Chapter 1
Solved Problems

1. Calculate:

(*a*) $\left(5-\frac{19}{7}+2.5^3\right)^2$ (*b*) $7\times3.1+\frac{\sqrt{120}}{5}-15^{5/3}$

Solution

```
>> % Part (a)
>> (5-19/7+2.5^3)^2
ans =
  320.7937
>> % Part (b)
>> 7*3.1+sqrt(120)/5-15^(5/3)
ans =
  -67.3421
```

2. Calculate:

(*a*) $\sqrt[3]{8+\frac{80}{2.6}}+e^{3.5}$ (*b*) $\left(\frac{1}{\sqrt{75}}+\frac{73}{3.1^3}\right)^{1/4}+55\times0.41$

Solution

```
>> % Part (a)
>> (8+80/2.6)^(1/3)+exp(3.5)
ans =
   36.5000
>> % Part (b)
>> (1/sqrt(0.75)+73/3.1^3)^(1/4)+55*0.41
ans =
   23.9279
```

3. Calculate:

(a) $\frac{23+\sqrt[3]{45}}{16\times 0.7}+\log_{10} 589006$ (b) $(36.1-2.25\pi)(e^{2.3}+\sqrt{20})$

Solution

```
>> % Part (a)
>> (23+45^(1/3))/(16*0.7)+log10(589006)
ans =
    8.1413
>> % Part (b)
>> (36.1-2.25*pi)*(exp(2.3)+sqrt(20))
ans =
  419.3971
```

4. Calculate:

(a) $\frac{3.8^2}{2.75-41\times 25}+\frac{5.2+1.8^5}{\sqrt{3.5}}$ (b) $\frac{2.1\times 10^6-15.2\times 10^5}{3\cdot\sqrt[3]{6\times 10^{11}}}$

Solution

```
>> % Part (a)
>> 3.8^2/(2.75-41*2.5)+(5.2+1.8^5)/sqrt(3.5)
ans =
   12.7349
>> % Part (b)
>> (2.1E6-15.2E5)/(3*6E11^(1/3))
ans =
   22.9222
```

5. Calculate:

(*a*) $\frac{\sin(0.2\pi)}{\cos(\pi/6)} + \tan 72°$ (*b*) $(\tan 64° \cos 15°)^2 + \frac{\sin^2 37°}{\cos^2 20°}$

Solution

```
>> % Part (a)
>> sin(0.2*pi)/cos(pi/6)+tand(72)
ans =
    3.7564
>> % Part (b)
>> (tand(64)*cosd(15))^2+sind(37)^2/cosd(20)^3
ans =
    4.3586
```

6. Define the variable z as $z = 4.5$, then evaluate:

(*a*) $0.4z^4 + 3.1z^2 - 162.3z - 80.7$ (*b*) $\left(z^3 - 23\right) / \left(\sqrt[3]{z^2 + 17.5}\right)$

Solution

```
>> z=4.5;
>> % Part (a)
>> 0.4*z^4+3.1*z^2-162.3*z-80.7
ans =
 -584.2500
>> % Part (b)
>> (z^3-23)/(z^2+17.5)^(1/3)
ans =
   20.3080
```

7. Define the variable t as $t = 3.2$, then evaluate:

(*a*) $\frac{1}{2}e^{2t} - 3.81t^3$ (*b*) $\frac{6t^2 + 6t - 2}{t^2 - 1}$

Solution

```
>> t=3.2;
>> % Part (a)
>> exp(2*t)/2-3.81*t^3
ans =
  176.0764
```

```
>> % Part (b)
>> (6*t^2+6*t-2)/(t^2-1)
ans =
    8.5108
```

8. Define the variables x and y as $x = 6.5$ and $y = 3.8$, then evaluate:

(a) $\left(x^2 + y^2\right)^{2/3} + \dfrac{xy}{y-x}$ (b) $\dfrac{\sqrt{x+y}}{(x-y)^2} + 2x^2 - xy^2$

Solution

```
>> x=6.5; y=3.8;
>> % Part (a)
>> (x^2+y^2)^(2/3)+x*y/(y-x)
ans =
    5.6091
>> % Part (b)
>> sqrt(x+y)/(x-y)^2+2*x^2-x*y^2
ans =
   -8.9198
```

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

$c = 4.6$, $d = 1.7$, $a = cd^2$, and $b = \dfrac{c+a}{c-d}$, then evaluate:

(a) $e^{(d-b)} + \sqrt[3]{c+a} - (ca)^d$ (b) $\dfrac{d}{c} + \left(\dfrac{ct}{b}\right)^2 - c^d - \dfrac{a}{b}$

Solution

```
>> c=4.6; d=1.7;
>> a=c*d^2;
>> b=(c+a)/(c-d);
>> % Part (a)
>> exp(d-b)+(c+a)^(1/3)-(c*a)^d
ans =
  -1.0861e+03
>> % Part (b)
>> d/c+(c/b)^2-c^d-a/b
ans =
  -14.6163
```

10. Two trigonometric identities are given by:

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

For each part, verify that the identity is correct by calculating the values of the left and right sides of the equation, substituting $x = \pi / 10$.

Solution

```
>> x=pi/10;
>> % Part (a)
>> Left=cos(x)^2-sin(x)^2
Left =
    0.8090
>> Right=1-2*sin(x)^2
Right =
    0.8090
>> % Part (b)
>> Left=tan(x)/(sin(x)-2*tan(x))
Left =
   -0.9533
>> Right=1/(cos(x)-2)
Right =
   -0.9533
```

11. Two trigonometric identities are given by:

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

For each part, verify that the identity is correct by calculating the values of the left and right sides of the equation, substituting $x = 20°$.

Solution

```
>> x=20;
>> % Part (a)
>> Left=(sind(x)+cosd(x))^2
Left =
    1.6428
>> Right=1+2*sind(x)*cosd(x)
Right =
    1.6428
>> % Part (b)
>> Left=(1-2*cosd(x)-3*cosd(x)^2)/sind(x)^2
Left =
```

```
  -30.1634
>> Right=(1-3*cosd(x))/(1-cosd(x))
Right =
  -30.1634
```

12. Define two variables: *alpha* = π/8, and *beta* = π/6. Using these variables, show that the following trigonometric identity is correct by calculating the values of the left and right sides of the equation.

$$\tan(\alpha + \beta) = \frac{\tan\alpha + \tan\beta}{1 - \tan\alpha\tan\beta}$$

Solution

```
>> alpha=pi/8; beta=pi/6;
>> Left=tan(alpha+beta)
Left =
    1.3032
>> Right=(tan(alpha)+tan(beta))/(1-tan(alpha)*tan(beta))
Right =
    1.3032
```

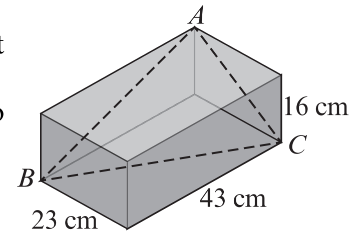
13. Given: $\int x^2\cos x\,dx = 2x\cos x + (x^2 - 2)\sin x$. Use MATLAB to calculate the following definite integral: $\int_{\pi/6}^{\pi/3} x^2\cos x\,dx$.

Solution

```
>> xa=pi/6; xb=pi/3;
>> Ia=2*xa*cos(xa)+(xa^2-2)*sin(xa)
Ia =
    0.0440
>> Ib=2*xb*cos(xb)+(xb^2-2)*sin(xb)
Ib =
    0.2648
>> I=Ib-Ia
I =
    0.2209
```

14. A rectangular box has the dimensions shown.
    (*a*) Determine the angle *BAC* to the nearest degree.
    (*b*) Determine the area of the triangle *ABC* to the nearest tenth of a cm.

    Law of Cosines: $c^2 = a^2 + b^2 - 2ab\cos\gamma$
    Heron's formula for triangular area:
    $A = \sqrt{p(p-a)(p-b)(p-c)}$, where $p = (a+b+c)/2$.



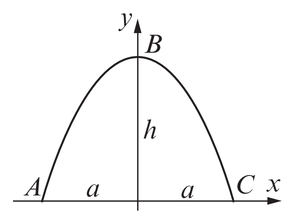
Solution

```
>> a=sqrt(23^2+43^2)
a =
   48.7647
>> b=sqrt(16^2+23^2)
b =
   28.0179
>> c=sqrt(43^2+16^2)
c =
   45.8803
>> % Part (a)
>> AngleABC=acosd((a^2+c^2-b^2)/(2*a*c))
AngleABC =
   34.2665
>> % Part (b)
>> p=(a+b+c)/2;
>> A=sqrt(p*(p-a)*(p-b)*(p-c))
A =
  629.8589
```

15. The arc length of a segment of a parabola *ABC* is given by:

$$L_{ABC} = \sqrt{a^2 + 4h^2} + \frac{a^2}{2h}\ln\left(\frac{2h}{a} + \sqrt{\left(\frac{2h}{a}\right)^2 + 1}\right)$$

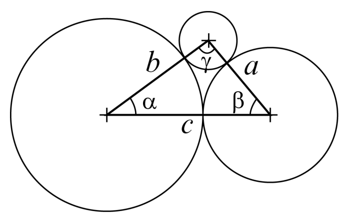
Determine L_{ABC} if a=8 in. and h=13 in.



Solution

```
>> a=8; h=13;
>>   L=sqrt(a^2+4*h^2)+a^2*log(2*h/a+sqrt((2*h/a)^2+1))/
(2*h)
L =
   31.8667
```

16. The three shown circles, with radius 15 in., 10.5 in., and 4.5 in., are tangent to each other.
(*a*) Calculate the angle γ (in degrees) by using the Law of Cosines.
(Law of Cosines: $c^2 = a^2 + b^2 - 2ab\cos\gamma$)
(*b*) Calculate the angles γ and α (in degrees) using the Law of Sines.
(*c*) Check that the sum of the angles is 180º.



Solution

Script File:

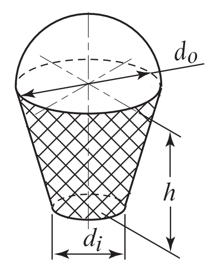
```
% Ch. 1, Prob. 16 (6th ed.)
a=10.5+4.5; b=15+4.5; c=15+10.5;
% Part (a)
Gam=acosd((a^2+b^2-c^2)/(2*a*b))
% Part (b)
Bet=asind(b*sind(Gam)/c)
Alp=asind(a*sind(Gam)/c)
% Part (c)
SumAng=Gam+Bet+Alp
```

Command Window:

```
>> HW_1_16
Gam =
```

```
   94.4117
Bet =
   49.6798
Alp =
   35.9085
SumAng =
   180
```

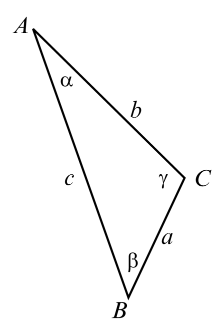
17. A frustum of cone is filled with ice cream such that the portion above the cone is a hemisphere. Define the variables d_i=1.25 in., d_0=2.25 in., h=2 in., and determine the volume of the ice cream.



Solution

```
>> ri=1.25/2; ro=2.25/2; h=2;
>> Vcon=pi*h/3*(ri^2+ri*ro+ro^2);
>> Vtop=2*pi*ro^3;
>> V=Vcon+Vtop
V =
   13.8876
```

18. In the triangle shown $a = 27$ in., $b = 43$ in., and $c = 57$ in. Define a, b, and c as variables, and then:
   (*a*) Calculate the angles α, β, and γ by substituting the variables in the Law of Cosines.
   (Law of Cosines: $c^2 = a^2 + b^2 - 2ab\cos\gamma$)
   (*b*) Verify the Law of Tangents by substituting the results into the right and left sides of:



$$\text{Law of Tangents: } \frac{b-c}{b+c} = \frac{\tan\left[\frac{1}{2}(\beta-\gamma)\right]}{\tan\left[\frac{1}{2}(\beta+\gamma)\right]}$$

Solution

Script file:

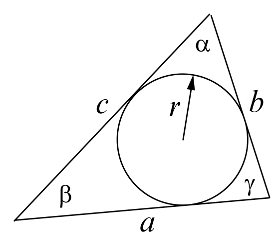
```
% HW 1_18 6ed
clear,clc
a=27; b=43; c=57;
disp('Part (a)')
```

```
Al=acosd((-a^2+b^2+c^2)/(2*b*c))
Bet=acosd((-b^2+a^2+c^2)/(2*a*c))
Gum=acosd((-c^2+a^2+b^2)/(2*a*b))
Tot=Al+Bet+Gum
disp('Part (b)')
LHS=(b-c)/(b+c)
RHS=tand((Bet-Gum)/2)/tand((Bet+Gum)/2)
```

Command Window:

```
Part (a)
Al =
   26.9669
Bet =
   46.2365
Gum =
  106.7966
Tot =
   180
Part (b)
LHS =
   -0.1400
RHS =
   -0.1400
```

19. For the triangle shown, $\alpha = 72°$, $\beta = 43°$, and its perimeter is $p = 114$ mm. Define α, β, and *p*, as variables, and then:
   (*a*) Calculate the triangle sides (Use the Law of Sines).
   (*b*) Calculate the radius *r* of the circle inscribed in the triangle using the formula:
   $$r = \sqrt{\frac{(s-a)(s-b)(s-c)}{s}}$$
   where $s = (a+b+c)/2$.



Solution

Script File:

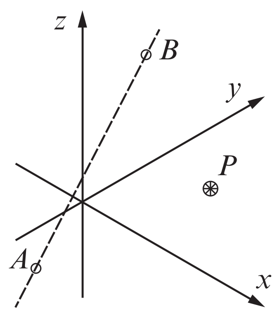
```
A=72; B=43;
G=180-A-B;
```

```
% Part (a)
a=114/(1+sind(B)/sind(A)+sind(G)/sind(A))
b=a*sind(B)/sind(A)
c=a*sind(G)/sind(A)
% Part (b)
s=(a+b+c)/2;
r=sqrt((s-a)*(s-b)*(s-c)/s)
```

Command Window:

```
a =
   42.6959
b =
   30.6171
c =
   40.6870
r =
   10.3925
```

20. The distance d from a point P (x_P, y_P, z_P) to the line that passes through the two points A (x_A, y_A, z_A) and B (x_B, y_B, z_B) can be calculated by $d = 2S/r$ where r is the distance between the points A and B, given by $r = \sqrt{(x_B - x_A)^2 + (y_B - y_A)^2 + (z_B - z_A)^2}$ and S is the area of the triangle defined by the three points calculated by $S = \sqrt{s_1^2 + s_2^2 + s_3^3}$ where



$s_1 = x_P y_A + x_A y_B + x_B y_P - (y_P x_A + y_A x_B + y_B x_P)$
$s_2 = y_P z_A + y_A z_B + y_B z_P - (z_P y_A + z_A y_B + z_B y_P)$
$s_3 = x_P z_A + x_A z_B + x_B z_P - (z_P x_A + z_A x_B + z_B x_P)$. Determine the distance of point $P(2, 6, -1)$ from the line that passes through point $A(-2, -1.5, -3)$ and point $B(-2.5, 6, 4)$. First define the variables x_P, y_P, z_P, x_A, y_A, z_A, x_B, y_B, and z_B, and then use the variable to calculate s_1, s_2, s_3, and r. Finally calculate S and d.

Solution

Script file:

```
clear, clc
```

```
A=[-2 -1.5 -3];
B=[-2.5 6 4];
P=[2 6 -1];
r=sqrt(sum((B-A).^2));
s1=P(1)*A(2)+A(1)*B(2)+B(1)*P(2)-
(P(2)*A(1)+A(2)*B(1)+B(2)*P(1));
s2=P(2)*A(3)+A(2)*B(3)+B(2)*P(3)-
(P(3)*A(2)+A(3)*B(2)+B(3)*P(2));
s3=P(1)*A(3)+A(1)*B(3)+B(1)*P(3)-
(P(3)*A(1)+A(3)*B(1)+B(3)*P(1));
S=sqrt(s1^2+s2^2+s3^2)/2;
DIS=2*S/r
```

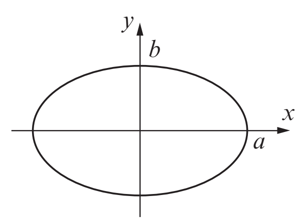
Command Window:

```
DIS =
    5.6655
>>
```

21. The perimeter of an ellipse can be approximated by:

$$P = \pi(a+b)\left(3 - \frac{\sqrt{(3a+b)(a+3b)}}{a+b}\right)$$

Calculate the perimeter of an ellipse with $a = 18$ in. and $b = 7$ in.



Solution

Command Window:

```
>> a=18; b=7;
>> P=pi*(a+b)*(3-sqrt((3*a+4)*(a+3*b))/(a+b))
P =
   86.2038
```

22. 4217 eggs have to be packed in boxes that can hold 36 eggs each. By typing one line (command) in the Command Window, calculate how many eggs will remain unpacked if every box that is used has to be full. (Hint: use MATLAB built-in function `fix`.)

Solution

Command Window:

```
>> 4217-fix(4217/36)*36
ans =
     5
```

23. 777 people have to be transported using buses that have 46 seats and vans that have 12 seats. Calculate how many buses are needed if all the buses have to be full, and how many seats will remain empty in the vans if enough vans are used to transport all the people that did not fit into the buses. (Hint: use MATLAB built-in functions `fix`. and `ceil`)

Solution

Command Window:

```
>> nBuses=fix(777/46)
nBuses =
    16
>> nPeoLeft=777-nBuses*46
nPeoLeft =
    41
>> nVans=ceil(nPeoLeft/12)
nVans =
     4
>> nSeatEmp=nVans*12-nPeoLeft
nSeatEmp =
     7
```

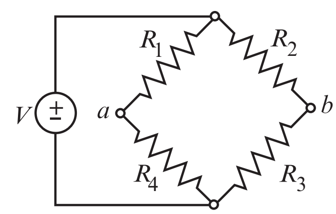
24. Change the display to `format long g`. Assign the number 7E8/13 to a variable, and then use the variable in a mathematical expression to calculate the following by typing one command:
    (*a*) Round the number to the nearest tenth.
    (*b*) Round the number to the nearest million.

Solution

Command Window:

```
>> format long g
>> x=7E8/13
x =
          53846153.8461538
>> a=round(x*10)/10
a =
                    53846153.8
>> b=round(x/1000000)*1000000
b =
    54000000
```

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



$$V_{ab} = V\left(\frac{c-d}{(c+1)(d+1)}\right)$$

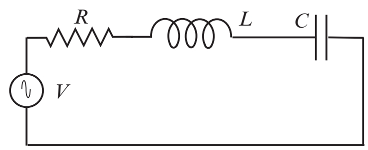
where $c = R_2 / R_1$ and $d = R_3 / R_4$. Calculate the V_{ab} if $V = 15$ volts, $R_1 = 119.8$ ohms, $R_2 = 120.5$ ohms, $R_3 = 121.2$ ohms, and $R_4 = 119.3$ ohms.

Solution

Command Window:

```
format short
>> V=15; R1=119.8; R2=120.5; R3=121.2; R4=119.3;
>> c=R2/R1; d=R3/R4;
>> Vab=V*(c-d)/((c+1)*(d+1))
Vab =
   -0.0374
```

26. The current in a series RCL circuit is given by:



$$I = \frac{V}{\sqrt{R^2 + (\omega L - \frac{1}{\omega C})^2}}$$

where $\omega = 2\pi f$. Calculate I for the circuit shown if the supply voltage is 80 V, $f = 50\,\text{Hz}$, $R = 6\Omega$, $L = 400 \times 10^{-3}$ H, and $C = 40 \times 10^{-6}$ F.

Solution

Command Window:

```
>> V=80; R=6; f=50; L=400E-3; C=40E-6;
>> w=2*pi*f;
>> I=V/sqrt(R^2+(w*L-1/(w*C))^2)
I =
     1.7213
```

27. The Monthly payment M of a mortgage P for n years with a fixed annual interest rate r can be calculated by the formula:

$$M = P\frac{\frac{r}{12}\left(1+\frac{r}{12}\right)^{12n}}{\left(1+\frac{r}{12}\right)^{12n}-1}$$

Determine the monthly payment of a 30 year $450,000 mortgage with interest rate of 4.2% ($r = 0.042$). Define the variables P, r, and n and then use them in the formula to calculate M.

Solution

Command Window:

```
>> format bank
>> n=30; P=450000; r=0.042;
>> rm=r/12;
>> C=(1+rm)^(12*n);
>> M=P*rm*C/(C-1)
M =
          2200.58
```

28. The number of permutations ${}_nP_r$ of taking r objects out of n objects without repetition is given by:

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

(*a*) Determine how many 6-letter passwords can be formed from the 26 letters in the English alphabet if a letter can only be used once.

(*b*) How many passwords can be formed if the digits 0, 1, 2, ..., 9 can be used in addition to the letters.

Solution

Command Window:

```
>> % Part (a):
>> n=26; r=6;
>> P=factorial(n)/factorial(n-r)
P =
   165765600
>>
>> % Part (b):
>> n=36; r=6;
>> P=factorial(n)/factorial(n-r)
P =
   1.4024e+09
>>
```

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

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

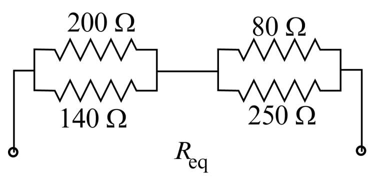
In the Powerball Lottery game the player chooses 5 numbers from 1 through 59, and then the Powerball number from 1 through 35.
Determine how many combinations are possible by calculating $C_{59,5}C_{35,1}$.
(Use the built-in function `factorial`.)

Solution

Command Window:

```
>> C5_59=factorial(59)/(factorial(5)*factorial(59-5));
>> C1_35=factorial(35)/(factorial(1)*factorial(35-1));
>> Combination=C5_59*C1_35
Combination =
     1.752235100000000e+08
```

30. The equivalent resistance of two resistors R_1 and R_2 connected in parallel is given by $R_{eq} = \frac{R_1 R_2}{R_1 + R_2}$. The equivalent resistance of two resistors R_1 and R_2 connected in series is given by, $R_{eq} = R_1 + R_2$. Determine the equivalent resistance of the four resistors in the circuit shown in the figure.

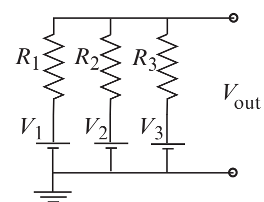


Solution

Command Window:

```
>> R1=200; R2=140;
>> R3=80; R4=250;
>> Req=R1*R2/(R1+R2)+R3*R4/(R3+R4)
Req =
       142.96
```

31. The output voltage V_{out} in the circuit shown is given by (Millman's Theorem):



$$V_{out} = \frac{\frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3}}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$

Calculate V_{out} given $V_1 = 36\,\text{V}$, $V_2 = 28\,\text{V}$, $V_3 = 24\,\text{V}$, $R_1 = 400\,\Omega$, $R_2 = 200\,\Omega$, $R_3 = 600\,\Omega$.

Solution

Script file:

```
clear, clc
V1=36; V2=28; V3=24;
R1=400; R2=200; R3=600;
N=V1/R1+V2/R2+V3/R3;
D=1/R1+1/R2+1/R3;
Vout=N/D
```

Command Window:

```
Vout =
   29.4545
>>
```

32. 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 taken from the ancient footprints of Acahualinca in Nicaragua shows that 77.45% of the initial ($t = 0$) carbon-14 is present. Determine the estimated age of the footprint. Solve the problem by writing a program in a script file. The program first determines the constant k, then calculates t for $f(t) = 0.7745 f(0)$, and finally rounds the answer to the nearest year.

Solution

Command Window:

```
>> k=log(0.5)/5730
k =
  -0.00012097
>> Age=round(log(.7745)/k)
Age =
        2112
>>
```

33. The greatest common divisor is the largest positive integer that divides the numbers without a remainder. For example, the GCD of 8 and 12 is 4. Use the MATLAB Help Window to find a MATLAB built-in function that determines the greatest common divisor of two numbers. Then use the function to show that the greatest common divisor of:
(*a*) 91 and 147 is 7.
(*b*) 555 and 962 is 37.

Solution

Command Window:

```
>> % Part (a):
>> gcd(91,147)
ans =
     7
>>
>> % Part (b):
```

```
>> gcd(555,962)
ans =
    37
```

34. The amount of energy E (in Joules) that is released by an earthquake, is given by:

$$E = 1.74 \times 10^{19} \times 10^{1.44M}$$

where M is the magnitude of the earthquake on the Richter scale.

(*a*) Determine the energy that was released from the Anchorage earthquake (1964, Alaska, USA), magnitude 9.2.

(*b*) The energy released in Lisbon earthquake (Portugal) in 1755 was one half the energy released in the Anchorage earthquake. Determine the magnitude of the earthquake in Lisbon on the Richter scale.

Solution

Command Window:

```
>> % Part (a):
>> MAn=9.2;
>> EAn=1.74E19*10^(1.44*MAn)
EAn =
     3.08e+32
>>
>> % Part (b):
>> ELi=EAn/2;
>> MLi=log10(ELi/1.74E19)/1.44
MLi =
         8.991
>>
```

35. According to the Doppler effect of light the perceived wavelength λ_p of a light source with a wavelength of λ_S is given by:

$$\lambda_P = \lambda_S \sqrt{\frac{1-\frac{v}{c}}{1+\frac{v}{c}}}$$

where c is the speed of light (about 300×10^6 m/s) and v is the speed the observer moves toward the light source. Calculate the speed the observer has to move in order to see a red light as green. Green wavelength is 530nm and red wavelength is 630nm.

Solution

Command Window:

```
>> c=300E6;
>> LR=630; LG=530;
>> r=530/630;
>> v=c*((1-r^2)/(r^2+1))
v =
   5.1343e+07
>>
```

36. Newton's law of cooling gives the temperature $T(t)$ of an object at time t in terms of T_0, its temperature at $t = 0$, and T_s, the temperature of the surroundings.

$$T(t) = T_s + (T_0 - T_s)e^{-kt}$$

A police officer arrives at a crime scene in a hotel room at 9:18 PM, where he finds a dead body. He immediately measures the body's temperature and find it to be 79.5°F. Exactly one hour later he measures the temperature again, and find it to be 78.0°F. Determine the time of death, assuming that victim body temperature was normal (98.6°F) prior to death, and that the room temperature was constant at 69°F.

Solution

Script File:

```
clear, clc
% Determining k:
Ts=69; T0=79.5; T60=78;
ta=60;
k=log((T0-Ts)/(T60-Ts))/ta;
% Determine min before 9:18 PM
T0=98.6; T9_18=79.5;
tb=round(log((T0-Ts)/(T9_18-Ts))/k);
Time=9*60+18-tb;
Hr=fix(Time/60)
Min=Time-Hr*60
```

Command Window:

```
Hr =
     2
Min =
    35
```

37. The velocity v and the falling distance d as a function of time of a skydiver that experience the air resistance can be approximated by:

$$v(t) = \sqrt{\frac{mg}{k}}\tanh\left(\sqrt{\frac{kg}{m}}\,t\right) \text{ and } d(t) = \frac{m}{k}\ln\left[\cosh\left(\sqrt{\frac{kg}{m}}\,t\right)\right]$$

where $k = 0.24$ kg/m is a constant, m is the skydiver mass, $g = 9.81$ m/s^2 is the acceleration due to gravity, and t is the time in seconds since the skydiver start falling. Determine the velocity and the falling distance at $t = 8$ s for a 95 kg skydiver

Solution

Command Window:

```
>> m=95; k=0.24; g=9.81; t=8;
>> v8=sqrt(m*g/k)*tanh(sqrt(k*g/m)*t)
v8 =
       53.024
>> d=m/k*log(cosh(sqrt(k*g/m)*t))
d =
       254.81
```

38. 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*) $1/3 - 11/13 + 2.7^2$

Solution

Command Window:

```
>> format rat
```

```
>> 5/8+16/6
ans =
      79/24
>> 1/3-11/13+2.7^2
ans =
    1247/184
```

39. Gosper's approximation for factorials is given by:

$$n! = \sqrt{\left(2n + \frac{1}{3}\right)\pi}\, n^n e^{-n}$$

Use the formula for calculating 19!. Compare the result with the true value obtained with MATLAB's built-in function `factorial` by calculating the error (*Error*=(*TrueVal*-*ApproxVal*)/*TrueVal*).

Solution

Command Window:

```
>> n=19;
>> nApp=sqrt((2*n+1/3)*pi)*n^n*exp(-n)
nApp =
     1.216428232016491e+17
>> nTru=factorial(n)
nTru =
     1.216451004088320e+17
>> Error=(nTru-nApp)/nTru
Error =
     1.872008963197555e-05
```

40. According to Newton's law of universal gravitation the attraction force between two bodies is given by:

$$F = G\frac{m_1 m_1}{r^2}$$

where m_1 and m_2 are the masses of the bodies, r is the distance between the bodies, and $G = 6.67 \times 10^{-11}$ N-m^2/kg^2 is the universal gravitational constant. Determine how many times the attraction force between the sun and the earth is larger than the attraction force between the earth and the moon. The distance between the sun and earth is 149.6×10^9 m, the distance between the moon and earth is 384.4×10^6 m, $m_{earth} = 5.98 \times 10^{28}$ kg,

$m_{sun} = 2.0 \times 10^{30}$ kg, and $m_{moon} = 7.36 \times 10^{22}$ kg.

Solution

Script File:

```
G=6.67E-11; dS_E=149.6E9; dM_E=384.4E6;
mE=5.98E28; mS=2E30; mM=7.36E22;
FSE=G*mS*mE/dS_E^2;
FME=G*mM*mE/dM_E^2;
Ratio=round(FSE/FME)
```

Command Window:

```
Ratio =
   179
```