1. Find the work done in raising a 60 kg mass from the floor to a height of 2 m.

2. A spring has natural length 20 cm and a 25 N force is needed to stretch the spring to a length of 30 cm. Find the work done in stretching the spring from length 20 cm to 25 cm.

3. If 6 J of work is needed to stretch a spring from length 10 cm to 12 cm, and 10 J of work is needed to stretch it from 12 cm to 14 cm, what is the spring’s natural length?

4. A 50 ft cable weighing 0.5 lb/ft hangs from the top of a building 120 ft high. a) Find the work done in pulling the cable to the top of the building. b) Find the work done in pulling half the cable to the top of the building. (hint: draw a picture)

5. a) A compressed gas inside a closed cylinder is expanding as a piston is withdrawn. The gas pressure is a function of the gas volume, \( P = P(V) \), and the force exerted by the gas on the piston is the product of the piston surface area and the gas pressure, \( F = \pi r^2 P \), where \( r \) is the cylinder radius. Show that the work done by the gas when it expands from volume \( V_1 \) to \( V_2 \) is

\[
W = \int_{V_1}^{V_2} P(V) \, dV.
\]

b) In a steam engine, the steam pressure \( P \) and volume \( V \) satisfy the relation \( PV^{1.4} = k \), where \( k \) is a constant. Use part (a) to calculate the work done by the engine during a cycle when the steam starts at pressure 1600 lb/in\(^2\) and volume 100 in\(^3\) and expands to volume 800 in\(^3\). Express the answer in ft-lb.

6. A tank with the indicated shape is full of water. Find the work done in pumping the water to the top of the outlet.

7. Is the integral proper or improper? Explain.

a) \( \int_1^2 \frac{1}{2x-1} \, dx \)  
b) \( \int_0^1 \frac{1}{2x-1} \, dx \)

8. Find the area under the curve \( y = 1/x^3 \) from \( x = 1 \) to \( x = b \) for \( b = 10, 100, 1000 \). Express the answer as a fraction and a decimal (e.g. in the case \( b = 10 \), the answer is \( 99/200 = 0.495 \)). Then find the area under the curve in the limit \( b \to \infty \).

9. True or False? Justify your answer.

a) If \( \int_a^b f(x) \, dx \leq \int_a^b g(x) \, dx \), then \( f(x) \leq g(x) \) for all \( x \) in the interval \( [a,b] \).

b) The area under the graph of \( \frac{1}{\sqrt{x}} \) from \( x = 0 \) to \( x = 1 \) is finite.

c) \( \int_{-1}^{1} \frac{dx}{x^2} = -2 \)

10. The error function, defined by \( \text{erf}(x) = \frac{2}{\sqrt{\pi}} \int_0^x e^{-t^2} \, dt \), is used in physics and probability. Find the following quantities. Compute the value in (c) using the midpoint rule with \( n = 2 \).

a) \( \text{erf}(0) \)  
b) \( \text{erf}(0) \)  
c) \( \text{erf}(1) \)  
d) \( \text{erf}(1) \)  
e) \( \lim_{x \to \infty} \text{erf}'(x) \)
f) Sketch the graph of \( \text{erf}(x) \) for \( x \geq 0 \). (hint: you may use the fact that \( \lim_{x \to \infty} \text{erf}(x) = 1 \))

**announcement:** On Friday Sept 25 the class will meet in room B727 in the basement of East Hall for a computer lab using Maple, a software package for calculus and graphics.