

# Graphs of Trigonometric Functions: math practice, Grade 12 – download the PDF

23 problems graded by difficulty (★ easy, ★★ medium, ★★★ hard). Try first, without looking at the solutions!

## 1 Amplitude and period

★ ★ ★

State the amplitude and the period of  $y = 4 \sin(3x)$ , then give its maximum and minimum values.

## 2 A reflected cosine

★ ★ ★

For  $y = -2 \cos\left(\frac{x}{2}\right)$ , find the amplitude, the period, and the first  $x \geq 0$  where the graph reaches its maximum.

## 3 Midline, maximum, minimum

★ ★ ★

The function  $y = 2 \sin x + 5$  models the water level of a small pond in inches. Give its midline, maximum and minimum values, and where in  $[0, 2\pi]$  each extreme occurs.

#### 4 A table of values



Complete the values of  $y = 3 \cos x$  for  $x = 0, \frac{\pi}{3}, \frac{\pi}{2}, \frac{2\pi}{3}, \pi$ , then say what kind of curve passes through these points.

#### 5 True or false?



Say whether each statement is true or false and justify briefly.

- The period of  $y = \cos x$  is  $2\pi$ .
- The range of  $y = \tan x$  is  $[-1, 1]$ .
- $\sec x$  is defined for every real number  $x$ .
- The graph of  $y = \sin x$  is symmetric about the origin.
- The amplitude of  $y = -4 \cos x$  is  $-4$ .

#### 6 Asymptotes of a tangent



For  $y = \tan(2x)$ , give the period and list the vertical asymptotes between  $x = -\frac{\pi}{2}$  and  $x = \frac{\pi}{2}$ .

#### 7 Inverse values



Evaluate exactly, giving each answer in radians.

- $\arcsin \frac{1}{2}$
- $\arccos \left( -\frac{1}{2} \right)$
- $\arctan 1$
- $\arcsin \left( -\frac{\sqrt{2}}{2} \right)$

### 8 Cosine becomes sine



The function  $y = \sin\left(x + \frac{\pi}{2}\right)$  is graphed. By which transformation of  $y = \sin x$  is it obtained, and which familiar function is it?

### 9 Factor before you read



For  $y = -4\cos(3x + \pi) + 2$ , find the amplitude, period, phase shift (state the direction), midline, maximum and minimum, and compute  $y$  at  $x = 0$ .

### 10 Equation of a sine wave



A sine wave in  $x$  has amplitude 6, midline  $y = 2$ , period 10, and passes through the midline going up at  $x = 0$ . Write its equation, then find  $y$  at  $x = 2.5$  and  $x = 7.5$ .

### 11 A cosine from its extremes



A function has a maximum value of 7 at  $x = \frac{\pi}{4}$  and a minimum value of  $-1$ ; the next maximum occurs at  $x = \frac{5\pi}{4}$ . Write it as  $y = A\cos(B(x - C)) + D$ .

### 12 Solving trigonometric equations



Solve on  $[0, 2\pi)$ .

a.  $\sin x = \frac{1}{2}$

b.  $2\cos x = -\sqrt{3}$

c.  $\tan x = -1$

**13 A shifted tangent**

Consider  $y = \tan\left(\frac{x}{2}\right) + 1$ . Find its period, its vertical asymptotes in  $(-2\pi, 2\pi)$ , its values at  $x = 0$  and  $x = \frac{\pi}{2}$ , and its  $x$ -intercept in  $(-\pi, \pi)$ .

**14 A stretched secant**

For  $y = 2 \sec x$ : (a) give the domain and the range; (b) compute  $y$  at  $x = \frac{\pi}{3}$  and  $x = \frac{2\pi}{3}$ ; (c) identify the local extremum at  $x = 0$  and at  $x = \pi$ .

**15 Compositions with inverses**

Find the exact value.

a.  $\sin(\arcsin 0.3)$

b.  $\cos\left(\arcsin \frac{8}{17}\right)$

c.  $\tan\left(\arccos \frac{5}{13}\right)$

d.  $\sin\left(\arctan \frac{3}{4}\right)$

**16 A bicycle pedal**

The height of a pedal above the ground is  $h(t) = 12 + 7 \sin(2.5\pi t)$  inches, with  $t$  in seconds. (Radius 7 in is about 17.8 cm.) (a) Find the maximum and minimum heights. (b) How long is one revolution, and how many revolutions per minute is that? (c) Find the height at  $t = 0.1$  s.

### 17 A sound wave



The pressure of a sound wave is modeled by  $p(t) = 0.4 \sin(2\pi \cdot 262 t)$ , with  $t$  in seconds. Find the amplitude, the period in milliseconds, and the number of full cycles in 0.05 s.

### 18 Tide model

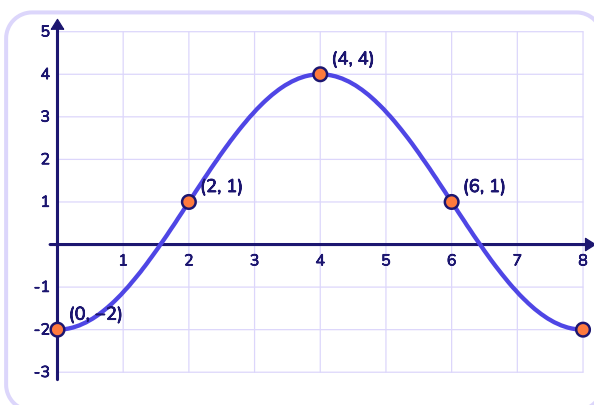


The depth of water in a harbor is  $d(t) = 6 + 2.5 \cos\left(\frac{\pi t}{6}\right)$  feet, where  $t$  is the number of hours after high tide. (a) Give the amplitude, period, maximum and minimum depths. (b) Find  $d(2)$ . (c) A boat needs at least 7.75 ft (about 2.4 m) of water. For how long, around one high tide, can it float?

### 19 Reading an equation from a graph



The curve below shows one full period of a sinusoidal function.



(a) Find the amplitude, midline and period. (b) Write an equation of the form  $y = A \cos(Bx) + D$ . (c) Write another equation of the form  $y = A \sin(B(x - C)) + D$  with  $A > 0$ .

**20 Inverse of the function, not the identity**

★★★

Evaluate each expression exactly and explain why the result differs from the angle inside.

a.  $\arcsin\left(\sin \frac{4\pi}{3}\right)$

b.  $\arccos\left(\cos\left(-\frac{\pi}{4}\right)\right)$

c.  $\arccos\left(\cos \frac{7\pi}{6}\right)$

d.  $\arctan\left(\tan \frac{3\pi}{4}\right)$

**21 An identity for inverse functions**

★★★

Prove that  $\arcsin x + \arccos x = \frac{\pi}{2}$  for every  $x$  in  $[-1, 1]$ , then check the claim numerically for  $x = 0.6$ .

**22 A decreasing tangent**

★★★

Let  $g(x) = -2 \tan\left(\frac{\pi x}{4}\right)$ . (a) Find the period. (b) Find the vertical asymptotes in  $(-4, 4)$  and the  $x$ -intercepts in  $(-2, 2)$ . (c) Compute  $g(1)$  and  $g(-1)$ . (d) Is  $g$  increasing or decreasing between consecutive asymptotes?

**23 Daily temperature**

★★★

In a desert town the temperature in  $^{\circ}\text{F}$  is modeled by  $T(t) = 73 + 11 \cos\left(\frac{\pi(t - 15)}{12}\right)$ , where  $t$  is the number of hours after midnight. (a) Find the hottest and coldest temperatures and when they occur. (b) Find  $T(9)$  and  $T(18)$ , and convert  $T(18)$  to  $^{\circ}\text{C}$ . (c) During which hours is it at least  $80^{\circ}\text{F}$ ? Give the times to the nearest minute.



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