Evaluate the following seven integrals:

1. $\int \frac{dx}{\sqrt{c^2+x^2}} =$
2. $\int ax^n dx =$
3. $\int \cos(x) dx =$
4. $\int \sin(x) dx =$
5. $\int \left(\sqrt{x^7} - \sqrt[7]{x^2} + 2\sqrt[3]{x^7}\right) dx =$
6. $\int \frac{dx}{x} =$
7. $\int (2x^2-1)(1+5x)dx =$

8. Determine $f(x)$ given that $f'(x) = 3x^5 - 4x^3 - 2x^2 + 7$

9. Determine $h(x)$ given $h'(x) = 3x^{-4} - x^{-3} + x^{-2} - 1$

10. A 62-N force acts at 30°and a second 62-N force acts at 60°.
a) Determine the resultant force.
b) What is the magnitude and direction of the force that produces equilibrium?

11. Two forces act on an object. One force is 6.0 N horizontally. The second force is 8.0 N vertically.
a) Find the magnitude and direction of the resultant.
b) Find the magnitude and direction of the equilibrant.

12. A car weighing 12,000 N is parked on a 36°slope.
a) Find the force tending to cause the car to roll down the hill.
b) What is the force the car exerts perpendicular to the hill?

In the following two problems, solve for x:

13. $x(x-c) = a$
14. $\frac{x}{2} + \frac{x}{3} = 1$

15. Determine the dot product of $\vec{a} \cdot \vec{b}$ for the following two cases:

a) $\vec{a} = <0, 4, -2>$ and $\vec{b} = 2\hat{\imath} - \hat{\jmath} + 7\hat{k}$
b) $\vec{a} = <9, 5, -4, 2>$ and $\vec{b} = <-3, -2, 7, -1>$

16. A 2-dimensional vector $\vec{r}$, starting at the origin, has a magnitude of $|\vec{r}| = 5$. The vector is at an angle of 54°with respect to the origin. Find the Cartesian components of this vector.

17. Evaluate the following integral:

$$\int \frac{dx}{(c^2+x^2)^{3/2}} =$$

18. Evaluate the following:

$$\frac{\vec{A} \times \vec{B}}{\vec{A} \cdot \vec{B}} =$$

19. Determine the cross product of $\vec{a} \times \vec{b}$ for the following two cases:

a) $\vec{a} = <2, 1, -1>$ and $\vec{b} = <-3, 4, 1>$
b) $\vec{a} = 4\hat{x} + 3\hat{y} + 7\hat{z}$ and $\vec{b} = <2, 8, 5>$

20. Determine the cross product of $\vec{b} \times \vec{a}$ for the following two cases:

$$\text{a) } \vec{a} = < 2, 1, -1 > \quad \text{and } \vec{b} = < -3, 4, 1 >$$
$$\text{b) } \vec{a} = 4\hat{x} + 3\hat{y} + 7\hat{z} \quad \text{and } \vec{b} = < 2, 8, 5 >$$

21. Vector $\vec{A}$ is along the negative x-axis while vector $\vec{B}$ is at an angle 67°from the positive x-axis towards the positive y-axis. $\vec{A}$ has a magnitude of 7 and $\vec{B}$ has a magnitude of 5. Find the resultant vector (direction and magnitude) of the cross product $\vec{A} \times \vec{B}$.

Evaluate the following derivatives:

22. $\dfrac{de^{bx}}{dx}$

23. $\dfrac{d\,(f(x)g(x))}{dx}$

24. $\dfrac{df(x)}{dt}$

25. $\dfrac{d\,(kx^n)}{dx}$

26. Given a time dependent acceleration of $\vec{a}(t) = \alpha t\hat{i} - \beta\hat{j}$, where the object started from the position $\vec{r} = H\hat{j}$, with an initial velocity directed vertically upwards with a magnitude of v_0, find the velocity and position as a function of time.

27. Two blocks are stacked and placed on a frictionless horizontal surface. Mass m_2 is on top of mass m_1. A constant, horizontal force F is applied to m_2 and the blocks move together, due to the presence of static friction between the two blocks.
a) Draw a complete free-body diagram for the system.
b) Identify any and all Newton's 3rd Law pairs. Justify your selection(s).

28. A particle of mass m is subject to a force of magnitude $\frac{a}{x^2}$, which repels it from the origin. If the particle starts moving towards the origin from *very, very far away* from the origin with an initial speed v_0, what is the closest it will get to the origin?

29. The position of a particle as a function of time is given by $\vec{x} = x_0 \cos(\omega t)\hat{i} + y_0 \sin(\omega t)\hat{j}$ where $x_0 > y_0$.
a) What is $\vec{v}(t)$ for this particle?
b) What is $\vec{a}(t)$ for this particle?
c) Draw a generic plot of the trajectory function for the particle. What kind of shape is this? In what direction/sense is the particle moving (indicate with an arrow on the trajectory)?
d) Draw separate plots of $x(t)$ and $y(t)$ on the same axes.

30. If a mass (near the surface of the Earth) that is dropped from rest from 5 meters takes 1 second to reach the ground, roughly how high do you have to drop it from for it to take 3 seconds to reach the ground? Neglect air resistance.

31. Solve the following for x:

$$\frac{M_1}{x^2} = \frac{M_2}{(d-x)^2}$$