Be sure to assign all input to appropriate variables. Do NOT use the control name directly in the calculations. Instead, assign the value of a control to a variable and use the variable in the calculations. Assign the result of the calculations to an appropriate form control. Ensure the forms are well-behaved. A form must contain an Exit button, sensible tabbing and alt-shortcuts where appropriate. Do NOT use form level variables in your solution. All variables should be local to an event subprocedure, or local to the defined functions.

Application 1: Growth & Decay Models

The growth or decay of a function P with respect to time t can be modeled as

$$P(t) = P_0 e^{kt}, \tag{1}$$

where P_0 is the value of P at $t = 0$ (sec) and k is a constant. If $k < 0$ then P decreases with time. if $k > 0$ then P increases with time.

Create an application that gets the values of the constants $P_0 > 0$ and k from the user. Note that we must restrict k in $-0.08 \leq k \leq 0.08$. Depending upon the sign of the constant the user should be notified that the model is a growth or decay model. For a growth model, the program should calculate the time at which $P = 2P_0$, i.e., *doubling time*. On the other hand, if it is a decay model, the program should find the time needed for P to reach $\frac{P_0}{2}$, i.e. *half life time*. In either case, the calculated time should be displayed to the user in units of `min`. Use a minimum of two functions in your program, one of which should be in the calculation of the half life or the doubling time.

Application 2: Mechanical Work

We are interested in creating an application to calculate the work done in extracting oil from a conical tank as shown in Figure 1a using calculus. Let us assume that the oil has a density of $\rho = 2000$ kg/m^3.

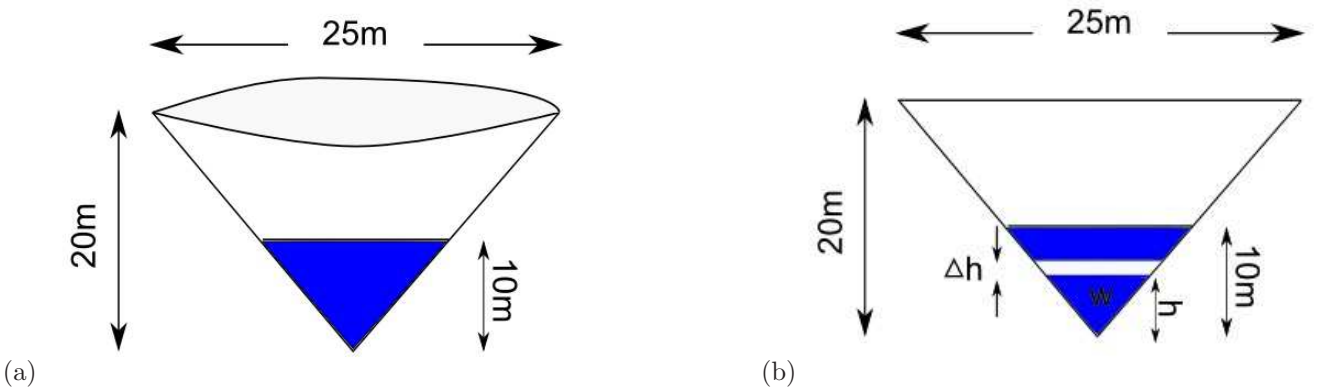

Figure 1: (a) Conical tank containing oil. (b) Slicing the oil sheets horizontally to calculate work.

The calculation proceeds in the following steps:

1. Volume of a slice of oil sheet of width w and thickness Δh is

$$V \approx \pi \left(\frac{w}{2}\right)^2 \Delta h \text{ m}^3. \tag{2}$$

2. Force of gravity on the sheet of oil is

$$F = \rho g V = \rho g \pi \left(\frac{w}{2}\right)^2 \Delta h, \tag{3}$$

where $g = 9.8$ m/s^2.

3. Work done on the slice alocated at height h is

$$W_h \approx F \cdot (20 - h) \tag{4}$$

.

For the illustration shown in Figure 1b, using similarity of triangles, we can relate the width of the sheet w at the height h as

$$\frac{w}{h} = \frac{25}{20}. \tag{5}$$

Using this relation in Eqn. (3), work done on the sheet can be written completely in terms of h.

Now, to find the total work done to to pump out all the oil we will use

$$W_{\text{Total}} = \sum_{i=1}^{N} W_h. \tag{6}$$

In the above equation, N is the number of such oil sheets of thickness Δh in the oil column in the tank. Thus, for the illustration in Fig. 1, $N = \frac{10}{\Delta h}$.

Create an application that gets the following information from the user:

1. Diameter of the conical tank.
2. Height of the conical tank.
3. Depth of the oil in the tank.
4. Thickness of the oil sheets to be used for the calculation.

You must use functions to implement each of the first 3 equations in your program. The program should calculate the total work as defined in Equation (6) and display it to the user to 3 decimal palces. Additionally, all the user defined inputs must also be displayed to the user.

Submitting the Assignment

In order for your Lab/Assignment to be eligible for grading you must submit the following:

- The code must contain your Full Name and Student ID in a comment block at the top of each form module.
- A .zip compressed file containing the entire VB.NET project to AVENUE. Use .zip compression only (no RAR, TAR etc). If there is more than one project, create a separate .zip file for each individual project. Be sure to add all project files and folders to the .zip file. If the compressed file is missing files/folders such that the project will not open or run, the lab assignment will receive a grade of 0.
- A Word .doc (or .docx) file containing:
  - A cover page that includes your name, Student ID, and MAC ID
  - The form code (event and other subprocedures and functions) including programmers block
  - Screen captures of the form showing sample input and output.

Upload the Word file and .zip file(s) **separately** to the appropriate assignment drop-box on AVENUE.

Labs and assignments will not be accepted for evaluation if any of the above items are omitted and will result in a grade of 0.