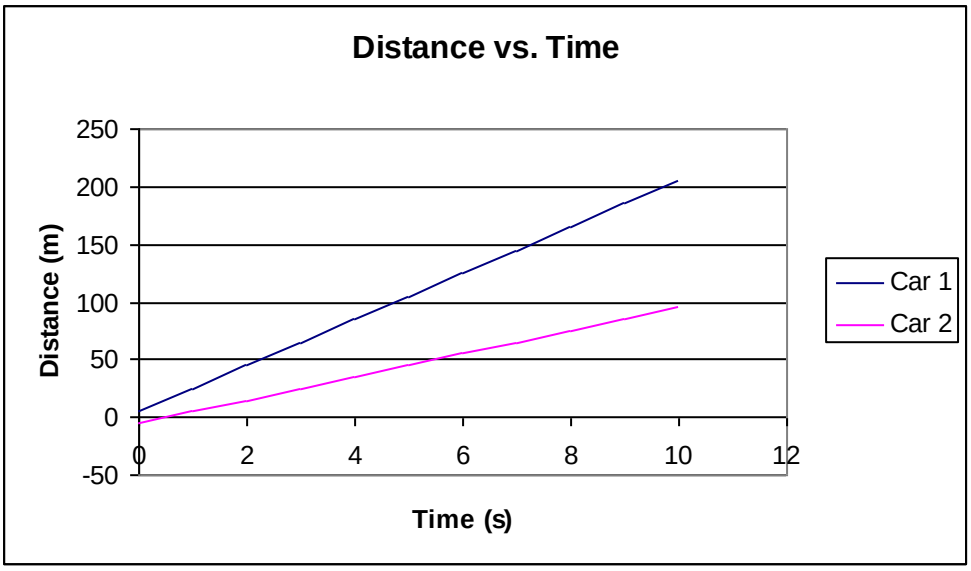
12. Explain how the graph of distance versus time would differ for a car heading east at 30 m/s and a car heading west at 30 m/s.

Depending on your choice of coordinate system, one would have a slope of +30 m/s and the other would have a slope of – 30 m/s.

13. A car travels east and covers a distance of 210 m in a time of 35 s. a) Sketch the situation. b) Find the average velocity for the car. c) Explain how you can use this information to predict how far the car will travel in 4.5 minutes. d) Find the distance traveled by the car in 4.5 minutes. e) Construct a quantitative motion diagram for the car in .5 minute intervals.

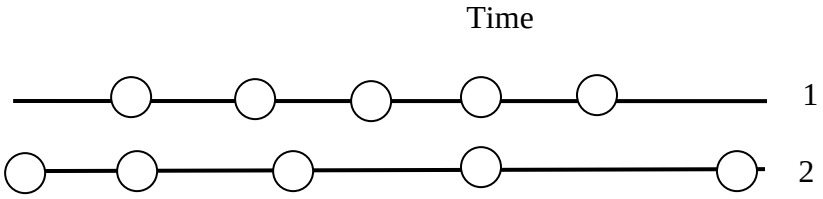


14. Below are shown two graphs of *distance versus time* for cars labeled 1 and 2. a) Your friend states the car 1 has the greater acceleration because the graph is steeper. Explain to your friend why he or she is wrong. b) Find the average velocity of each car. c) Find the average acceleration of each car.



a) Your friend is wrong because they are confusing acceleration and velocity. Car 1 has a greater velocity because the slope of its position vs. time graph is steeper. b) We can find the slope of each line. For car 1 the slope is 20 m/s and for car 2, the slope is 10 m/s, so car 1 is travelling twice as fast as car 2. c) Both cars are travelling at constant velocity, so both cars have an average acceleration of 0 m/s/s.

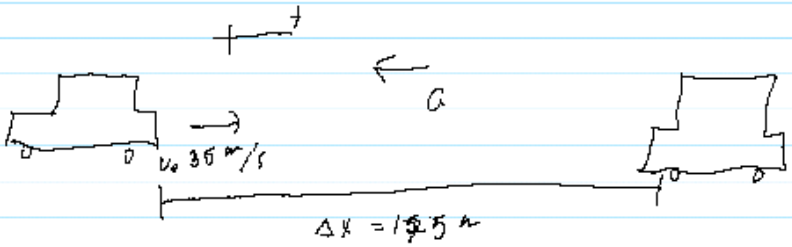
15. Shown below is a motion diagram for two cars traveling in adjacent lanes on a highway. At time 4 the car 2 passes car 1. a) How do the velocities of the cars compare at this time. b) Explain your answer.

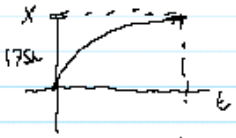


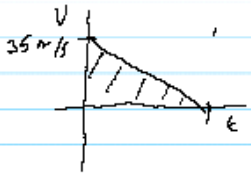
a) Car two is travelling faster. b) The dots being next to each other indicate that at the moment in time they are at the same position, but it is the spacing of the dots which shows average speed. Since the spacing of dots is greater for car 2, it is travelling faster.

16. A car travels initially at a speed of 35 m/s. The driver steps on the brake and brings the car to a stop with a constant acceleration in a distance of 175 m. a) Sketch the situation. b) Explain how you can find the acceleration and the time it takes for the car to stop. c) Find the acceleration and the time it takes for the car to stop. d) Explain why the acceleration is negative.

16.







$\Delta x = \frac{1}{2} t \cdot 35 m/s = 175 m$

$\frac{17.5 m/s \cdot t}{17.5 m/s} = \frac{175 m}{17.5 m/s}$

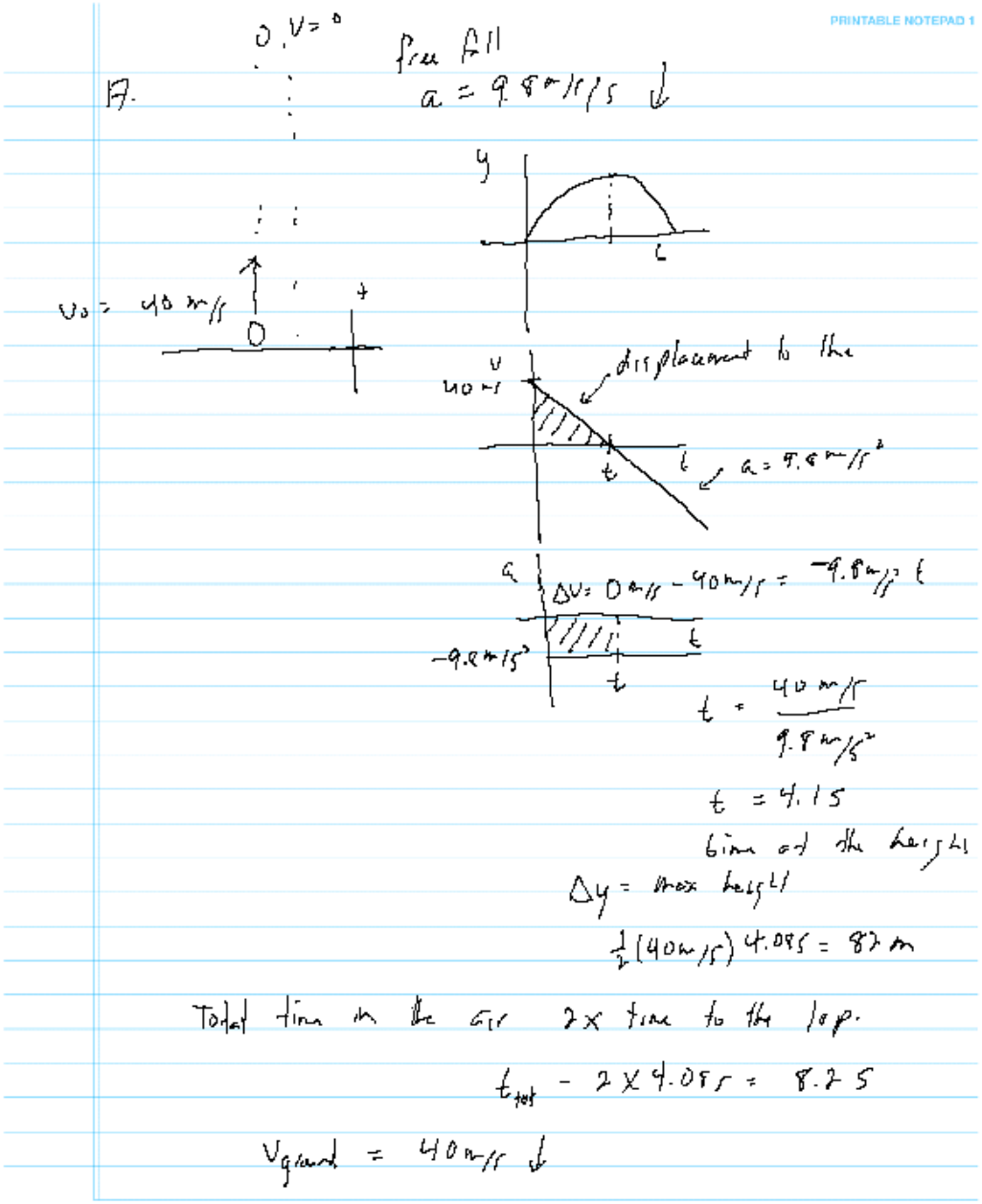
$t = 10.0 s$

$\Delta v = at = -35 m/s = 0 m/s - 35 m/s$

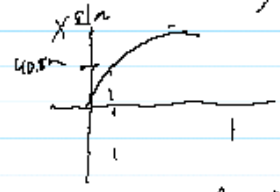
$a \cdot 10.0 s = -35 m/s$

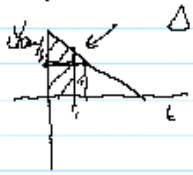
$a = \frac{-35 m/s}{10.0 s} = -3.5 m/s/s$

17. A ball is tossed up from ground level with an initial velocity of 40 m/s. a) Sketch the situation. b) Explain how you can find the maximum height reached by the ball. c) Find the maximum height reached by the ball. d) How long does it take for the ball to reach the maximum height? e) At what time will the ball reach the ground again? f) What will be the speed of the ball as it reaches the ground? g) At what time will the ball reach half its maximum height? What will be the speed of the ball at that height?

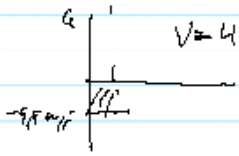


Half maximum height = 40.8 m





$\Delta y = 40.8\,m = \frac{1}{2}(40\,m/s + v)\,t$



$v = 40\,m/s - 9.8\,t$ $\quad (v) = -9.8t + 40\,m/s$

$40.8\,m = \frac{1}{2}(40\,m/s - 9.8t + 40\,m/s)\,t$

$40.8\,m = -4.9t^2 + 40\,m/s\,t$

$0 = -4.9t^2 + 40\,m/s\,t - 40.8$

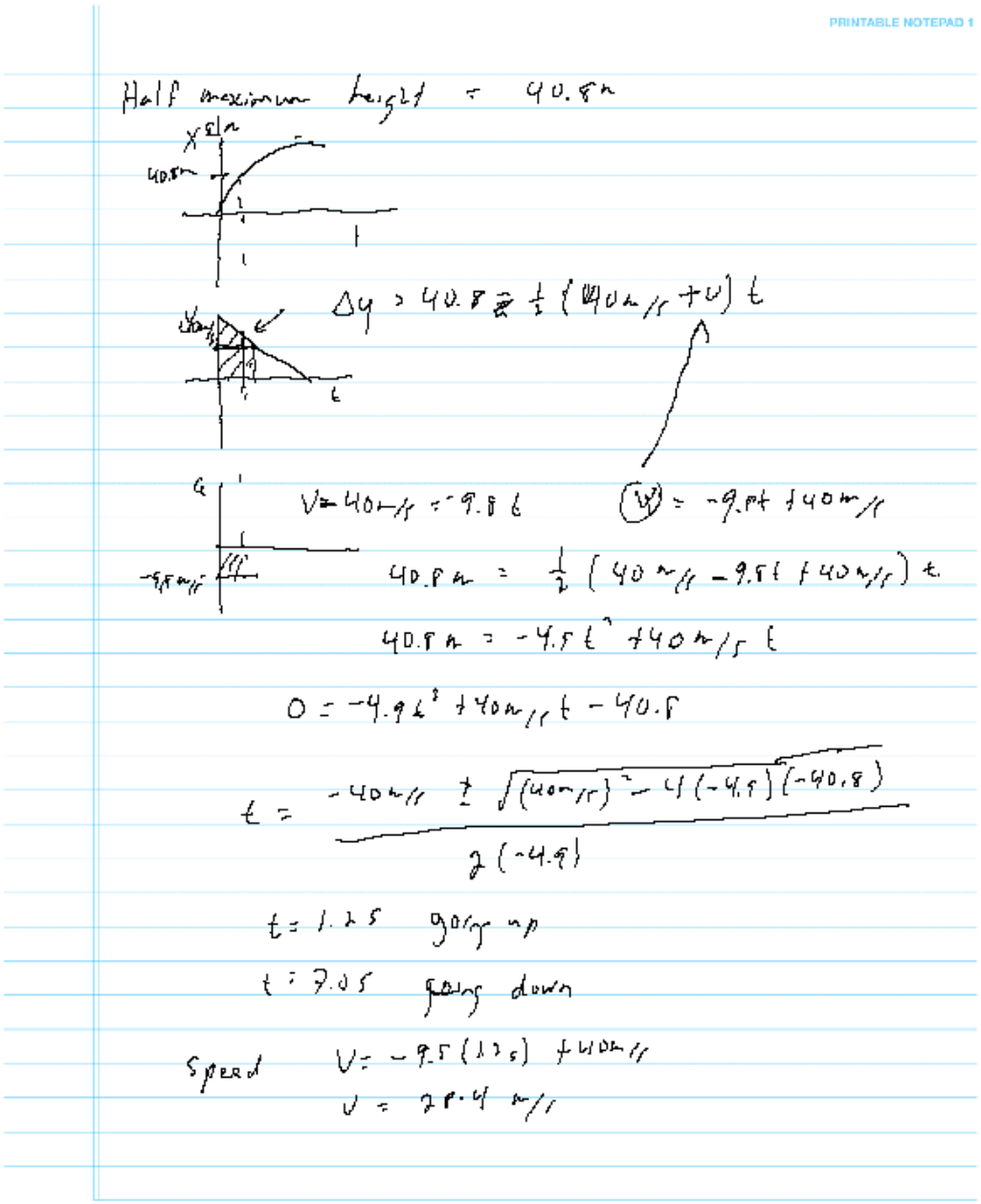
$$t = \frac{-40\,m/s \pm \sqrt{(40\,m/s)^2 - 4(-4.9)(-40.8)}}{2(-4.9)}$$

$t = 1.25$ going up

$t = 7.05$ going down

Speed $\quad v = -9.5(1.25) + 40\,m/s$

$v = 28.4\,m/s$



18. A rubber ball is bounced on the ground and bounces up but not all the way to the height from which it was released. a) Does this motion exhibit time reversal symmetry? b) Explain your reasoning.

a) No. b) Time reversal symmetry means that the motion looks identical whether you run time forward or in reverse. Running the time forward, the height of the ball decreases

after each bounce. Running time backward, the height of the ball increases after each bounce. You can clearly distinguish between these so this motion does not exhibit time reversal symmetry.

Problems from the text
Ch. 1
13. a) Write each number to the same power keeping the number of significant figures the same.
3.783×10^6 kg + 1.25×10^8 kg = $.03783 \times 10^8$ kg + 1.25×10^8 kg = 1.28783×10^8 kg
Rounded to the correct number of significant figures = 1.29×10^8 kg

b) 3.783×10^6 m ÷ (3.0×10^{-2} s) = 1.3×10^8 m/s
Since second number only has two significant figures, final answer should be rounded to two significant figures.

18. a) 3 b) 3 c) 2 d) 3 e) 3 f) 2 g) 4

35. U = mgh. Looking only at the units joules = J = kg × m/s^2 ×m = kg m^2/s^2

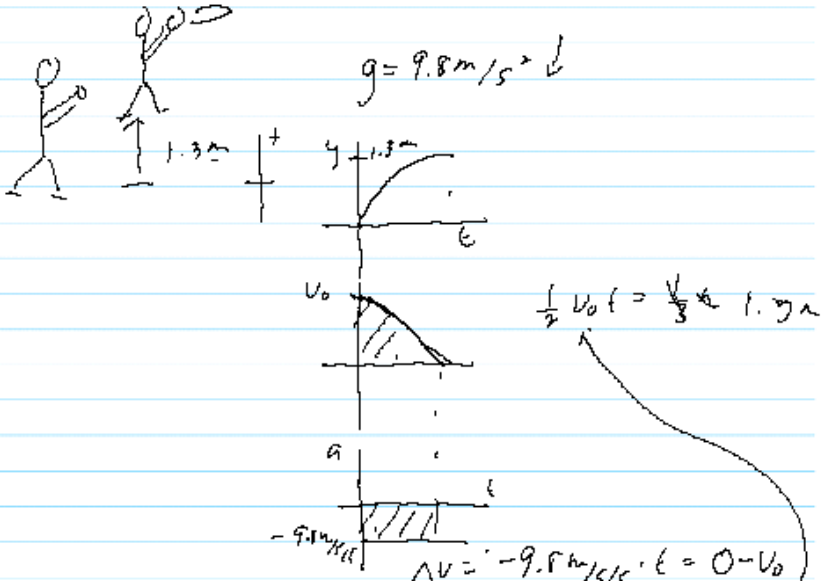
44. Assume 60 beats per minute and a life expectancy of 80 years
beats/lifetime = 60 beats/min × 60 min/hr × 24 hr/day × 365 days/year × 80 year/lifetime = 2.5 billion beat

72. We want the units of both sides to be m/s
$v = K \lambda^p g^q$ K is dimensionless so it has no units
$m/s = m^p (m/s^2)^q$
$m/s = m^{p+q}/s^{2q}$
comparing units on both sides we see 1 = 2q so q =1/2 and p+q = 1 so p = ½

79. The man's net worth is now \$59000000000-\$100 =\$ 59000000000 to the correct number of significant figures.

Ch. 2

47.



$g = 9.8\ m/s^2 \downarrow$

$\frac{1}{2} v_0 t = \frac{1}{3}$ of 1.3 m

$\Delta v = -9.8\ m/s^2 \cdot t = 0 - v_0$

$-9.8\ m/s^2\, t = -v_0$

$\frac{1}{2}(9.8\ m/s^2) t^2 = 1.3\ m$

$4.9 t^2 = 1.3$

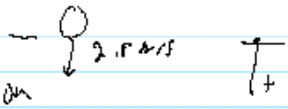
$t^2 = \frac{1.3}{4.9}$

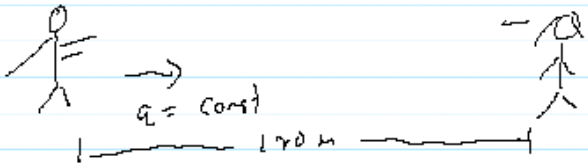
$t = \sqrt{\frac{1.3}{4.9}} = .515$

$-9.8\ m/s^2 \cdot .515\ s = -v_0$

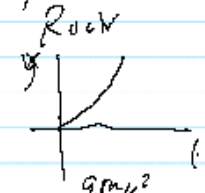
$v_0 = 5.0\ m/s$

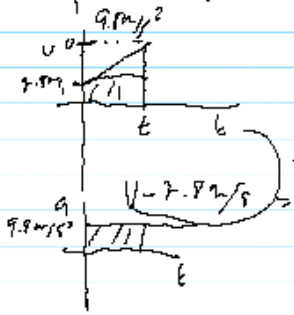
53





How long does it take for the rock to hit Lois?





$\Delta y = 14\text{m} = 2.8\,\frac{\text{m}}{\text{s}}\,t + \frac{1}{2}\,t\,(v - 2.8\,\frac{\text{m}}{\text{s}})$

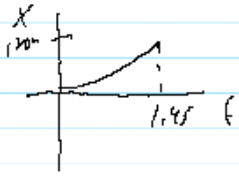
$v = 9.8\,\frac{\text{m}}{\text{s}^2}\,t$

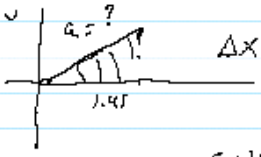
$14\text{m} = 2.8\,\frac{\text{m}}{\text{s}}\,t + \frac{1}{2}\,9.8\,\frac{\text{m}}{\text{s}^2}\,t^2$

$0 = 4.9t^2 + 2.8t - 14$

$t = \dfrac{-2.8 \pm \sqrt{(2.8)^2 - 4(4.9)(-14)}}{2 \cdot 4.9}$

$t = 1.43\text{ s}$, -Dos





$\Delta x = 120m = \frac{1}{2}(1.45)v$

$a \cdot 1.45 = V - 0$

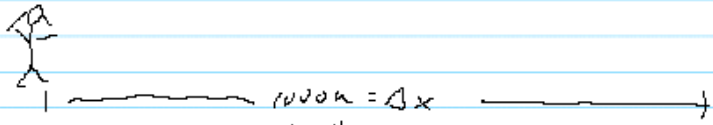
$1.45a = v$

$120m = .75 \cdot (1.45)a$

$120m = .95a$

$a = \frac{120m}{.995^2} \cdot 120 \frac{m}{s^2}$

64.



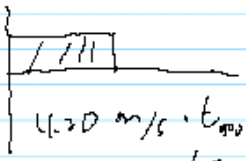
$1000m = \Delta x$

$v = 4.00 m/s$

total time.

$4.00 m/s \cdot t = 1000m$

$t = 250 s$



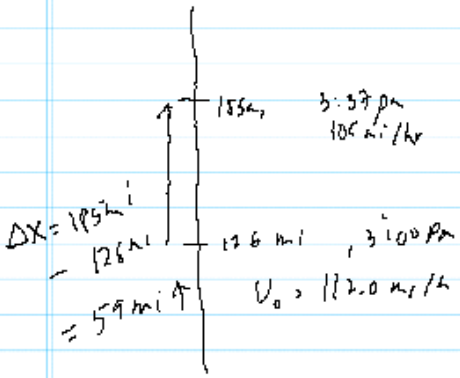
$4.20 m/s \cdot t_{500} = 500m$

$t = \frac{500m}{4.20 m/s} = 119 s$

$t_{remain} = 250s - 119s = 131 s$

$v_{final part} = \frac{500m}{131 s} = 3.82 m/s$

65.



$$V_A = \frac{\Delta X}{\Delta t} = \frac{59\ mi}{37\ min}$$

$$= 1.6\ \frac{mi}{min}$$

$$a_{ave} = \frac{\Delta v}{\Delta t} = \frac{105\ mi/h - 112.0\ mi/h}{37\ min}$$

$$= \frac{-7.0\ mi/hr}{37\ min} = -.19\ \frac{mi/h}{min}$$