All "Arc-trig" functions have the traditional ranges unless otherwise stated.

1. B Since $\frac{6\pi}{3} = 2\pi$, we need the remainder when 2020 is divided by 6, which is 4. Thus, $\cos\left(\frac{2020\pi}{3}\right) = \cos\left(\frac{4\pi}{6}\right) = \cos\left(\frac{2\pi}{3}\right) = -\frac{1}{2}$.

2. C $\sin(2x) = \cos(x)$ implies $2\sin(x)\cos(x) = \cos(x)$ so $\cos(x)\,(2\sin(x) - 1) = 0$. Thus, $\cos(x) = 0$ for which $x = \frac{\pi}{2}, \frac{3\pi}{2}$ or $\sin(x) = \frac{1}{2}$ for which $x = \frac{\pi}{6}, \frac{5\pi}{6}$. The sum of solutions is $2\pi + \pi = 3\pi$.

3. C The domain of sine is all reals, so we only need *x* to be in the domain of Arccos$(\frac{x}{2})$. Thus, $-1 \le \frac{x}{2} \le 1$ so the domain is [-2, 2].

4. A Since the range of Arccos$(\frac{x}{2})$ is $[0, \pi]$, the range of *f* is the set of outputs of sine over the interval $[0, \pi]$, which is $[0, 1]$. Note: By drawing a right triangle, one can show *f* is the graph of the upper half of the ellipse $\frac{x^2}{4} + y^2 = 1$.

5. C For the given point, we can draw a right triangle in Quadrant II whose vertex is the origin with legs -3 & 5 and hypotenuse $\sqrt{9+25} = \sqrt{34}$. Noting $\cos(\theta) = -\frac{3}{\sqrt{34}}$, by a double angle identity, $\cos(2\theta) = 2\cos^2(\theta) - 1 = 2\left(\frac{9}{34}\right) - 1 = -\frac{16}{34} = -\frac{8}{17}$.

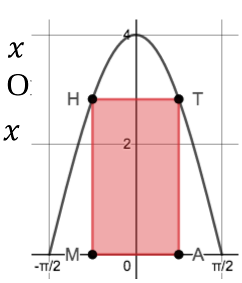
6. D Let *a*, *b*, *c* be the side lengths of the triangle where side *c* opposes angle 120°. By Law of Cosines, $c^2 = a^2 + b^2 - 2ab\cos(120°)$. Since $\cos(120°) = -\frac{1}{2}$, $c^2 = a^2 + b^2 - 2ab\left(-\frac{1}{2}\right) = a^2 + ab + b^2$. We check each option:

6, 10, 13: $169 = 13^2 \ne 10^2 + 10 \cdot 13 + 13^2 = 399$. Fail.
4, 5, 8: $64 = 8^2 \ne 4^2 + 4 \cdot 5 + 5^2 = 61$. Fail.
8, 15, 17: $289 = 17^2 \ne 8 + 8 \cdot 15 + 15^2 = 289$. Fail.
5, 16, 19: $361 = 19^2 = 5^2 + 5 \cdot 16 + 16^2 = 361$. Thus, 5, 16, 19 works.

7. B Using the difference identity, $\sin(\theta - \frac{3\pi}{4}) = \sin\theta\cos\left(\frac{3\pi}{4}\right) - \cos\theta\sin\left(\frac{3\pi}{4}\right)$ or $-\frac{1}{\sqrt{2}}(\sin\theta + \cos\theta)$. Thus, $(\sin\theta + \cos\theta) = -\sqrt{2}\sin(\theta - \frac{3\pi}{4})$ so $a = -\sqrt{2}$.

8. C Let $\alpha > \beta$ be the acute angles that the two given lines make relative to the horizontal. Then $\tan\alpha = 3$ and $\tan\beta = \frac{1}{3}$. Then $\alpha - \beta$ is the angle between the two lines. So $\tan(\alpha - \beta) = \frac{\tan\alpha - \tan\beta}{1 + \tan\alpha\tan\beta} = \frac{\left(3 - \frac{1}{3}\right)}{1 + 3 \cdot \frac{1}{3}} = \frac{\frac{8}{3}}{2} = \frac{4}{3}$.

9. C $2\sin^3 x + 2\sin x + 5\cos^2 x = 5$ implies $2\sin^3 x + 2\sin x - 5\sin^2 x$
$\sin x\,(2\sin^2 x - 5\sin x + 2) = \sin x\,(2\sin x - 1)(\sin x - 2) = 0$. O
interval, $\sin x = 0$ has 3 solutions, $\sin x = \frac{1}{2}$ has 2 solutions, and $\sin x$
Thus, there is a total of 5 solutions on $[0, 2\pi]$.



10. B Consider the diagram shown. Since $MA = \frac{\pi}{2}$, then the *x*-coordinate of *A* is $\frac{\pi}{4}$ and thus the height *AT* = $4\cos\left(\frac{\pi}{4}\right) = 4\left(\frac{1}{\sqrt{2}}\right) = 2\sqrt{2}$.
The perimeter of *MATH* is $2\left(\frac{\pi}{2} + 2\sqrt{2}\right) = \pi + 4\sqrt{2}$.

11. C $\cos(\alpha - \frac{\pi}{2}) + \cos^2(\alpha) = \cos\left(\frac{\pi}{2} - \alpha\right) + 1 - \sin^2\alpha = \sin\alpha + 1 - \sin^2\alpha$.
By substitution, this equals $-\frac{3}{7} + 1 - \left(-\frac{3}{7}\right)^2 = -\frac{21}{49} + \frac{49}{49} - \frac{9}{49} = \frac{19}{49}$.

12. A $\frac{\cos^4(2x) - \sin^4(2x)}{\cos(4x)} = \frac{(\cos^2(2x) - \sin^2(2x))(\cos^2(2x) + \sin^2(2x))}{\cos(2\cdot 2x)} = \frac{\cos(2\cdot 2x)(1)}{\cos(2\cdot 2x)}$ by a double angle identity. This equals 1.

13. D From the given base area, we know $PQ = \sqrt{8} = 2\sqrt{2}$ and $PR = \sqrt{2}PQ = 4$.
Since height $VR = 2\sqrt{6}$, we know diagonal $VP = \sqrt{4^2 + \left(2\sqrt{6}\right)^2} = \sqrt{16 + 24} = 2\sqrt{10}$.
Thus, $\cos(\angle VPR) = \frac{4}{2\sqrt{10}} = \frac{2}{\sqrt{10}} = \frac{\sqrt{10}}{5}$.

14. D The domain of *f* is the same as the domain of $\sec x = \frac{1}{\cos x}$: $\{x | x \neq \frac{\pi}{2} + \pi k\}$
For the range, $-\sec x$ has range $(-\infty, -1] \cup [1, \infty)$. Thus, $2^{-\sec x}$ has range $\{y | 0 < y \leq \frac{1}{2} \text{ or } y \geq 2\}$.

15. C $12 - 4\sin^2\beta - 4\sin^2\beta\cot^2\beta = 12 - 4\sin^2\beta\,(1 + \cot^2\beta) = 12 - 4\sin^2\beta\csc^2\beta$
$= 12 - 4 = 8$

16. C $\sin(x) = k\cos(x)$ so $\tan(x) = k$. Drawing a right triangle, $\sin(x) = \frac{k}{\sqrt{k^2+1}}$ and $\cos(x) = \frac{1}{\sqrt{k^2+1}}$. Thus, $\frac{24}{25} = \sin(2x) = 2\frac{k}{\sqrt{k^2+1}} \cdot \frac{1}{\sqrt{k^2+1}}$ by a double angle identity.
Hence, $\frac{12}{25} = \frac{k}{k^2+1}$ so $12k^2 - 25k + 12 = (3k-4)(4k-3) = 0$. Since *k* < 1, then $k = \frac{3}{4}$.

17. A $\sin(3\theta) = \sin(2\theta + \theta) = \sin(2\theta)\cos(\theta) + \cos(2\theta)\sin(\theta)$
$= 2\sin\theta\cos^2\theta + (1 - 2\sin^2\theta)\sin\theta = 2\sin\theta(1 - \sin^2\theta) + \sin\theta - 2\sin^3\theta$
$= 2\sin\theta - 2\sin^3\theta + \sin\theta - 2\sin^3\theta = \sin\theta(-4\sin^2\theta + 3)$
From this, *A* = −4 and *B* = 3 so $A \cdot B = -12$

18. E We are given $180 - A = 110 + 0.6(90 - A)$ so $1800 - 10A = 1100 + 540 - 6A$.
Simplifying, $160 = 4A$ so *A* = 40.

19. A $\sum_{k=1}^{359} \cos(k°) = 2(\cos 1° + \cos 179° + \cos 2° + \cos 178° + \cdots + \cos 89° + \cos 91°)$
$+2\cos 90° + \cos 180°$. By symmetry, the first sum is 0. The second sum is also 0.
This leaves $\cos 180° = -1$.

20. A $\sin^4 x + \cos^4 x = (\sin^2 x + \cos^2 x)^2 - 2(\sin x \cos x)^2 = 1 - \frac{1}{2}(2 \sin x \cos x)^2$
$= 1 - \frac{1}{2}(\sin 2x)^2 = 1 - \frac{c^2}{2}$.

21. D $\sin^2 \theta > \frac{1}{4}$ implies either $\sin \theta > \frac{1}{2}$ or $\sin \theta < -\frac{1}{2}$. The former implies θ lies on the interval $\left(\frac{\pi}{6}, \frac{5\pi}{6}\right)$. The latter implies θ lies on the interval $\left(\frac{7\pi}{6}, \frac{11\pi}{6}\right)$. Thus, the desired probability is $\frac{2\left(\frac{4\pi}{6}\right)}{2\pi} = \frac{4}{6} = \frac{2}{3}$.

22. C Draw in *KT* to form two congruent 30-60-90 triangles where $ET = TI = \frac{12}{\sqrt{3}} = 4\sqrt{3}$.
The area of the kite is twice the area of one of these triangles: $2 \cdot \frac{1}{2} \cdot 12 \cdot 4\sqrt{3} = 48\sqrt{3}$.

23. B Let $\text{Arcsin}\left(\frac{1}{5}\right) = x$ so $\sin x = \frac{1}{5}$. Draw a right triangle with acute angle *x* with this ratio.
Let *y* be the other acute angle in the triangle. We see that $\cos y = \frac{1}{5}$ so $\text{Arccos}\left(\frac{1}{5}\right) = y$.
Thus, $x + y = \frac{\pi}{2}$ since they are the two acute angles in the same right triangle.
Thus, $\cot(\text{Arcsin}\left(\frac{1}{5}\right) + \text{Arccos}(\frac{1}{5})) = \cot\left(\frac{\pi}{2}\right) = 0$.

24. C The area of the given right triangle is $\frac{1}{2}(3)(4) = 6$. Letting *r* be the inradius, the area is also $\frac{1}{2}(3)(r) + \frac{1}{2}(4)(r) + \frac{1}{2}(5)(r) = \frac{1}{2}r(3 + 4 + 5) = 6r$. Thus, $6r = 6$ and *r* = 1.

25. C The range of $y = 6\sin(2x) - 4$ is $[-10, 2]$. Taking the absolute value makes negative values in the range positive. Since the absolute value is non-negative, the range of *f* is $[0, 10]$.

26. D Expanding the sum, $g(x) = \sin(x) + \sin\left(\frac{x}{2}\right) + \sin\left(\frac{x}{3}\right) + \cdots + \sin\left(\frac{x}{10}\right)$. The period of each summand is $2\pi, 4\pi, 6\pi, \ldots, 20\pi$, respectively. The period of g is the least common multiple of these even multiples of π, in other words, $2\pi \cdot lcm(1,2,3, \ldots ,10)$.
$lcm(1,2,3, \ldots ,10) = 8 \cdot 9 \cdot 5 \cdot 7 = 2520$, so the period of g is 5040π.

27. A The quadratic must factor as $\left(x - \tan\left(\frac{\pi}{12}\right)\right)\left(x - \cot\left(\frac{\pi}{12}\right)\right)$.
Expanding, we get $x^2 - (\tan\frac{\pi}{12} + \cot\frac{\pi}{12})x + \tan\frac{\pi}{12}\cot\frac{\pi}{12}$.
Note $(\tan\frac{\pi}{12} + \cot\frac{\pi}{12}) = \frac{\tan^2\frac{\pi}{12}+1}{\tan\frac{\pi}{12}} = \frac{\sec^2\frac{\pi}{12}}{\tan\frac{\pi}{12}} = \frac{1}{\sin\frac{\pi}{12}\cos\frac{\pi}{12}} = \frac{2}{\sin\frac{\pi}{6}} = 4$.
Also, $\tan\frac{\pi}{12}\cot\frac{\pi}{12} = 1$. Thus, our quadratic $f(x) = x^2 - 4x + 1$ so $a + b = -3$.

28. B Although the parent secant function is even, I is false due to the horizontal shift.
The new period is $\frac{2\pi}{\pi} = 2$ so II is true. *f* is defined at $x = \frac{\pi}{4}$ so III is false. Only II is true.

29. C The six trig expressions can be grouped into 3 reciprocal pairs so the product is 1.
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30. B Let $\angle CDB = \theta$ so $\angle CDA = \pi - \theta$. By Law of Cosines, we can write two equations:
1) $11^2 = 11^2 + 8^2 - 2 \cdot 11 \cdot 8 \cdot \cos\theta$ so $\cos\theta = \frac{4}{11}$.
2) $13^2 = 11^2 + x^2 - 2 \cdot 11 \cdot x \cdot \cos(\pi - \theta)$
By symmetry, $\cos(\pi - \theta) = -\cos(\theta)$. Substituting this and 1) into 2):
$13^2 = 11^2 + x^2 + 8x$ or $x^2 + 8x - 48 = (x + 12)(x - 4) = 0$
for which only the positive quantity can be a length. Thus, $x = 4$.