When the script file is executed, the following (the values of the variables `B`, `t`, `years`, and `months`) is displayed in the Command Window:

```
>> format short g
B =
        20011
t =
       16.374
years =
    16
months =
     5
```

The values of the variables `B`, `t`, `years`, and `months` are displayed (since a semicolon was not typed at the end of any of the commands that calculate the values).

1.10 PROBLEMS

The following problems can be solved by writing commands in the Command Window, or by writing a program in a script file and then executing the file.

1. Calculate:

(*a*) $\dfrac{(14.8^2 + 6.5^2)}{3.8^2} + \dfrac{55}{\sqrt{2} + 14}$ (*b*) $(-3.5)^3 + \dfrac{e^6}{\ln 524} + 206^{1/3}$

2. Calculate:

(*a*) $\dfrac{16.5^2(8.4 - \sqrt{70})}{4.3^2 - 17.3}$ (*b*) $\dfrac{5.2^3 - 6.4^2 + 3}{1.6^8 - 2} + \left(\dfrac{13.3}{5}\right)^{1.5}$

3. Calculate:

(*a*) $15\left(\dfrac{\sqrt{10} + 3.7^2}{\log_{10}(1365) + 1.9}\right)$ (*b*) $\dfrac{2.5^3\left(16 - \dfrac{216}{22}\right)}{1.7^4 + 14} + \sqrt[4]{2050}$

4. Calculate:

(*a*) $\dfrac{2.3^2 \cdot 1.7}{\sqrt{(1 - 0.8^2)^2 + (2 - \sqrt{0.87})^2}}$ (*b*) $2.34 + \dfrac{1}{2}2.7(5.9^2 - 2.4^2) + 9.8\ln 51$

5. Calculate:

(a) $\dfrac{\sin\left(\frac{7\pi}{9}\right)}{\cos^2\left(\frac{5}{7}\pi\right)} + \dfrac{1}{7}\tan\left(\dfrac{5}{12}\pi\right)$ (b) $\dfrac{\tan 64°}{\cos^2 14°} - \dfrac{3\sin 80°}{\sqrt[3]{0.9}} + \dfrac{\cos 55°}{\sin 11°}$

6. Define the variable x as $x = 2.34$, then evaluate:

(a) $2x^4 - 6x^3 + 14.8x^2 + 9.1$ (b) $\dfrac{e^{2x}}{\sqrt{14 + x^2 - x}}$

7. Define the variable t as $t = 6.8$, then evaluate:

(a) $\ln(|t^2 - t^3|)$ (b) $\dfrac{75}{2t}\cos(0.8t - 3)$

8. Define the variables x and y as $x = 8.3$ and $y = 2.4$, then evaluate:

(a) $x^2 + y^2 - \dfrac{x^2}{y^2}$ (b) $\sqrt{xy} - \sqrt{x+y} + \left(\dfrac{x-y}{x-2y}\right)^2 - \sqrt{\dfrac{x}{y}}$

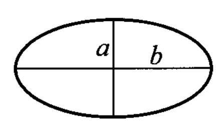
9. Define the variables a, b, c, and d as:

$a = 13$, $b = 4.2$, $c = (4b)/a$, and $d = \dfrac{abc}{a+b+c}$, then evaluate:

(a) $a\dfrac{b}{c+d} + \dfrac{da}{cb} - (a - b^2)(c + d)$ (b) $\dfrac{\sqrt{a^2 + b^2}}{(d - c)} + \ln(|b - a + c - d|)$

10. A cube has a side of 18 cm.
    (a) Determine the radius of a sphere that has the same surface area as the cube.
    (b) Determine the radius of a sphere that has the same volume as the cube.

11. The perimeter P of an ellipse with semi-minor axes a and b is given approximately by: $P = 2\pi\sqrt{\frac{1}{2}(a^2 + b^2)}$.



(a) Determine the perimeter of an ellipse with $a = 9$ in. and $b = 3$ in.
(b) An ellipse with $b = 2a$ has a perimeter of $P = 20$ cm. Determine a and b.

12. Two trigonometric identities are given by:

(a) $\sin 4x = 4\sin x\cos x - 8\sin^3 x\cos x$ (b) $\cos 2x = \dfrac{1 - \tan^2 x}{1 + \tan^2 x}$

For each part, verify that the identity is correct by calculating the values of the left and right sides of the equation, substituting $x = \dfrac{\pi}{9}$.

13. Two trigonometric identities are given by:

(*a*) $\tan 4x = \dfrac{4\tan x - 4\tan^3 x}{1 - 6\tan^2 x + \tan^4 x}$ (*b*) $\sin^3 x = \dfrac{1}{4}(3\sin x - \sin 3x)$

For each part, verify that the identity is correct by calculating the values of the left and right sides of the equation, substituting $x = 12°$.

14. Define two variables: *alpha* = 5π/8, and *beta* = π/8. Using these variables, show that the following trigonometric identity is correct by calculating the values of the left and right sides of the equation.

$$\sin\alpha\cos\beta = \frac{1}{2}[\sin(\alpha-\beta) + \sin(\alpha+\beta)]$$

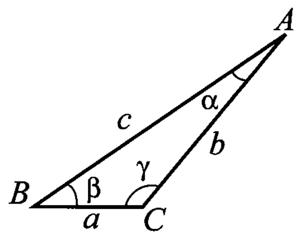
15. Given: $\int \cos^2(ax)dx = \frac{1}{2}x - \frac{\sin 2ax}{4a}$. Use MATLAB to calculate the following definite integral: $\int_{\pi/9}^{3\pi/5} \cos^2(0.5x)dx$.

16. In the triangle shown $a = 9$ cm, $b = 18$ cm, and $c = 25$ cm. Define *a*, *b*, and *c* as variables, and then:

(*a*) Calculate the angle α (in degrees) by substituting the variables in the Law of Cosines.
(Law of Cosines: $c^2 = a^2 + b^2 - 2ab\cos\gamma$)

(*b*) Calculate the angles β and γ (in degrees) using the Law of Sines.

(*c*) Check that the sum of the angles is 180°.



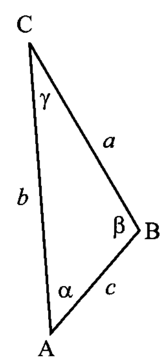
17. In the triangle shown $a = 5$ in., $b = 7$ in., and $\gamma = 25°$. Define *a*, *b*, and γ as variables, and then:

(*a*) Calculate the length of *c* by substituting the variables in the Law of Cosines.
(Law of Cosines: $c^2 = a^2 + b^2 - 2ab\cos\gamma$)

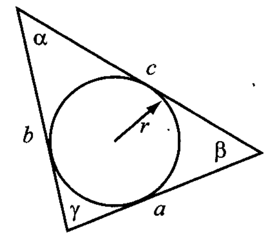
(*b*) Calculate the angles α and β (in degrees) using the Law of Sines.

(*c*) Verify the Law of Tangents by substituting the results from part (*b*) into the right and left sides of the equation.

(Law of Tangents: $\dfrac{a-b}{a+b} = \dfrac{\tan\left[\frac{1}{2}(\alpha-\beta)\right]}{\tan\left[\frac{1}{2}(\alpha+\beta)\right]}$)



18. For the triangle shown, $a = 200$ mm, $b = 250$ mm, and $c = 300$ mm. Define a, b, and c as variables, and then:



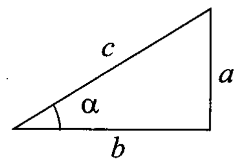
(*a*) Calculate the angle γ (in degrees) by substituting the variables in the Law of Cosines.

(Law of Cosines: $c^2 = a^2 + b^2 - 2ab\cos\gamma$)

(*b*) Calculate the radius r of the circle inscribed in the triangle using the formula $r = \frac{1}{2}(a+b-c)\tan\left(\frac{1}{2}\gamma\right)$.

(*c*) Calculate the radius r of the circle inscribed in the triangle using the formula $r = \frac{\sqrt{s(s-a)(s-b)(s-c)}}{s}$, where $s = \frac{1}{2}(a+b+c)$.

19. In the right triangle shown $a = 16$ cm and $c = 50$ cm. Define a and c as variables, and then:



(*a*) Using the Pythagorean Theorem, calculate b by typing one line in the Command Window.

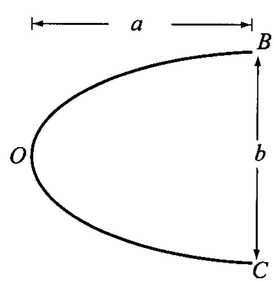
(*b*) Using b from part (*a*) and the `acosd` function, calculate the angle α in degrees by typing one line in the Command Window.

20. The distance d from a point (x_0, y_0, z_0) to a plane $Ax + By + Cz + D = 0$ is given by:

$$d = \frac{|Ax_0 + By_0 + Cz_0 + D|}{\sqrt{A^2 + B^2 + C^2}}$$

Determine the distance of the point $(8, 3, -10)$ from the plane $2x + 23y + 13z - 24 = 0$. First define the variables A, B, C, D, x_0, y_0, and z_0, and then calculate d. (Use the `abs` and `sqrt` functions.)

21. The arc length s of the parabolic segment BOC is given by:



$$s = \frac{1}{2}\sqrt{b^2 + 16a^2} + \frac{b^2}{8a}\ln\left(\frac{4a + \sqrt{b^2 + 16a^2}}{b}\right)$$

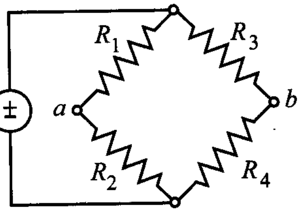
Calculate the arc length of a parabola with $a = 12$ in. and $b = 8$ in.

22. Oranges are packed such that 52 are placed in each box. Determine how many boxes are needed to pack 4,000 oranges. Use MATLAB built-in function `ceil`.

23. The voltage difference V_{ab} between points a and b in the Wheatstone bridge circuit is:

$$V_{ab} = V\left(\frac{R_2}{R_1+R_2} - \frac{R_4}{R_3+R_4}\right)$$

Calculate the voltage difference when $V = 12$ volts, $R_1 = 120$ ohms, $R_2 = 100$ ohms, $R_3 = 220$ ohms, and $R_4 = 120$ ohms.



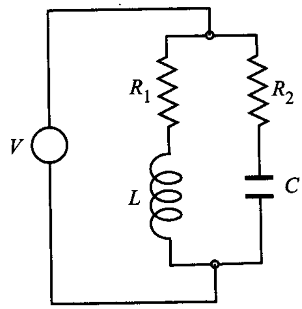
24. The prices of an oak tree and a pine tree are \$54.95 and \$39.95, respectively. Assign the prices to variables named oak and pine, change the display format to `bank`, and calculate the following by typing one command:

(*a*) The total cost of 16 oak trees and 20 pine trees.
(*b*) The same as part (*a*), and add 6.25% sale tax.
(*c*) The same as part (*b*) and round the total cost to the nearest dollar.

25. The resonant frequency f (in Hz) for the circuit shown is given by:

$$f = \frac{1}{2\pi}\sqrt{LC\frac{R_1^2C-L}{R_2^2C-L}}$$

Calculate the resonant frequency when $L = 0.2$ henrys, $R_1 = 1500$ ohms, $R_2 = 1500$ ohms, and $C = 2 \times 10^{-6}$ farads.



26. The number of combinations $C_{n,r}$ of taking r objects out of n objects is given by:

$$C_{n,r} = \frac{n!}{r!(n-r)!}$$

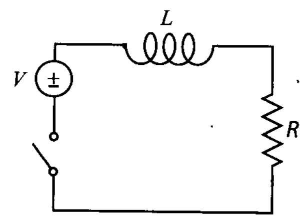
A deck of poker cards has 52 different cards. Determine how many different combinations are possible for selecting 5 cards from the deck. (Use the built-in function `factorial`.)

27. The formula for changing the base of a logarithm is:

$$\log_a N = \frac{\log_b N}{\log_b a}$$

(*a*) Use MATLAB's function `log(x)` to calculate $\log_4 0.085$.
(*b*) Use MATLAB's function `log10(x)` to calculate $\log_6 1500$.

28. The current I (in amps) t seconds after closing the switch in the circuit shown is:



$$I = \frac{V}{R}(1 - e^{-(R/L)t})$$

Given $V = 120$ volts, $R = 240$ ohms, and $L = 0.5$ henrys, calculate the current 0.003 seconds after the switch is closed.

29. Radioactive decay of carbon-14 is used for estimating the age of organic material. The decay is modeled with the exponential function $f(t) = f(0)e^{kt}$, where t is time, $f(0)$ is the amount of material at $t = 0$, $f(t)$ is the amount of material at time t, and k is a constant. Carbon-14 has a half-life of approximately 5,730 years. A sample of paper taken from the Dead Sea Scrolls shows that 78.8% of the initial ($t = 0$) carbon-14 is present. Determine the estimated age of the scrolls. Solve the problem by writing a program in a script file. The program first determines the constant k, then calculates t for $f(t) = 0.788f(0)$, and finally rounds the answer to the nearest year.

30. Fractions can be added by using the smallest common denominator. For example, the smallest common denominator of 1/4 and 1/10 is 20. Use the MATLAB Help Window to find a MATLAB built-in function that determines the least common multiple of two numbers. Then use the function to show that the least common multiple of:
(*a*) 6 and 26 is 78.
(*b*) 6 and 34 is 102.

31. The Moment Magnitude Scale (MMS), denoted M_W, which is used to measure the size of an earthquake, is given by:

$$M_W = \frac{2}{3}\log_{10} M_0 - 10.7$$

where M_0 is the magnitude of the seismic moment in dyne-cm (measure of the energy released during an earthquake). Determine how many times more energy was released from the earthquake in Sumatra, Indonesia ($M_W = 8.5$), in 2007 than the earthquake in San Francisco, California ($M_W = 7.9$), in 1906.

32. According to special relativity, a rod of length L moving at velocity v will shorten by an amount δ, given by:

$$\delta = L\left(1 - \sqrt{1 - \frac{v^2}{c^2}}\right)$$

where c is the speed of light (about 300×10^6 m/s). Calculate how much a rod 2 meter long will contract when traveling at 5,000 m/s.

33. The monthly payment M of a loan amount P for y years and interest rate r can be calculated by the formula:

$$M = \frac{P(r/12)}{1-(1+r/12)^{-12y}}$$

(*a*) Calculate the monthly payment of a \$85,000 loan for 15 years and interest rate of 5.75% ($r = 0.0575$). Define the variables P, r, and y and use them to calculate M.

(*b*) Calculate the total amount needed for paying back the loan.

34. The balance B of a savings account after t years when a principal P is invested at an annual interest rate r and the interest is compounded yearly is given by $B = P(1+r)^t$. If the interest is compounded continuously, the balance is given by $B = Pe^{rt}$. An amount of \$40,000 is invested for 20 years in an account that pays 5.5% interest and the interest is compounded yearly. Use MATLAB to determine how many fewer days it will take to earn the same if the money is invested in an account where the interest is compounded continuously.

35. The temperature dependence of vapor pressure p can be estimated by the Anteing equation:

$$\ln(p) = A - \frac{B}{C+T}$$

where ln is the natural logarithm, p is in mm Hg, T is in kelvins, and A, B, and C are material constants. For toluene ($C_6H_5CH_3$) in the temperature range from 280 to 410 K the material constants are $A = 16.0137$, $B = 3096.52$, and $C = -53.67$. Calculate the vapor pressure of toluene at 315 and 405 K.

36. Sound level L_P in units of decibels (dB) is determined by:

$$L_P = 20\log_{10}\left(\frac{p}{p_0}\right)$$

where p is the sound pressure of the sound, and $p_0 = 20 \times 10^{-6}$ Pa is a reference sound pressure (the sound pressure when $L_P = 0$ dB).

(*a*) The sound pressure of a passing car is 80×10^{-2} Pa. Determine its sound level in decibels.

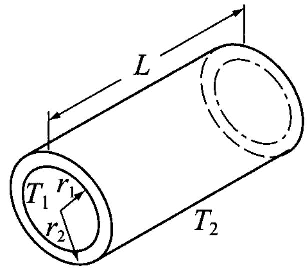
(*b*) The sound level of a jet engine is 110 decibels. By how many times is the sound pressure of the jet engine larger (louder) than the sound of the passing car?

37. Use the Help Window to find a display format that displays the output as a ratio of integers. For example, the number 3.125 will be displayed as 25/8. Change the display to this format and execute the following operations:

(a) $5/8+16/6$ (b) $1/3-11/13+2.7^2$

38. The steady-state heat conduction q from a cylindrical solid wall is determined by:

$$q = 2\pi Lk\frac{T_1 - T_2}{\ln\left(\frac{r_2}{r_1}\right)}$$



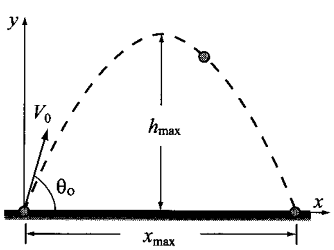
where k is the thermal conductivity. Calculate q for a copper tube ($k = 401$ Watts/°C/m) of length $L = 300$ cm with an outer radius of $r_2 = 5$ cm and an inner radius of $r_1 = 3$ cm. The external temperature is $T_2 = 20°$ C and the internal temperature is $T_1 = 100°$C.

39. Stirling's approximation for large factorials is given by:

$$n! = \sqrt{2\pi n}\left(\frac{n}{e}\right)^n$$

Use the formula for calculating 20!. Compare the result with the true value obtained with MATLAB's built-in function `factorial` by calculating the error ($Error = (TrueVal - ApproxVal)/TrueVal$).

40. A projectile is launched at an angle θ and speed of V_0. The projectile's travel time t_{travel}, maximum travel distance x_{max}, and maximum height h_{max} are given by:



$$t_{travel} = 2\frac{V_0}{g}\sin\theta_0, \quad x_{max} = 2\frac{V_0^2}{g}\sin\theta_0\cos\theta_0,$$

$$h_{max} = 2\frac{V_0^2}{g}\sin^2\theta_0$$

Consider the case where $V_0 = 600$ ft/s and $\theta = 54°$. Define V_0 and θ as MATLAB variables and calculate t_{travel}, x_{max}, and h_{max} ($g = 32.2$ ft/s^2).