

Graphs of Trigonometric Functions: math test solutions, Grade 12 – download the PDF

Test solutions with the detailed point scale. Add up your points and spot what to review.

Suggested time: 45 minutes. Out of 20 points. Calculator allowed only when the problem says so.

1 Analyzing a sinusoid

/ 4 pts

- (a) $3x - \pi = 3\left(x - \frac{\pi}{3}\right)$, so $y = -2 \sin\left(3\left(x - \frac{\pi}{3}\right)\right) + 1$: amplitude 2, period $\frac{2\pi}{3}$. (1 pt)
- (b) Phase shift $\frac{\pi}{3}$ to the right. (1 pt)
- (c) Midline $y = 1$, maximum 3, minimum -1 . (1 pt)
- (d) At $x = \frac{\pi}{3}$: $\sin 0 = 0$, so $y = 1$. At $x = \frac{\pi}{2}$: $3x - \pi = \frac{\pi}{2}$, $\sin \frac{\pi}{2} = 1$, so $y = -2 + 1 = -1$. (1 pt)

2 Writing an equation

/ 4 pts

- (a) Amplitude $\frac{12-2}{2} = 5$; midline $\frac{12+2}{2} = 7$; half a period is 3, so the period is 6. (1.5 pt)
- (b) $B = \frac{2\pi}{6} = \frac{\pi}{3}$, so $y = 5 \cos\left(\frac{\pi x}{3}\right) + 7$. (1 pt)
- (c) $y(1) = 5 \cos \frac{\pi}{3} + 7 = 9.5$. For $y = 9.5$: $\cos \frac{\pi x}{3} = \frac{1}{2} \Rightarrow \frac{\pi x}{3} = \frac{\pi}{3}$ or $\frac{5\pi}{3}$, so $x = 1$ or $x = 5$. (1.5 pt)

3 Tangent and cotangent

/ 3 pts

- (a) Period $\frac{\pi}{3}$; asymptotes $3x = \pm \frac{\pi}{2}$, i.e. $x = \pm \frac{\pi}{6}$; $y\left(\frac{\pi}{12}\right) = \tan \frac{\pi}{4} = 1$. (1.5 pt)
- (b) Asymptotes $x = 0$ and $x = \pi$; zero at $x = \frac{\pi}{2}$; $\cot \frac{\pi}{4} = 1$ and $\cot \frac{3\pi}{4} = -1$. (1.5 pt)

4 Cosecant

/ 3 pts

- (a) Asymptotes $x = k\pi$ (zeros of sine). Range $(-\infty, -3] \cup [3, \infty)$. (1 pt)
- (b) $y\left(\frac{\pi}{6}\right) = \frac{3}{1/2} = 6$; $y\left(\frac{7\pi}{6}\right) = \frac{3}{-1/2} = -6$. (1 pt)
- (c) Local minimum 3 at $x = \frac{\pi}{2}$; local maximum -3 at $x = \frac{3\pi}{2}$. (1 pt)

5 Inverse trigonometric values

/ 3 pts

- (a) $\frac{\pi}{3}$ (0.5 pt)
- (b) $\frac{\pi}{4}$ (0.5 pt)
- (c) $\tan\left(-\frac{\pi}{3}\right) = -\sqrt{3}$, so the answer is $-\frac{\pi}{3}$. (0.5 pt)
- (d) Opposite 5, hypotenuse 13, adjacent 12: $\frac{12}{13}$. (1 pt)
- (e) $\sin \frac{7\pi}{6} = -\frac{1}{2}$, so the answer is $-\frac{\pi}{6}$. (0.5 pt)

6

Hours of daylight

/ 3 pts

(a) Maximum $12 + 3.5 = 15.5$ h, minimum $12 - 3.5 = 8.5$ h, period 365 days. (1 pt)

(b) $D(172) = 12 + 3.5 \sin\left(\frac{2\pi \cdot 92}{365}\right) \approx 12 + 3.5(0.99992) \approx 15.50$ h. (1 pt)

(c) Need $\sin \theta \geq \frac{2}{3.5} \approx 0.5714$ where $\theta = \frac{2\pi(t - 80)}{365}$. With $\arcsin 0.5714 \approx 0.6082$, this holds for $0.6082 \leq \theta \leq \pi - 0.6082$, an interval of length $\pi - 1.2164 \approx 1.9252$. The number of days is $\frac{1.9252}{2\pi} \cdot 365 \approx 112$ days. (1 pt)



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