Math Formulas: Trigonometry Identities

Right-Triangle Definitions

1. $$\sin \alpha = \frac{\text{Opposite}}{\text{Hypotenuse}}$$

2. $$\cos \alpha = \frac{\text{Adjacent}}{\text{Hypotenuse}}$$

3. $$\tan \alpha = \frac{\text{Opposite}}{\text{Adjacent}}$$

4. $$\csc \alpha = \frac{1}{\sin \alpha} = \frac{\text{Hypotenuse}}{\text{Opposite}}$$

5. $$\sec \alpha = \frac{1}{\cos \alpha} = \frac{\text{Hypotenuse}}{\text{Adjacent}}$$

6. $$\cot \alpha = \frac{1}{\tan \alpha} = \frac{\text{Adjacent}}{\text{Opposite}}$$

Reduction Formulas

7. $$\sin(-x) = -\sin(x)$$

8. $$\cos(-x) = \cos(x)$$

9. $$\sin\left(\frac{\pi}{2} - x\right) = \cos(x)$$

10. $$\cos\left(\frac{\pi}{2} - x\right) = \sin(x)$$

11. $$\sin\left(\frac{\pi}{2} + x\right) = \cos(x)$$

12. $$\cos\left(\frac{\pi}{2} + x\right) = -\sin(x)$$

13. $$\sin(\pi - x) = \sin(x)$$

14. $$\cos(\pi - x) = -\cos(x)$$

15. $$\sin(\pi + x) = -\sin(x)$$

16. $$\cos(\pi + x) = -\cos(x)$$

Basic Identities

17. $$\sin^2 x + \cos^2 x = 1$$

18. $$\tan^2 x + 1 = \frac{1}{\cos^2 x}$$

19. $$\cot^2 x + 1 = \frac{1}{\sin^2 x}$$

Sum and Difference Formulas

20. $$\sin(\alpha + \beta) = \sin\alpha \cdot \cos\beta + \sin\beta \cdot \cos\alpha$$

21. $$\sin(\alpha - \beta) = \sin\alpha \cdot \cos\beta - \sin\beta \cdot \cos\alpha$$

22. $$\cos(\alpha + \beta) = \cos\alpha \cdot \cos\beta - \sin\alpha \cdot \cos\beta$$

23. $$\cos(\alpha - \beta) = \cos\alpha \cdot \cos\beta + \sin\alpha \cdot \cos\beta$$

24. $$\tan(\alpha + \beta) = \frac{\tan\alpha + \tan\beta}{1 - \tan\alpha \cdot \tan\beta}$$

25. $$\tan(\alpha - \beta) = \frac{\tan\alpha - \tan\beta}{1 + \tan\alpha \cdot \tan\beta}$$

Double Angle and Half Angle Formulas

26. $$\sin(2\,\alpha) = 2 \cdot \sin\alpha \cdot \cos\alpha$$

27. $$\cos(2\,\alpha) = \cos^2\alpha - \sin^2\alpha$$

28. $$\tan(2\,\alpha) = \frac{2\tan\alpha}{1 - \tan^2\alpha}$$

29. $$\sin\frac{\alpha}{2} = \pm\sqrt{\frac{1 - \cos\alpha}{2}}$$

30. $$\cos\frac{\alpha}{2} = \pm\sqrt{\frac{1 + \cos\alpha}{2}}$$

31. $$\tan\frac{\alpha}{2} = \frac{1 - \cos\alpha}{\sin\alpha} = \frac{\sin\alpha}{1 - \cos\alpha}$$

32. $$\tan\frac{\alpha}{2} = \pm\sqrt{\frac{1 + \cos\alpha}{1 - \cos\alpha}}$$

Other Useful Trig Formulas

Law of sines

33. $$\frac{\sin\alpha}{\alpha} = \frac{\sin\beta}{\beta} = \frac{\sin\gamma}{\gamma}$$

Law of cosines

34.
$$a^2 = b^2 + c^2 - 2 \cdot b \cdot c \cdot \cos\alpha$$
$$b^2 = a^2 + c^2 - 2 \cdot a \cdot c \cdot \cos\beta$$
$$c^2 = a^2 + b^2 - 2 \cdot a \cdot b \cdot \cos\gamma$$

Area of triangle

35. $$A = \frac{1}{2}a\,b\,\sin\gamma$$