

Geometry

Circle of radius r : circumference = $2\pi r$; area = πr^2 .

Sphere of radius r : area = $4\pi r^2$; volume = $\frac{4}{3}\pi r^3$.

Right circular cylinder of radius r and height h : area = $2\pi r^2 + 2\pi rh$;
volume = $\pi r^2 h$.

Quadratic Formula

$$\text{If } ax^2 + bx + c = 0, \text{ then } x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}.$$

The earth

| | |
|--|---------------------------------------|
| Mass | 5.98×10^{24} kg |
| Equatorial radius | 6.378×10^6 m |
| | 3963 mi |
| Polar radius | 6.357×10^6 m |
| | 3950 mi |
| Radius of a sphere of the same volume | 6.37×10^6 m |
| | 3600 mi |
| Mean density | 5522 kg/m ³ |
| Acceleration of gravity ^a | 9.80665 m/s ² |
| | 32.1740 ft/s ² |
| Mean orbital speed | 29,770 m/s |
| | 18.50 mi/s |
| Angular speed | 7.29×10^{-5} rad/s |
| Solar constant ^b | 1340 W/m ² |
| Magnetic field [at Washington, D.C.] | 5.7×10^{-5} T |
| Magnetic dipole moment | 8.1×10^{22} A·m ² |
| Standard atmosphere | 1.013×10^5 Pa |
| | 14.70 lb/in. ² |
| | 760.0 mm-Hg |
| Density of dry air at STP ^c | 1.29 kg/m ³ |
| Speed of sound in dry air at STP | 331.4 m/s |
| | 1089 ft/s |
| | 742.5 mi/h |

The Greek Alphabet

| | | | | | |
|---------|-----------|------------|---------|----------|--------------------|
| Alpha | A | α | Nu | N | ν |
| Beta | B | β | Xi | Ξ | ξ |
| Gamma | Γ | γ | Omicron | O | \omicron |
| Delta | Δ | δ | Pi | Π | π |
| Epsilon | E | ϵ | Rho | P | ρ |
| Zeta | Z | ζ | Sigma | Σ | σ |
| Eta | H | η | Tau | T | τ |
| Theta | Θ | θ | Upsilon | Y | υ |
| Iota | I | ι | Phi | Φ | ϕ , φ |
| Kappa | K | κ | Chi | X | χ |
| Lambda | Λ | λ | Psi | Ψ | ψ |
| Mu | M | μ | Omega | Ω | ω |

The moon

| | |
|--------------------------|--------------------------|
| Mass | 7.36×10^{22} kg |
| Radius | 1738 km |
| Mean density | 3340 kg/m ³ |
| Surface gravity | 1.67 m/s ² |
| Mean earth-moon distance | 3.80×10^5 km |

The sun

| | |
|----------------------|--------------------------|
| Mass | 1.99×10^{30} kg |
| Radius | 6.96×10^5 km |
| Mean density | 1,410 kg/m ³ |
| Surface gravity | 274 m/s ² |
| Surface temperature | 6000 K |
| Total radiation rate | 3.92×10^{26} W |

| Constant | Symbol | Computational value | Best (1973) Value | |
|---|--------------|---|--------------------|--------------------------|
| | | | Value ^a | Uncertainty ^b |
| Speed of light in a vacuum | c | 3.00×10^8 m/s | 2.99792458 | 0.004 |
| Elementary charge | e | 1.60×10^{-19} C | 1.6021892 | 2.9 |
| Electron rest mass | m_e | 9.11×10^{-31} kg | 9.109534 | 5.1 |
| Permittivity constant | ϵ_0 | 8.85×10^{-12} F/m | 8.854187818 | 0.008 |
| Permeability constant | μ_0 | 12.6×10^{-7} H/m | 4π [exactly] | — |
| Electron charge to mass ratio | e/m_e | 1.76×10^{11} C/kg | 1.7588047 | 2.8 |
| Proton rest mass | m_p | 1.67×10^{-27} kg | 1.6726485 | 5.1 |
| Ratio of proton mass to electron mass | m_p/m_e | 1840 | 1836.15152 | 0.38 |
| Neutron rest mass | m_n | 1.68×10^{-27} kg | 1.6749543 | 5.1 |
| Muon rest mass | m_μ | 1.88×10^{-28} kg | 1.883566 | 5.6 |
| Planck constant | h | 6.63×10^{-34} J·s | 6.626176 | 5.4 |
| Electron Compton wavelength | λ_C | 2.43×10^{-12} m | 2.4263089 | 1.6 |
| Molar gas constant | R | 8.31 J/mol·K | 8.31441 | 31 |
| Avogadro constant | N_A | 6.02×10^{23} /mol | 6.022045 | 5.1 |
| Boltzmann constant | k | 1.38×10^{-23} J/K | 1.380662 | 32 |
| Molar volume of ideal gas at STP ^c | V_m | 2.24×10^{-2} m ³ /mol | 2.241383 | 31 |
| Faraday constant | F | 9.65×10^4 C/mol | 9.648456 | 2.8 |
| Stefan-Boltzmann constant | σ | 5.67×10^{-8} W/m ² ·K ⁴ | 5.67032 | 125 |
| Rydberg constant | R | 1.10×10^7 /m | 1.097373177 | 0.075 |
| Gravitational constant | G | 6.67×10^{-11} m ³ /s ² ·kg | 6.6720 | 615 |
| Bohr radius | a_0 | 5.29×10^{-11} m | 5.2917706 | 0.82 |
| Electron magnetic moment | μ_e | 9.28×10^{-24} J/T | 9.284832 | 3.9 |
| Proton magnetic moment | μ_p | 1.41×10^{-26} J/T | 1.4106171 | 3.9 |
| Bohr magneton | μ_B | 9.27×10^{-24} J/T | 9.274078 | 3.9 |
| Nuclear magneton | μ_N | 5.05×10^{-27} J/T | 5.050824 | 3.9 |

MATH REFRESHER

1. SOLVE FOR X:

A. $4(x+7) = 92$

C. $x^2 + 2x - 15 = 0$

B. $x^2 - 7 = 74$

D. $x^2 + 25x - 120 = 0$

2. WRITE IN SCIENTIFIC NOTATION:

A. 10,000

B. .06

C. $(800)(4000)$

3. SOLVE THESE SIMULTANEOUS EQUATIONS FOR X AND Y:

$2x + y = 5$ AND $3x - 2y = 18$.

4. FIND AN EXPRESSION FOR X AND THEN FIND ITS VALUE USING A CALCULATOR.

A. $3(10^x) = 8$

E. $\frac{1}{75}x = \sin 36.9^\circ$

B. $7 + e^x = 15$

F. $\sin x = .342$

C. $5 \log x = 22$

G. $\sin^2 x + 3 \cos^2 x = 2.5$

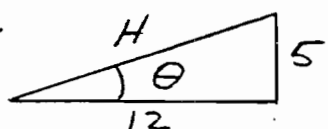
D. $2 \ln x^3 + \ln x^4 = 50$

H. $\sin x = 1.732 \cos x$

5. GRAPH: A) $-5x + y = 20$

B) $y = x^2 - 8x + 13$

6.



$H =$

$\tan \theta =$

$\sin \theta =$

$\theta =$

$\cos \theta =$

7. FOR EACH OF THE FOLLOWING EQUATIONS, FIND:

A. A FORMULA FOR THE DERIVATIVE, dy/dx .

B. THE VALUE OF Y AT $x = 3$,

C. THE VALUE OF THE SLOPE AT $x = 3$.

i) $y = 2x^5$

ii) $y = 2x^4 + 100x + 80$

8. FIND THE INDEFINITE INTEGRAL OF:

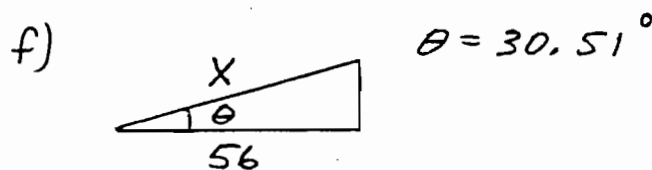
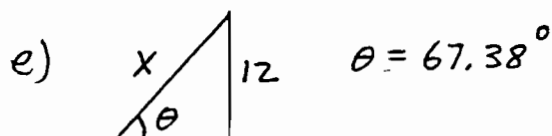
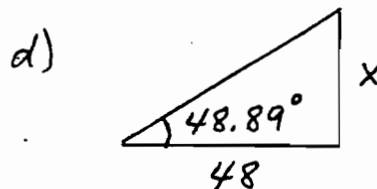
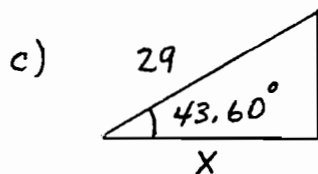
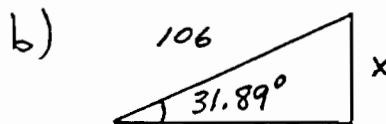
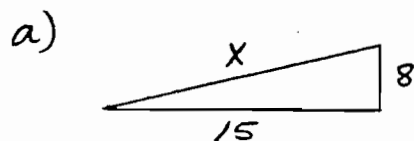
$$\int (36x^3 + 15x^2 + 8x + 10) dx$$

ANSWERS: 16, ±9, 3, -5, 4, 12, -29, 12, 1×10^4 , 6×10^{-2} , 3.2×10^6 , 4, -3, .426, 2.08, 2.51×10^4 , 148.4, 45, 20, 30, 60, ~~4~~, ~~U~~ (4, -3), 13, $5/13$, $12/13$, $5/12$, 22.6, $10x^4$, 486, 810, $8x^3 + 100$, 542, 3/6, $9x^4 + 5x^3 + 4x^2 + 10x + C$

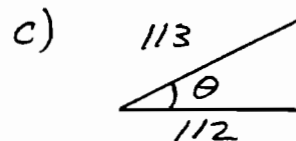
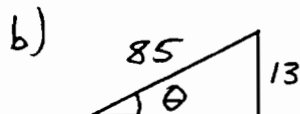
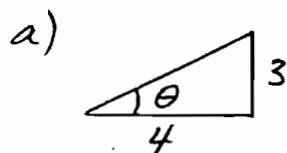
THE TRIGONOMETRY OF RIGHT TRIANGLES

WITH ACKNOWLEDGMENT TO THE PHYSICIST PYTHAGORAS (500 B.C.) AND THE ASTRONOMER HIPPARCHUS (150 B.C.).

1. FIND THE LENGTH OF THE UNKNOWN SIDE:



2. FIND θ :



(17, 56, 21, 55, 13, 65, 36.87° , 8.80° , 7.63°)

APPENDIX: FOR YOUR OWN ENLIGHTENMENT
GENERATING PYTHAGOREAN TRIPLES.

| X | Y | $a = y^2 - x^2$ | $b = 2xy$ | $c = x^2 + y^2$ |
|---|---|-----------------|-----------|-----------------|
| 1 | 2 | 3 | 4 | 5 |
| 2 | 3 | 5 | 12 | 13 |

PICK X AND Y AS ANY INTEGERS. THEN, $a^2 + b^2 = c^2$.
IF X AND Y HAVE OPPOSITE PARITY AND NO COMMON FACTOR, THEN THE TRIPLE IS PRIMITIVE, AS ABOVE.

1 3 8 6 10 NOT PRIMITIVE

PROOF: $(y^2 - x^2)^2 + (2xy)^2 = y^4 - 2y^2x^2 + x^4 + 4x^2y^2$
 $= x^4 + 2x^2y^2 + y^4 = (x^2 + y^2)^2$

UNIT CONVERSIONS AND CHAIN CALCULATIONS

I. METRIC SYSTEM PREFIXES

SI prefixes

| SI prefixes | | | SI base units | | | | | |
|-------------|--------|--------|---------------|--------|--------|---------------------------|--------------------|--------|
| Factor | Prefix | Symbol | Factor | Prefix | Symbol | Quantity | Name | Symbol |
| 10^1 | deka | da | 10^{-1} | deci | d | Length | meter ^a | m |
| 10^2 | hecto | h | 10^{-2} | centi | c | Mass | kilogram | kg |
| 10^3 | kilo | k | 10^{-3} | milli | m | Time | second | s |
| 10^6 | mega | M | 10^{-6} | micro | μ | Electric current | ampere | A |
| 10^9 | giga | G | 10^{-9} | nano | n | Thermodynamic temperature | kelvin | K |
| 10^{12} | tera | T | 10^{-12} | pico | p | Amount of substance | mole | mol |
| 10^{15} | peta | P | 10^{-15} | femto | f | Luminous intensity | candela | cd |
| 10^{18} | exa | E | 10^{-18} | atto | a | | | |

II. CONVERSION FACTORS

A. 1 INCH = 2.54 CM EXACTLY

B. 1 MILE = 5280 FEET

III. PROBLEMS

A. FILL IN THE BLANKS

1. 1 km = _____ m

2. 1 m = _____ μ m

3. 1 m = _____ dm

4. 1 dam = _____ m

B. SHOW A CHAIN CALCULATION TO CONVERT TO THE SPECIFIED UNITS.

1. 200 cm (_____) = _____ m

2. 400 km (_____) (_____) = _____ μ m

3. 150 dm (_____) (_____) = _____ nm

| | | |
|-----|--------------------------------|-------------------------|
| 4.* | 1 MILE | 7 KM |
| 5.* | 1 m | ft |
| 6. | 100 YARDS | m |
| 7. | 4000 m | MILES |
| 8. | 72 YEARS | SECONDS |
| 9. | 65 MPH | $\frac{KM}{HR}$ |
| 10. | $\frac{60 \text{ miles}}{HR}$ | $\frac{ft}{SEC}$ |
| 11. | 216 ft ³ | YARDS ³ |
| 12. | 4 km ² | Mm ² |
| 13. | 43560 ft ² | hm ² |
| 14. | $\frac{9.8 \text{ m}}{SEC^2}$ | $\frac{ft}{(MIN.)^2}$ |
| 15. | $\frac{3 \text{ CM}^3}{SEC^2}$ | $\frac{INCHES^3}{HR^2}$ |

ANSWERS: 1000, 1×10^6 , 10, 10, 2, 4×10^{11} , 1.5×10^{10} , 1.6093, 3.28084, 91.44, 2.486, 2.27×10^9 , 105, 88, 8, 4×10^{-6} , .4049, 1.157×10^5 , 2.37×10^6

C. SOLVE THE FOLLOWING WITH A SINGLE CHAIN.

1. FIND THE MASS, IN MEGAGRAMS, OF 15 m^3 OF SULPHUR, WHOSE DENSITY IS 2 g/cm^3 . (30)
2. FIND THE VOLUME, IN CUBIC METERS, OF 1922.4 kg OF NICKEL, WHOSE DENSITY IS 8.9 g/cm^3 . FIND THE LENGTH OF ONE SIDE OF THIS CUBE. ($.216 \text{ m}^3$, $.6 \text{ m}$)
3. GOLD, WHOSE DENSITY IS 19.3 g/cm^3 , COSTS $\$14$ PER GRAM. FIND THE VOLUME, IN CUBIC METERS, OF $\$800$ MILLION WORTH OF GOLD. (2.96)
4. PURE GOLD COSTS $\$14$ PER GRAM. 18 KARAT "GOLD" IS AN ALLOY WHOSE MASS IS $(18/24)^{\text{th}}$ GOLD. THE REMAINING MASS IS SILVER. PURE SILVER HAS A DENSITY OF 11 g/cm^3 . AN 18K "GOLD" RING OF THE ROMANOV JEWELS CONTAINS $\$231$ WORTH OF PURE GOLD. FIND THE VOLUME IN mm^3 OF PURE SILVER IN THIS RING. (500)
5. LAUNDRY TIME! WE DESIRE TO WASH ONE LOAD OF CLOTHES. POLLUTION RESTRICTIONS ALLOW ONLY 25 g OF PHOSPHATE PER LOAD OF CLOTHES. TIDE[®] DETERGENT, WHOSE DENSITY IS $.35 \text{ g/cm}^3$, IS 20% PHOSPHATE BY MASS. THERE ARE 237 cm^3 PER CUP OF DETERGENT. FIND THE MAXIMUM NUMBER OF CUPS OF TIDE WHICH WE MAY USE TO WASH OUR CLOTHES. (1.51)
6. A HUMAN BODY CONTAINS 12 PINTS OF BLOOD, WHERE ONE PINT EQUALS 28.875 inches^3 . EACH CUBIC mm OF BLOOD CONTAINS FIVE MILLION RED BLOOD CELLS. THERE IS ONE WHITE BLOOD CELL FOR EVERY SIX HUNDRED RED ONES, FIND THE NUMBER OF WHITE BLOOD CELLS IN MR. HARVIE. (4.73×10^{10} WBC)