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MATHEMATICS TEST - CHAPTER 9: TRIGONOMETRIC FUNCTIONS

Name:		Roll No.		Section:

Total Time: 3:20 Hour
Time Allowed: 200 Minutes

Total Marks: 200

PAPER OBJECTIVE
SECTION-A (MARKS 200)

NOTE: Section-A is compulsory. All parts of this section are to be answered on these pages and handed over to the center superintendent. Deleting / overwriting is not allowed. Do not use lead pencil.

Q.1 Fill the relevant bubble for each part. All parts carry one mark.

Questions	A	B	C	D	A B C D
1. The domain of a function f(x) is the set of all values of x for which f(x) is:	defined	negative	positive	zero	●○○○
2. The range of a function f(x) is the set of all:	roots of x	values of x	zeros of f	values the function can take	○○○●
3. A closed interval [a, b] consists of the numbers from a to b:	excluding both a and b	including both a and b	excluding a only	excluding b only	○●○○
4. The domain of sin θ is:	(0, 2π)	(0, π)	the set of all real numbers	[−1, 1]	○○●○
5. The range of sin θ is:	[−1, 1]	(−∞, ∞)	(0, 1)	[0, 2π]	●○○○
6. The domain of cos θ is:	(−π, π)	[−1, 1]	the set of all real numbers	(0, π)	○○●○
7. The range of cos θ is:	(−∞, ∞)	[−1, 1]	(0, 1)	[0, 2]	○●○○
8. The domain of tan θ is:	all real numbers except odd multiples of π/2	all real numbers except multiples of π	all real numbers	[−1, 1]	●○○○
9. The range of tan θ is:	the set of all real numbers	(1, ∞)	[−1, 1]	(0, ∞)	●○○○
10. The domain of cot θ is:	all real numbers	[−1, 1]	all real numbers except odd multiples of π/2	all real numbers except integer multiples of π	○○○●
11. The range of cot θ is:	the set of all real numbers	(−∞, −1] ∪ [1, ∞)	(0, ∞)	[−1, 1]	●○○○
12. The domain of sec θ is:	all real numbers except multiples of π	[−1, 1]	all real numbers	all real numbers except odd multiples of π/2	○○○●
13. The range of sec θ is:	(−∞, ∞)	(0, 1)	y ≤ −1 or y ≥ 1	[−1, 1]	○○●○
14. The domain of cosec θ is:	[−1, 1]	all real numbers except integer multiples of π	all real numbers except odd multiples of π/2	all real numbers	○●○○

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Questions	A	B	C	D	A B C D
15. The range of cosec θ is:	$[-1, 1]$	$y \leq -1$ or $y \geq 1$	$(0, \infty)$	$(-\infty, \infty)$	○●○○
16. The maximum value of sin θ and cos θ is:	π	0	1	2	○○●○
17. The minimum value of sin θ and cos θ is:	-1	0	-2	$-\pi$	●○○○
18. The functions tan θ and cot θ can take:	only values in $[-1, 1]$	any real value	only positive values	only integer values	○●○○
19. The functions sec θ and cosec θ cannot take any value in the interval:	$(0, \infty)$	$(-1, 1)$	$(1, 2)$	$[-1, 1]$	○●○○
20. The domain of the function y = 2 + 3 sin x is:	$[2, 3]$	all real numbers	$(0, \infty)$	$[-1, 5]$	○●○○
21. The range of the function y = 2 + 3 sin x is:	$[-1, 5]$	$[-1, 3]$	$[-3, 3]$	$[2, 5]$	●○○○
22. The range of the function y = 5 − 4 cos x is:	$[1, 9]$	$[1, 5]$	$[-4, 4]$	$[5, 9]$	●○○○
23. The range of the function y = 3 sin x + 4 is:	$[4, 7]$	$[-3, 3]$	$[1, 7]$	$[0, 7]$	○○●○
24. The function y = 1/(2 − sin 3x) is defined for:	$x \neq 0$	$x \neq \pi/6$ only	all real values of x	$x > 0$ only	○○●○
25. The range of y = 1/(2 − sin 3x) is:	$[-1, 1]$	$[1/3, 1]$	$[1, 3]$	$(0, \infty)$	○●○○
26. The domain of y = tan 2x is:	all real numbers	all real x except $x = (2n + 1)\pi/2$	all real x except $x = n\pi/2$	all real x except $x = (2n + 1)\pi/4$	○○○●
27. The function y = 1/(1 + cos x) is not defined when:	$\sin x = 1$	$\sin x = 0$	$\cos x = -1$	$\cos x = 1$	○○●○
28. A function whose value repeats after a specific interval is called a:	constant function	odd function	even function	periodic function	○○○●
29. A periodic function satisfies f(x + P) = f(x), where P is the:	amplitude	domain	range	period of the function	○○○●
30. Which of the following is periodic in nature?	A hyperbola	Sine wave	A straight line	A parabola	○●○○
31. Which of the following waves is periodic?	Exponential curve	Parabola	Straight line	Square wave	○○○●

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Questions	A	B	C	D	A B C D
32. The 24-hour day–night cycle is an example of:	a periodic phenomenon	a random phenomenon	a linear phenomenon	a constant phenomenon	●○○○
33. The values of a trigonometric function at θ and 2nπ + θ, for n an integer, are:	unrelated	opposite	the same	reciprocal	○○●○
34. The period of the sine function is:	π/2	4π	π	2π	○○○●
35. The period of the cosine function is:	π	4π	π/2	2π	○○○●
36. The period of the tangent function is:	π/2	2π	4π	π	○○○●
37. The period of the cotangent function is:	π	2π	4π	π/2	●○○○
38. The period of the secant function is:	2π	π/2	π	4π	●○○○
39. The period of the cosecant function is:	π	4π	2π	π/2	○○●○
40. The sine function cannot have period π because sin(θ + π) equals:	0	−sin θ	cos θ	sin θ	○●○○
41. The tangent function has period π because tan(θ + π) equals:	cot θ	0	tan θ	−tan θ	○○●○
42. The smallest positive real number p for which sin(θ + p) = sin θ for all θ is:	π/2	3π/2	2π	π	○○●○
43. The secant function has period 2π because sec θ is the reciprocal of:	sin θ	tan θ	cot θ	cos θ	○○○●
44. The cosecant function has period 2π because cosec θ is the reciprocal of:	cot θ	tan θ	sin θ	cos θ	○○●○
45. If p is the period of a function f(x) with f(x) ≠ 0, the reciprocal function 1/f(x) has period:	1/p	p/2	2p	p	○○○●
46. If p is the period of f(x), then the period of f(ax + b), a > 0, is:	p/a	pa	p + a	p − a	●○○○
47. If p is the period of f(x), then a f(x) + b, for a > 0, has period:	ap	p/a	p	p + b	○○●○
48. The period of sin 3x is:	2π/3	3π	6π	π/3	●○○○

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Questions	A	B	C	D	A B C D
49. The period of cos 2x is:	π	4π	2π	π/2	●○○○
50. The period of tan(x/2) is:	4π	π	π/2	2π	○○○●
51. The period of 7 sin(3x + 5) is:	3π	2π/3	14π/3	7π	○●○○
52. The period of cot 3x is:	3π	2π/3	π	π/3	○○○●
53. The period of cos(x/3) is:	3π	6π	π/3	2π/3	○●○○
54. The period of sin(πx) is:	2	2π	1	π	●○○○
55. The period of cos(2πx/5) is:	2π	5	5π	5/2	○●○○
56. The period of sec 4x is:	π/2	π/4	2π	4π	●○○○
57. The period of cosec(x/2) is:	2π	π/2	4π	π	○○●○
58. The period of tan 5x is:	π/5	5π	2π/5	π	●○○○
59. The period of the function f(x) = cot 3x + sin(x/2) is:	π/3	4π	12π	π	○●○○
60. The period of a sum of periodic functions with periods p_1 and p_2 is found by taking the:	sum of p_1 and p_2	HCF of p_1 and p_2	LCM of p_1 and p_2	product of p_1 and p_2	○○●○
61. The period of sin x + cos x is:	π	π/2	2π	4π	○○●○
62. The period of sin 2x + cos 3x is:	2π	2π/3	6π	π	●○○○
63. The period of $\sin^2 x$ is:	π/2	4π	π	2π	○○●○
64. The period of |sin x| is:	2π	4π	π	π/2	○○●○
65. The period of $\cos^2 x$ is:	4π	π/2	π	2π	○○●○

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Questions	A	B	C	D	A B C D
66. For y = a + b sin θ, the maximum value occurs when sin θ equals:	1	0	a	−1	●○○○
67. For y = a + b sin θ with b > 0, the maximum value is:	a − b	b	a + b	a	○○●○
68. For y = a + b sin θ with b > 0, the minimum value is:	−b	a − b	b − a	a + b	○●○○
69. For y = a + b cos θ, the maximum value occurs when cos θ equals:	b	0	−1	1	○○○●
70. The maximum value of y = 3 + 4 sin θ is:	12	1	3	7	○○○●
71. The minimum value of y = 3 + 4 sin θ is:	−1	0	3	7	●○○○
72. The maximum value of y = 5 − 3 cos θ is:	15	8	2	5	○●○○
73. The minimum value of y = 5 − 3 cos θ is:	8	2	−3	5	○●○○
74. The maximum value of y = 4 − 2 sin θ is:	4	2	6	8	○○●○
75. The minimum value of y = 4 − 2 sin θ is:	4	0	6	2	○○○●
76. The maximum value of y = 2 sin θ is:	0	1	2	−2	○○●○
77. The maximum value of y = 6 + 2 cos(3θ + 1) is:	6	12	4	8	○○○●
78. The minimum value of y = 6 + 2 cos(3θ + 1) is:	0	8	6	4	○○○●
79. The maximum value of y = −3 + 5 sin 2θ is:	2	−3	−8	5	●○○○
80. The minimum value of y = −3 + 5 sin 2θ is:	2	−5	−3	−8	○○○●
81. The maximum value of 7 cos x + 24 sin x is:	17	25	31	7	○●○○
82. The minimum value of 7 cos x + 24 sin x is:	−25	−17	−7	−31	●○○○

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Questions	A	B	C	D	A B C D
83. The minimum value of f(θ) = 17 sin 4θ is:	17	−68	−4	−17	○○○●
84. If the range of f(θ) = a sin 2θ + b, where a > 0, is [3, 5], then a and b are:	a = 2, b = 3	a = 1, b = 4	a = 3, b = 2	a = 4, b = 1	○●○○
85. The maximum value of the reciprocal function 1/(2 + sin θ) is:	3	1/3	1/2	1	○○○●
86. The minimum value of the reciprocal function 1/(2 + sin θ) is:	1/2	1	3	1/3	○○○●
87. The maximum value of 1/(3 − 2 cos θ) is:	1	3	1/3	1/5	●○○○
88. The minimum value of 1/(3 − 2 cos θ) is:	1/3	1/5	1	5	○●○○
89. The reciprocal of a function is maximum when the original positive function is:	zero	maximum	undefined	minimum	○○○●
90. A trigonometric function of type a + b sin(cθ + d) has its maximum value when sin(cθ + d) equals:	−1	1	0	c	○●○○
91. Graphs of trigonometric functions can be drawn over intervals of length equal to their:	periods	domains	ranges	amplitudes	●○○○
92. Once the graph of a periodic function is drawn in one period, the whole graph is obtained by:	rotating it only	stretching it only	repeating it over intervals of length equal to the period	reflecting it only	○○●○
93. To sketch y = a sin bx (b > 0), Step 1 is to find the period:	2πb	b/2π	2π/b	π/b	○○●○
94. In sketching y = a sin bx, the interval of length one period is divided into:	four equal parts	five equal parts	two equal parts	three equal parts	●○○○
95. In sketching y = a sin bx, the points obtained from the quarter divisions are maximum points, minimum points and:	domains	y-intercepts only	asymptotes	x-intercepts	○○○●
96. The graph of y = sin x in [0, 2π] is called a:	amplitude	period	asymptote	cycle	○○○●
97. The amplitude of y = a sin bx is:	b	|a|	a/b	2π/b	○●○○
98. The amplitude of y = sin x is:	2	1	0	π	○●○○
99. The amplitude of y = 3 sin 2x is:	1	3	6	2	○●○○

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Questions	A	B	C	D	A B C D
100. The period of y = 3 sin 2x is:	3π	π/2	π	2π	○○●○
101. The amplitude of y = 3 cos 2x is:	6	3	2	1	○●○○
102. The period of y = 3 cos 2x is:	2π	3π	π/2	π	○○○●
103. For y = 3 sin 2x, the graph in [0, π] is divided into eight equal parts, so each part has length:	π/8	π/16	π/4	π/2	●○○○
104. The graph of y = sin x passes through the:	point (0, −1)	point (0, 1)	point (π, 1)	origin	○○○●
105. The graph of y = cos x at x = 0 has the value:	−1	1	0	2	○●○○
106. The values of sin(π/6) and sin(π/3) used for plotting are respectively:	0.5 and 0.86	0.5 and 1	1 and 0.5	0.86 and 0.5	●○○○
107. The values of tan(π/6) and tan(π/3) used for plotting are about:	1.73 and 0.58	0.5 and 0.86	0.58 and 1.73	1 and 1.73	○○●○
108. The graph of y = tan x has vertical asymptotes at:	x = π/2 + nπ	x = nπ/4	x = 2nπ	x = nπ	●○○○
109. The graph of y = cot x has vertical asymptotes at:	x = π/2 + nπ	x = 2nπ	x = nπ	x = nπ/4	○○●○
110. The graph of y = sec x has vertical asymptotes at:	x = π/2 + nπ	x = 2nπ	x = nπ/4	x = nπ	●○○○
111. The graph of y = cosec x has vertical asymptotes at:	x = nπ	x = 2nπ	x = nπ/4	x = π/2 + nπ	●○○○
112. The graph of y = tan x is drawn over one period of length:	2π	π	4π	π/2	○●○○
113. The graph of y = cosec x over [0, 2π] has no points between:	0 and 1	1 and 2	−1 and 1	−2 and 2	○○●○
114. The graph of y = sec x has no points between:	1 and 2	0 and 1	−2 and 2	−1 and 1	○○○●
115. The graph of y = tan x is symmetric about the:	line y = x	x-axis	y-axis	origin	○○○●
116. The graph of y = cos x is symmetric about the:	line y = x	y-axis	x-axis	origin	○●○○

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Questions	A	B	C	D	A B C D
117. A function is even if and only if:	f(−x) = f(x)	f(x) = x	f(−x) = −f(x)	f(x) = 0	●○○○
118. A function is odd if and only if:	f(x) = 0	f(−x) = −f(x)	f(−x) = f(x)	f(x) = 1/x	○●○○
119. The graph of an even function is symmetric about the:	y-axis	origin	x-axis	line y = x	●○○○
120. The graph of an odd function is symmetric about the:	y-axis	origin	line y = 1	x-axis	○●○○
121. The sine function is:	odd	even	both even and odd	neither even nor odd	●○○○
122. The cosine function is:	both even and odd	odd	even	neither even nor odd	○○●○
123. The tangent function is:	neither even nor odd	even	odd	both even and odd	○○●○
124. The cotangent function is:	odd	constant	even	neither even nor odd	●○○○
125. The secant function is:	both even and odd	even	odd	neither even nor odd	○●○○
126. The cosecant function is:	even	constant	odd	neither even nor odd	○○●○
127. The function f(x) = x^2 cos x is:	both even and odd	neither even nor odd	odd	even	○○○●
128. The function f(x) = x sin x is:	odd	both even and odd	even	neither even nor odd	○○●○
129. The function f(x) = x cos x is:	neither even nor odd	both even and odd	even	odd	○○○●
130. The function f(x) = x + sin x is:	neither even nor odd	both even and odd	odd	even	○○●○
131. The function f(x) = sin x + cos x is:	both even and odd	odd	even	neither even nor odd	○○○●
132. The function f(x) = $\sin^2$ x is:	both even and odd	odd	even	neither even nor odd	○○●○
133. The function f(x) = |tan x| is:	odd	even	neither even nor odd	both even and odd	○●○○

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Questions	A	B	C	D	A B C D
134. The function f(x) = sin x cos x is:	odd	both even and odd	neither even nor odd	even	●○○○
135. The function f(x) = x^3 sin x is:	both even and odd	neither even nor odd	odd	even	○○○●
136. Sine and cosine graphs can be transformed to fit a specific situation using:	y = a f[b(x − c)] + d	y = a + f(x)	y = f(ax)b	y = f(x)/b	●○○○
137. In y = a f[b(x − c)] + d, the quantity a gives the:	amplitude (vertical stretch)	phase shift	midline	period	●○○○
138. In y = a f[b(x − c)] + d, the quantity b is related to the:	period (horizontal stretch)	midline	phase shift	amplitude	●○○○
139. In y = a f[b(x − c)] + d, the quantity c is the:	amplitude	period	phase shift (horizontal translation)	midline	○○●○
140. In y = a f[b(x − c)] + d, the quantity d is the:	amplitude	vertical translation (midline)	phase shift	period	○●○○
141. The amplitude of a sinusoidal function with maximum M and minimum m is:	(M − m)/2	M − m	(M + m)/2	M + m	●○○○
142. The midline value of a sinusoidal function with maximum M and minimum m is:	(M − m)/2	Mm	M − m	(M + m)/2	○○○●
143. A Ferris wheel has diameter 30 m and centre 17 m above the ground. The radius of the wheel is:	15 m	30 m	32 m	17 m	●○○○
144. For the same Ferris wheel, the height of the lowest point above the ground is:	32 m	2 m	15 m	17 m	○●○○
145. For the same Ferris wheel, the height of the highest point above the ground is:	47 m	17 m	32 m	30 m	○○●○
146. The same Ferris wheel makes one revolution every 60 seconds. The period is:	30 s	15 s	60 s	120 s	○○●○
147. A rider starts at the lowest point of the Ferris wheel. The height function using cosine is:	h(t) = −15 cos(2πt) + 17	h(t) = −17 cos(πt/30) + 15	h(t) = 15 cos(πt/30) + 17	h(t) = −15 cos(πt/30) + 17	○○○●
148. The height of the rider on the above Ferris wheel at t = 45 s is:	17 m	32 m	2 m	15 m	●○○○
149. A Ferris wheel of diameter 40 m is boarded from a platform 4 m above the ground and completes one revolution in 16 minutes. The amplitude of its height function is:	40	20	4	16	○●○○
150. For that Ferris wheel, the vertical shift of the height function is:	4	44	24	20	○○●○

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Questions	A	B	C	D	A B C D
151. For that Ferris wheel, the period of the height function is:	4 minutes	16 minutes	32 minutes	8 minutes	○●○○
152. For that Ferris wheel, the height function is:	h(t) = 24 − 20 cos(πt/16)	h(t) = 24 − 20 cos(πt/8)	h(t) = 20 − 24 cos(πt/8)	h(t) = 24 + 20 sin(πt/8)	○●○○
153. The height of a person on that Ferris wheel after 5 minutes is about:	31.65 m	24 m	12.35 m	44 m	●○○○
154. Alternating current reverses direction in a:	linear fashion	constant fashion	random fashion	cyclic fashion	○○○●
155. The period of an AC supply of frequency 60 Hz is:	120 s	60 s	1/30 s	1/60 s	○○○●
156. The amplitude of an AC voltage whose maximum is 170 V is:	120 V	340 V	170 V	85 V	○○●○
157. A 60 Hz AC voltage with a maximum of 170 V can be modelled as:	V(t) = 60 sin(170πt)	V(t) = 170 sin(60πt)	V(t) = 170 sin(120πt)	V(t) = 170 cos(60t)	○○●○
158. In V(t) = a sin[k(t − d)] + c for an AC voltage, the quantity a represents the:	phase shift	frequency	period	amplitude	○○○●
159. For an AC supply, the angular frequency k equals:	frequency/2π	1/frequency	π × frequency	2π × frequency	○○○●
160. The pendulum of a clock is at rest 16 cm above the base and its highest point is 20 cm above the base. The amplitude of its motion is:	36 cm	4 cm	20 cm	16 cm	○●○○
161. For that pendulum, the midline of its height is at:	18 cm	16 cm	20 cm	4 cm	○●○○
162. The pendulum takes 2 seconds for one full swing, so the period is:	2 s	1 s	4 s	π s	●○○○
163. The pendulum released from its highest point has the height function:	h(t) = 16 + 4 sin(πt)	h(t) = 20 + 4 cos(πt)	h(t) = 4 + 16 cos(πt)	h(t) = 16 + 4 cos(πt)	○○○●
164. At t = 1 s, the height of the pendulum above is:	16 cm	20 cm	12 cm	4 cm	○○●○
165. The top of a flagpole sways 8 cm to each side of its resting position. The amplitude of its motion is:	0	4 cm	8 cm	16 cm	○○●○
166. If a flagpole top moves back and forth 260 times per minute, the period is:	1/260 s	13/3 s	3/13 s	260 s	○○●○
167. Domain and range for real-life models such as height versus time are usually restricted to:	meaningful values of time (t ≥ 0) and the heights reached	all real numbers for both	only negative numbers	only integers	●○○○

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Questions	A	B	C	D	A B C D
168. Trigonometric functions are used to model:	tides, sound waves and seasons	only circles' areas	only straight lines	only parabolas	●○○○
169. The ideal angle for solar panel placement is one of the real-world applications of:	matrices	polynomial division	trigonometric functions	sequences	○○●○
170. The domain of y = sec 2x is all real x except:	$x = n\pi$	$x = (2n + 1)\pi/4$	$x = (2n + 1)\pi/2$	$x = n\pi/2$	○●○○
171. The range of y = 4 sin x − 1 is:	$[-4, 4]$	$[-5, 4]$	$[-1, 3]$	$[-5, 3]$	○○○●
172. The range of y = 2 cos x + 3 is:	[1, 5]	$[-2, 2]$	[1, 3]	[3, 5]	●○○○
173. The range of y = 3 − 2 sin x is:	[1, 5]	$[-2, 2]$	[3, 5]	[1, 3]	●○○○
174. The domain of y = 1/sin x is all real x except:	$x = \pi$	$x = n\pi$	$x = (2n + 1)\pi/2$	$x = 2n\pi$	○●○○
175. The period of cos(3x − 2) is:	3π	$2\pi/3$	$\pi/3$	2π	○●○○
176. The period of 5 sin(2x + 1) is:	2π	π	5π	$\pi/2$	○●○○
177. The period of tan 3x is:	$2\pi/3$	π	3π	$\pi/3$	○○○●
178. The period of cot(x/2) is:	π	2π	$\pi/2$	4π	○●○○
179. The period of sec(x/3) is:	3π	$\pi/3$	$2\pi/3$	6π	○○○●
180. The period of cosec 2x is:	π	2π	4π	$\pi/2$	●○○○
181. The period of sin x + tan x is:	3π	π	2π	$\pi/2$	○○●○
182. The period of cos x + sin(x/2) is:	2π	6π	π	4π	○○○●
183. The period of 3 cos(2πx) is:	2π	1	π	2	○●○○
184. The maximum value of 2 + 3 cos θ is:	5	2	6	−1	●○○○

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Questions	A	B	C	D	A B C D
185. The maximum value of 1 − 4 sin 2θ is:	1	−4	−3	5	○○○●
186. The minimum value of 1 − 4 sin 2θ is:	1	−3	−4	5	○●○○
187. The maximum value of 9 sin θ + 12 cos θ is:	3	21	15	108	○○●○
188. The minimum value of 5 sin θ − 12 cos θ is:	−5	−17	−13	−7	○○●○
189. The maximum value of 1/(5 + 3 sin θ) is:	1/8	1	1/5	1/2	○○○●
190. The minimum value of 1/(5 + 3 sin θ) is:	1/5	1/2	1/8	1/3	○○●○
191. In [0, 2π], the graph of y = sin x has its maximum at x equal to:	2π	3π/2	π	π/2	○○○●
192. In [0, 2π], the graph of y = sin x has its minimum at x equal to:	π/2	3π/2	0	π	○●○○
193. In [0, 2π], the graph of y = cos x has its minimum at x equal to:	3π/2	π/2	π	0	○○●○
194. The x-intercepts of y = sin x in [0, 2π] are:	π/2 and 3π/2	π/2, π and 3π/2	0 and π only	0, π and 2π	○○○●
195. The x-intercepts of y = cos x in [0, 2π] are:	π/2 and 3π/2	0 and 2π	0, π and 2π	π only	●○○○
196. The maximum value of y = 2 sin x is:	1	0	4	2	○○○●
197. The graph of y = −sin x is the reflection of the graph of y = sin x in the:	y-axis	x-axis	origin only	line y = x	○●○○
198. The graph of y = sin 2x completes how many cycles in [0, 2π]?	4	1/2	2	1	○○●○
199. The midline of the graph of y = 3 sin x + 2 is the line:	y = 0	y = 2	y = 5	y = 3	○●○○
200. The graph of y = sin(x − π/3) is the graph of y = sin x shifted:	π/3 downward	π/3 to the right	π/3 upward	π/3 to the left	○●○○

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