Phys 111-01 Fall 2019

Homework Wk 1

Solutions

Prob. 1

What is the max height of rocket when the height can be modeled with the relationship

$$h(t) = -4.9t^2 + 229t + 112.$$

h in m, t in s.

max @ vertex $t_m = -\frac{b}{2a}$

$$t_m = \frac{-229}{2(-4.9)} \text{ s} = 23.4 \text{ s}$$

$$h(t_m) = -4.9(23.4)^2 + 229(23.4) + 112$$

$$\boxed{h(t_m) = 2787.6 \text{ m} = 2.79 \text{ km}}$$

Prob. 2

At what t can $h=0$ if $[t]=s$, $[h]=m$,

$$h(t) = -4.9t^2 + 229t + 112$$

for $t \geq 0$.

(a) mathematically (b) physically

$$h=0 \rightarrow -4.9t^2 + 229t + 112 = 0$$

$$t = \frac{-229 \pm \sqrt{(229)^2 - 4(-4.9)(112)}}{2(-4.9)}\ s$$

$$t = \frac{-229 \pm 233.7}{-9.8}\ s$$

(a) $\boxed{t = -0.48\,s \quad \text{or} \quad t = 47.2\,s}$

(b) $\boxed{t = 47.2\,s}$

Prob. 3

A radioactive substance with a half-life of 15 h is originally measured to be 100 mg.

How much remains after 45 hr?

45 hr = 3 half-lives

$$100\,\text{mg} \cdot \frac{1}{2} \cdot \frac{1}{2} \cdot \frac{1}{2} = \frac{100}{8}\,\text{mg}$$

There will be $\boxed{12.5\ \text{mg}}$ left after 45 h.

Alt.

$$A(t) = A_0\, e^{-\frac{\ln 2}{15\,\text{hr}} t}$$

$$A(45\text{h}) = (100\,\text{mg})\, e^{-3\ln 2} = \boxed{12.5\,\text{mg}}$$

Prob. 4

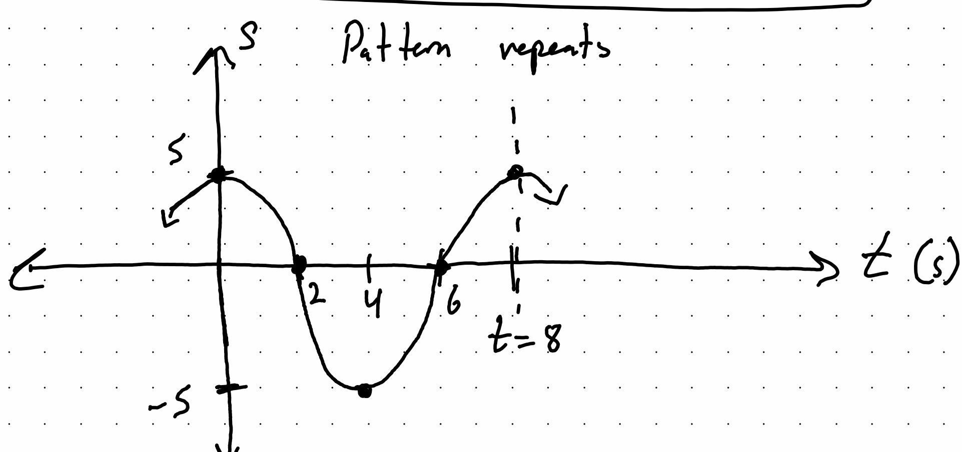
Graph $s(t) = 5\cos\left(\frac{\pi}{4}t\right)$ and state the amplitude A, the period T, and the first two zeros t_1, t_2.

$\cos\left(\frac{\pi}{4}t\right) = 0$ @ $\frac{\pi}{4}t = \frac{\pi}{2} + 2k\pi$

s.t. k is an integer

$$T = \frac{2\pi}{\frac{\pi}{4}} = 8$$

$$\boxed{A = 5,\ T = 8,\ t_1 = 2,\ t_2 = 6}$$



Prob. 5

Convert the speed $34.0\,\frac{mi}{h}$ to

(a) $\frac{km}{h}$ (b) $\frac{m}{s}$.

$1\,\frac{mi}{h} = 1.6\,\frac{km}{h}$; $1.0\,\frac{m}{s} = 3.6\,\frac{km}{h}$

(a) $34.0\,\frac{mi}{h} = \boxed{54.4\,\frac{km}{h}}$

(b) $34.0\,\frac{mi}{h} = 54.4\,\frac{km}{h} \cdot \frac{1\,\frac{m}{s}}{3.6\,\frac{km}{h}}$

$34.0\,\frac{mi}{h} = \boxed{15.1\,\frac{m}{s}}$

Prob. 6

Determine $d = \frac{a^3}{c\,b^2}$ if $a = 9.7\,m$, $b = 4.2\,s$, and $c = 69\,\frac{m}{s}$.

$$d = \frac{(9.7\,m)^3}{\left(69\,\frac{m}{s}\right)(4.2\,s)^2}$$

$$= \frac{9.7^3}{69\,(4.2)^2} \quad \frac{m^3}{\frac{m}{s} \cdot s^2}$$

$$\boxed{d = 0.75\,\frac{m^2}{s}}$$

Prob. 7

What dimensions must z have for $v = \frac{1}{3} z x t^2$ to be consistent if

$[v] = \frac{m}{s}$, $[x] = m$, $[t] = s$?

$$[z] = \frac{[v]}{[x t^2]} = \frac{\frac{m}{s}}{m \cdot s^2}$$

$$\boxed{[z] = \frac{1}{s^3}} \quad \text{or} \quad \frac{1}{[T]^3} \quad \text{or} \quad \frac{1}{T^3}$$

Prob. 8

Use the following conversions to determine the conversion for 1 oz to mL.

$$1\ \text{gal} = 128\ \text{oz}\ ,\quad 3.785 \times 10^{-3}\ m^3 = 1\ \text{gal}$$

$$1\ mL = 10^{-6}\ m^3$$

$$1\ \text{oz} = 1\ \text{oz} \cdot \frac{1\ \text{gal}}{128\ \text{oz}} \cdot \frac{3.78 \times 10^{-3}\ m^3}{1\ \text{gal}} \cdot \frac{1\ mL}{10^{-6}\ m^3}$$

$$1\ \text{oz} = 0.0295 \times 10^{3}\ mL$$

$$\boxed{1\ \text{oz} = 29.5\ mL}$$

Prob. 9

What are the dimensions of a spring constant given the following relationship $T = 2\pi\sqrt{\frac{m}{k}}$

$$T = 2\pi\sqrt{\frac{m}{k}} \Rightarrow T\sqrt{k} = 2\pi\sqrt{m}$$

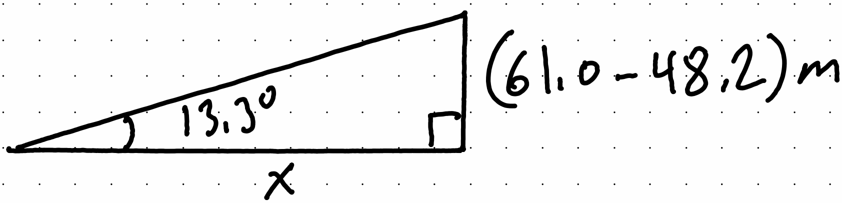
$$k = \frac{4\pi^2 m}{T^2}$$

$$[k] = \frac{[m]}{[T^2]} = \frac{kg}{s^2} = \frac{N}{m}$$

$$\boxed{[k] = \frac{kg}{s^2}}$$

Prob. 10

What is the horizontal distance x between two hot air balloons if their relative positions form the following right triangle?



$$\tan 13.3° = \frac{12.8 \text{ m}}{x}$$

$$x = \frac{12.8 \text{ m}}{\tan 13.3°}$$

$$\boxed{x = 54.1 \text{ m}}$$