1. For the following optimization problems, setup the primary/secondary equations, feasible domain and say which variable you’re optimizing in which interval:

(a) A *cylindrical* snowball is to have a surface area of $2\pi$ square inches. What height should the cylindrical snowball be for its volume to be a maximum? (Hints: $V = \pi r^2 h$).

(b) The product of two positive numbers is 16, minimize the sum of the first with thrice the second.

(c) The sum of two positive numbers is 15, maximize the product.

(d) A rectangular nightstand is to be constructed having a volume of 24 cubic feet. The stand is to have a top, a bottom, and one shelf, a back and 2 sides (see picture). Also, the length is twice the width. Find the dimensions of the nightstand having minimal wood.

(e) A frustum has two flat circular faces (see picture). The smaller circular face has diameter that is always half the size of that of the other circular face. The curved surface area has to be 100 square inches. What radius should the larger circle be for the volume to be a maximum?

(f) An open box with square base is to have surface area equal 54 square cm. Find the dimension of a box with the maximum volume.

2. Use total differentials to estimate

(a) $\sqrt{25.25}$  (b) $\sqrt{99.4}$  (c) $\sqrt{64.008}$  (d) $\sqrt{26.5}$
3. Sketch the graph of the following by analysing its first and second derivatives, domain, intercepts, asymptotes, symmetry, extremas and concavity.

(a) \( f(x) = \frac{x^2}{x^2 + 3} \)  
(b) \( f(x) = \frac{5}{1 + e^{-x}} \)  
(c) \( f(x) = (x + 1)(x + 2)(x + 4) \)  
(d) \( f(x) = (x + 1)^3(x + 2) \)

4. Evaluate the following indefinite integrals:

(a) \( \int x^2 \sqrt{x} \, dx \)  
(b) \( \int x^3 + \cos x - e^x \, dx \)  
(c) \( \int \frac{3}{1 + x^2} - \frac{2}{\sqrt{4 - (2x)^2}} \, dx \)

(d) \( \int \sec x(\sec x + \tan x) \, dx \)  
(e) \( \int (x^2 + 1) \left( \frac{1}{x} + x \right) \, dx \)

5. Use limit process to find the area under \( y = f(x) \) in the indicated interval

(a) \( f(x) = 3 - 2x, \quad [0, 1] \)  
(b) \( f(x) = 16 - x^2, \quad [1, 3] \)  
(c) \( f(x) = x^2 - x^3, \quad [0, 1] \)

6. Use limit process to evaluate the following definite integrals.

(a) \( \int_0^3 2 - x \, dx \)  
(b) \( \int_0^2 1 - x^2 \, dx \)  
(c) \( \int_{-1}^2 3 - 2x \, dx \)