

Physics of Astronomy - week 1 HW due wk 2 - Zifa

ESTIMATES ARE FINE. Try using your brain, not your calculator.

Phys.A: Giancoli 1, Introduction # 16, 23, 24, 38, 50, 54, 56
and drill on many odd #

brain, not your calculator.

- (16) (I) The Sun, on average, is 93 million miles from the Earth. How many meters is this? Express (a) using powers of ten, and (b) using a metric prefix.

done in class

- (23) (II) A light-year is the distance light (speed = 2.998×10^8 m/s) travels in one year. (a) How many meters are there in 1.00 light-year? (b) An astronomical unit (AU) is the average distance from the Sun to Earth, 1.50×10^8 km. How many AU are there in 1.00 light-year? (c) What is the speed of light in AU/h?

$$\begin{array}{c|c|c|c|c} \text{year} & 365 \text{ d} & 24 \text{ hr} & 60 \text{ min} & 60 \text{ sec} \\ \hline \text{yr} & \text{d} & \text{hr} & \text{min} & \text{sec} \end{array} = 3.65 \times 24 \times 3600 \text{ sec}$$

$$t = 1 \text{ year} = 3.65 \times 24 \times 3.6 \times 10^{2+1+3} = 3.16 \times 10^7 \text{ s} \approx \pi \times 10^7 \text{ sec}$$

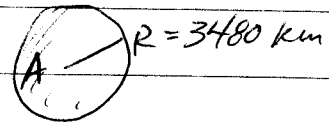
$$\text{Speed} = \frac{\text{distance}}{\text{time}} \quad \text{Speed of light} = c = 3 \times 10^8 \text{ m/s}$$

(a) $c = \frac{x}{t} \Rightarrow x = ct = 3 \times 10^8 \frac{\text{m}}{\text{s}} \times \pi \times 10^7 \text{ sec} \approx 9 \times 10^{15} \text{ m}$

(b) $ly \approx 9 \times 10^{15} \text{ m} \left| \frac{\text{AU}}{1.5 \times 10^8 \text{ km}} \right| \left| \frac{\text{km}}{10^3 \text{ m}} \right| = \text{AU}$

(c) $c = 3 \times 10^8 \frac{\text{m}}{\text{s}} \left| \frac{\text{AU}}{\text{m}} \right| = \frac{\text{AU}}{\text{s}}$

- (24) (II) The diameter of the moon is 3480 km. What is the surface area, and how does it compare to the surface area of the Earth?



$$A_{\text{moon}} = 4\pi R^2 = 4\pi (3480 \text{ km})^2 = 4\pi 3480^2 \text{ km}^2 = \text{km}^2$$

$$\frac{A_E}{A_M} = \frac{4\pi R_E^2}{4\pi R_M^2} = \left(\frac{R_E}{R_M}\right)^2 = \left(\frac{6.38 \times 10^3 \text{ km}}{3.48 \times 10^2 \text{ km}}\right)^2 =$$

- 38) (II) Three students derive the following equations in which x refers to distance traveled, v the speed, a the acceleration (m/s^2), t the time, and the subscript (0) means a quantity at time $t = 0$: (a) $x = vt^2 + 2at$, (b) $x = v_0t + \frac{1}{2}at^2$, and (c) $x = v_0t + 2at^2$. Which of these could possibly be correct according to a dimensional check?

done in class

- 50) Hold a pencil in front of your eye at a position where its blunt end just blocks out the Moon (Fig. 1-11). Make appropriate measurements to estimate the diameter of the Moon, given that the Earth-Moon distance is $3.8 \times 10^5 \text{ km} = x_M$

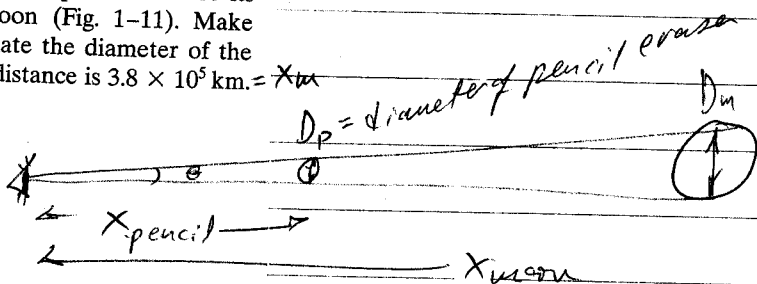


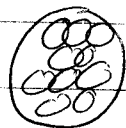
FIGURE 1-11 Problem 50.
How big is the Moon?

Similar triangles: $\frac{D_p}{x_p} = \frac{D_M}{x_M} \rightarrow D_M =$ Solve for D_M ALGEBRAICALLY

Measure $x_p =$ _____ $D_p =$ _____

Calculate $D_M =$ _____

- 54) One liter (1000 cm^3) of oil is spilled onto a smooth lake. If the oil spreads out uniformly until it makes an oil slick just one molecule thick, with adjacent molecules just touching, estimate the diameter of the oil slick. Assume the oil molecules have a diameter of $2 \times 10^{-10} \text{ m} = D$



$$\text{volume}_{\text{tot}} = N_{\text{molecules}} \times V_{\text{mol}}$$

$$\text{Volume of molecule} = V_m = \frac{4}{3}\pi R^3 \text{ where } D = 2R = 2 \times 10^{-10} \text{ m}$$

$$R =$$

Calculate $V_m =$ _____

$$\text{Number of molecules } N_m = \frac{V_{\text{tot}}}{V_m} =$$

2 Radius of oil slick = R_0

$$\text{Volume of oil slick} = V_0 = \text{Area of slick} \times \text{thickness of mol.} = \pi R_0^2 \times D$$

Volume of oil slick = volume tot

$$V_o = V_{tot} = \pi R_o^2 \cdot D$$

Solve algebraically for $R_o =$ _____

Then plug in numbers for V_{tot} and D to solve for

$$D \text{ oil slick} = 2R_o = \underline{\hspace{2cm}}$$

- (56) You are lying on the sand at the edge of the sea, watching a sailboat. If you know (or measured) that the distance from the water to the top of the boat hull is 2.5 m, estimate how far away the boat is when (using binoculars) you can no longer see the hull. The radius of the Earth is 6.38×10^6 m.

done in class - write it
up neatly.

Phys.B: Giancoli 1-4, review Classical Mech. Ch.1 # 23, 38,

Done in Phys A HW

56 (p.14); Ch.2 # 16, 22, 28, 54, 68, 69, 74 (p.39); Ch.3 #

12-15, 24, 28, 56, 62 (p.70); Ch.4 # 5, 22, 34, 40, 72 (p.98)

→ next week

Math.B: Boas 3.4, Vectors (practice problems with answers)

Q2

(16) (II) An airplane travels 2100 km at a speed of 800 km/h, and then encounters a tailwind that boosts its speed to $v_2 = 1000$ km/h for the next 1800 km. What was the total time for the trip? What was the average speed of the plane for this trip? [Hint: Think carefully before using Eq. 2-12d.]

$x_1 =$ $v_1 =$

x_2

Solve algebraically first.

speed = $\frac{\text{distance}}{\text{time}}$

$v = \frac{x}{t} \rightarrow t =$

$t_1 = \frac{x_1}{v_1} =$

$t_2 = \frac{x_2}{v_2} =$

$t_{\text{tot}} = t_1 + t_2 =$

$v_{\text{average}} =$

22. (I) Figure 2-32 shows the velocity of a train as a function of time. (a) At what time was its velocity greatest? (b) During what periods, if any, was the velocity constant? (c) During what periods, if any, was the acceleration constant? (d) When was the magnitude of the acceleration greatest?

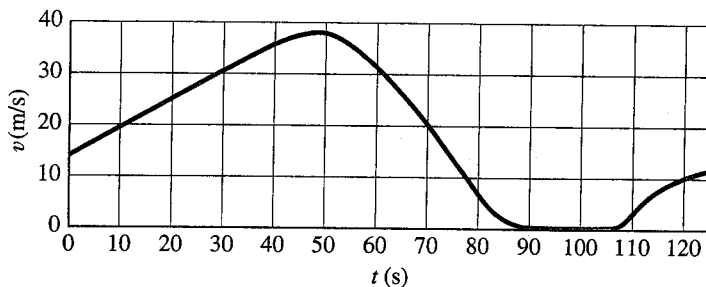


FIGURE 2-32 Question 18 and Problem 22.

- (28.) (II) The position of a body is given by $x = At + 6Bt^3$, where x is in meters and t is in seconds. (a) What are the units of A and B ? (b) What is the acceleration as a function of time? (c) What is the velocity and acceleration at $t = 5.0$ s? (d) What is the velocity as a function of time if $x = At + Bt^{-3}$?

(a) $x = At + 6Bt^3$
(m) = [A](s) + [B](s³)

units of $A = [A] = \left(\frac{\text{m}}{\text{s}}\right)$

units of $B = [B] =$

(b) velocity $v = \frac{dx}{dt} = \frac{d}{dt} (At + 6Bt^3)$
 $= \frac{d}{dt} (At) + \frac{d}{dt} (6Bt^3)$
 $= A \frac{d}{dt} (t) + 6B \left(\frac{d}{dt} t^3 \right)$

Differentiate: $v =$

acceleration $a = \frac{dv}{dt} = \frac{d}{dt} ($

92.7

Follow the example 2-15 of ball thrown upward

- (54) (II) The best rebounders in basketball have a vertical leap (that is, the vertical movement of a fixed point on their body) of about 120 cm. (a) What is their initial "launch" speed off the ground? (b) How long are they in the air?

- *68 (III) The acceleration of a particle is given by $a = A\sqrt{t} = At^{1/2}$ where $A = 2.0 \text{ m/s}^{5/2}$. At $t = 0$, $v = 10 \text{ m/s}$ and $x = 0$.
 (a) What is the speed as a function of time? (b) What is the displacement as a function of time? (c) What are the acceleration, speed and displacement at $t = 5.0 \text{ s}$?

Recall that for $a = \text{const}$:

$$a = \text{acceleration} = \frac{dv}{dt} \rightarrow \Delta v = \int a dt = at$$

$$v(t) - v_0 = at$$

$$\underline{v(t) = at + v_0}$$

$$v = \text{velocity} = \frac{dx}{dt}$$

$$\rightarrow \Delta x = \int v dt = \int (at + v_0) dt$$

$$= \int at dt + \int v_0 dt$$

$$x(t) - x_0 = \frac{at^2}{2} + v_0 t$$

$$\underline{x(t) = \frac{at^2}{2} + v_0 t + x_0}$$

In this case, however $a \neq \text{constant}$.

You can use the same method! However

$$a = \frac{dv}{dt} \rightarrow \Delta v = v(t) - v_0 = \int a dt = \int A\sqrt{t} dt$$

Integrate and find $v(t) =$

$$v = \frac{dx}{dt} \rightarrow \Delta x = x(t) - x_0 = \int v(t) dt =$$

Integrate and find $x(t) =$

Q2

69. The acceleration due to gravity on the Moon is about one sixth what it is on Earth. If an object is thrown vertically upward on the Moon, how many times higher will it go than it would on Earth, assuming the same initial velocity?

From Ex 2-15, $y = \frac{v_0^2}{2g}$ where $v_0 = \text{initial speed}$
 $g = \text{accl of gravity}$

$y_{\text{moon}} = \frac{v_0^2}{2g_{\text{moon}}}$
 $y_{\text{earth}} = \frac{v_0^2}{2g_{\text{earth}}}$

FIRST Simplify algebraically; then plug in $g_{\text{moon}} = \frac{1}{6} g_{\text{earth}}$ and evaluate.

74. Figure 2-40 is a position versus time graph of an object along the x axis. As the object moves from A to B: (a) Is the object moving in the positive or negative direction? (b) Is the object speeding up or slowing down? (c) Is the acceleration of the object positive or negative? Next, for the time interval from D to E: (d) Is the object moving in the positive or negative direction? (e) Is the object speeding up or slowing down? (f) Is the acceleration of the object positive or negative? (g) Finally, answer these same three questions for the time interval from C to D.

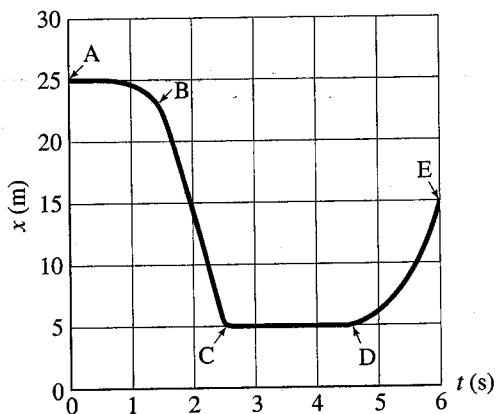


FIGURE 2-40 Problem 74.

Q3

- (28) (1) Determine how much farther a person can jump on the Moon as compared to the Earth if the takeoff speed and angle are the same. The acceleration due to gravity on the Moon is one-sixth what it is on Earth.

Use the results of Q2 # 69
and the method of Q2 # 57

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do these NEXT week - not now

Ch 3 # 12-15 (24) 28, (56, 62)

12. (II) Three vectors are shown in Fig. 3-41. Their magnitudes are given in arbitrary units. Determine the sum of the three vectors. Give the resultant in terms of (a) components, (b) magnitude and angle with x axis.

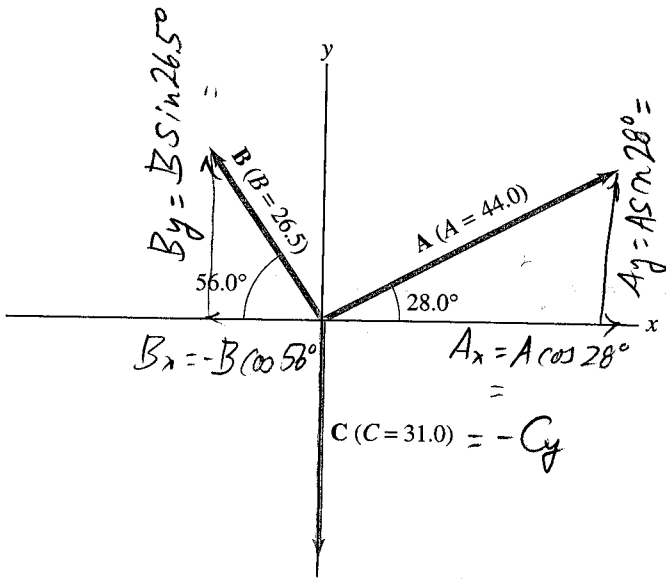


FIGURE 3-41 Problems 12, 13, 14, and 15. Vector magnitudes are given in arbitrary units.

13. (II) (a) Given the vectors \mathbf{A} and \mathbf{B} shown in Fig. 3-41, determine $\mathbf{B} - \mathbf{A}$. (b) Determine $\mathbf{A} - \mathbf{B}$ without using your answer in (a). Then compare your results and see if they are opposite.
14. (II) For the vectors given in Fig. 3-41, determine (a) $\mathbf{A} - \mathbf{B} + \mathbf{C}$, (b) $\mathbf{A} + \mathbf{B} - \mathbf{C}$, and (c) $\mathbf{C} - \mathbf{A} - \mathbf{B}$.
15. (II) For the vectors shown in Fig. 3-41, determine (a) $\mathbf{B} - 2\mathbf{A}$, (b) $2\mathbf{A} - 3\mathbf{B} + 2\mathbf{C}$.

ASTRO
A+B

week 1 HW due wk 2

Z7a

Astro. A: Universe 1, Astronomy & the universe:
20, 23, 26, 29, 32, 33, 34, and, (34b) Could you
resolve the crescent of Venus with naked eyes?
Why or why not?; Observing Projects: 43-45

20. The diameter of the Sun is 1.4×10^{11} cm, and the distance to the nearest star, Proxima Centauri, is 4.2 ly. Suppose you want to build an exact scale model of the Sun and Proxima Centauri, and you are using a ball 30 cm in diameter to represent the Sun. In your scale model, how far away would Proxima Centauri be from the Sun? Give your answer in kilometers, using powers-of-ten notation.