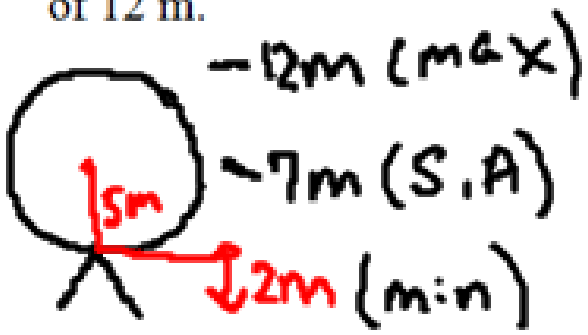
Applications of Trig Equations

$y = -5\cos(12x) + 7$

1. The height of a specific car on a Ferris wheel varies sinusoidally with time. At 0 s, the car is at the lowest height, 2 m above the ground. The radius of the wheel is 5 m and it takes 30 s to complete one revolution. → period

Determine the times during the first 3 minutes when the car is at a height of 12 m.



Amp = 12 − 7 = 5

0 seconds → starting pt
→ 2m

(0, 2) starting pt min (−cos)

VS = Amp = 5

VT = S.A = 7

HT → 0

HS = $\frac{1}{12}$

period = HS · 360

30 = HS · 360

HS = $\frac{1}{12}$

Key pts

$\frac{30}{4}$

7.5

$y = -5\cos(12x) + 7$

$h = -5\cos(12t) + 7$

$12 = -5\cos(12t) + 7$

$5 = -5\cos(12t)$

$-1 = \cos(12t)$ → let $m = 12t$

$-1 = \cos m$

$180° \pm 360°k, k$

$\cos^{-1}(-1) = 12t$

$\frac{180}{12} \pm \frac{360}{12} k, k \in \mathbb{I} = \frac{12t}{12}$

$15 \pm 30k, k \in \mathbb{I} = t$

$t = \{15, 45, 75, 105, 135, 165\}$

$[0, 180]$

First 3 min

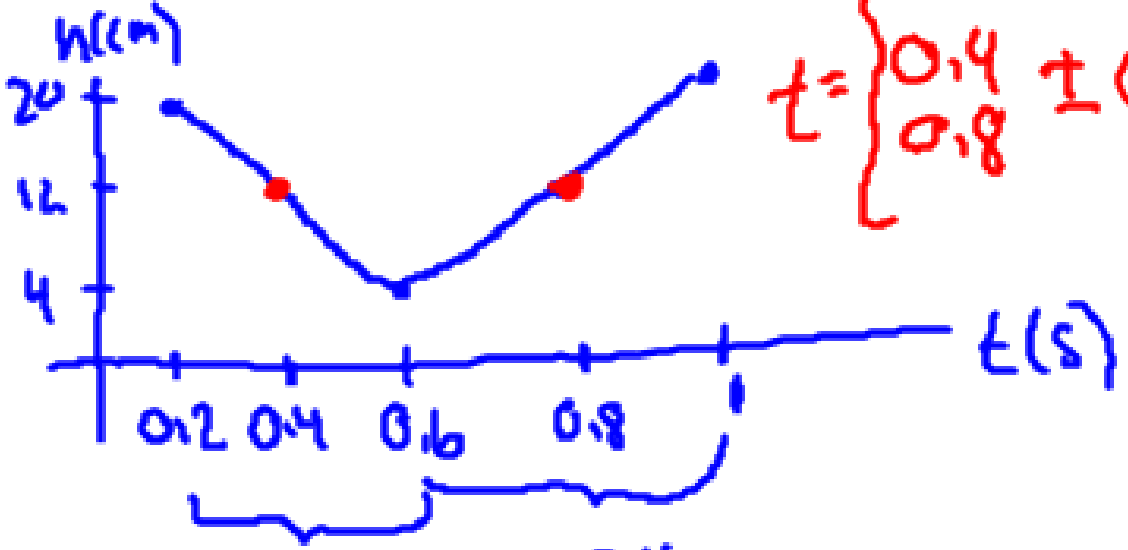
No degree symbol b/c t in seconds not degrees

2. Dean is holding on to the end of a spring attached to a weight. He moves his hand slightly up and down which causes the weight to oscillate. The weight repeatedly reaches a maximum height of 20 cm from the table and a minimum height of 4 cm. The first maximum height occurs at 0.2 s and the first minimum occurs at 0.6 s.

max 20
min 4

starting at a max (cos) → HT 0.2

Determine ALL times when the weight is 12 cm from the top of the table.



$t = \begin{cases} 0.4 \\ 0.8 \end{cases} \pm 0.8k, k \in I$

SA = (20+4)/2

SA: y = 12 VT

Amp = max − SA
= 20 − 12
= 8 VS

0.4 seconds to get from max to min

0.4 again to get back to max

period = 0.8 seconds

period = HS · 360

0.8 = HS · 360

0.8/360 = HS = 1/450

$y = 8\cos[450(x-0.2)] + 12$

$$12 = 8\cos\underbrace{[450(x-0.2)]}_{m} + 12$$

$$12 = 8\cos m + 12$$

$$\frac{0}{8} = \frac{8\cos m}{8}$$

$$0 = \cos m$$

$$m = \begin{matrix} 90 \\ 270 \end{matrix} \pm 360k, k \in I$$

$$\frac{450(x-0.2)}{450} = \begin{matrix} 90 \\ 270 \end{matrix} \pm 360k, k \in I$$

$\div 450$ $\div 450$ $\div 450$

$$x - 0.2 = \begin{matrix} 0.2 \\ 0.6 \end{matrix} \pm 0.8k$$

$$x = \begin{matrix} 0.4 \\ 0.8 \end{matrix} \pm 0.8k, k \in I$$

* no degree symbol b/c our x value is in seconds not degrees

3. A robot on Mars records the temperature every Mars day.

Number of Mars Days	0	100	200	300	400	500	600	700	800
Temp. (°C)	-43	-15	-5	-21	-59	-79	-68	-50	-27
Number of Mars Days	900	1000	1100	1200	1300				
Temp. (°C)	-5	-15	-70	-78	-68				

x

y

y = T x = n for # of days

A) Find the maximum and minimum temperatures recorded by the robot.

max = $-5°$ min = $-79°$

B) Find a sine model for the temperature, T, in terms of the number of Martian days, n.

$S.A = \frac{max + min}{2}$

$= \frac{-5 + -79}{2} = -42$

$Amp = max - S.A$

$= -5 - -42$

$= 37$

Period = 700

$700 = HS \cdot 360$

$\frac{700}{360} = HS$

$\frac{35}{18} = HS$

C) Use this information to estimate the length of a Martian year.

starting pt = 0 days $T = -43°$ (essentially S.A)

↓

sin starts on S.A

$y = 37 \sin\left(\frac{18}{35}x\right) - 42$

c) 700 days

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#8, 9, 15, 16, 18, 19