Attachment 26

TABLE OF EQUIVALENTS AND NET QUANTITY OF GAS CONVERSION FORMULA

A26.1. Metrics. Figure A26.1. provides a list of metric prefixes.

Figure A26.1. Metric Prefixes.

Deci	0.1	Deca	10
Centi	0.01	Hecto	100
Milli	0.001	Kilo	1,000
Micro	0.000001	Mega	1,000,000
Nano	0.000000001	Giga	1,000,000,000
Pico	0.000000000001	Tera	1,000,000,000,000

A26.2. Miscellaneous Conversions. Figure A26.2. provides a list of general miscellaneous conversions for use with this manual.

Figure A26.2. Miscellaneous Conversions.

VOLUME		WEIGHT	
1 liter	0.264 gallon, 1.057 quarts, 61.025 cubic inches, 33.815 fluid ounces	1 gram 1 kilogram	0.03527 ounces, 0.0022 pounds avoirdupois 2.205 pounds,
1 cubic foot	28.32 liters, 7.481 gallons, 1728 cubic inches	 1 pound	35.274 ounces 0.4536 kg
1 cubic meter	1000 liters, 35.31 cubic feet, 264.2 gallons	1 ounce	28.35 grams
1 milliliter	0.0338 oz	PRESSURE:	
1 gallon	3.785l	1 pound per square inch	6.895 kilopascal
1 oz	29.57 ml	1 kilopascal	0.145 psi
LENGTH		RADIOACTIVE	ACTIVITY
1 centimeter 1 meter	0.3937 inches 3.28 feet, 39.37 inches	1 TBq 1 Sv/hr	27 Ci 100 rem/hr
1 inch	2.54 cm, 25.4 mm	1 rem/hr	0.01 Sv/hr
1 foot	0.3048 m		
1 millimeter	0.03937 in		
VOLUME			
1 newton	101.97 gram force		

A26.3. Temperature Conversion. Use Figure A26.3. to convert temperatures between Celsius and Fahrenheit.

Figure A26.3. Temperature Conversion Formula.

C = (F-32) times 5/9
F = (C times 9/5) + 32
K = C + 273.15
C = degrees Celsius
F = degrees Fahrenheit,
K = degrees Kelvin (absolute)

A26.4. Tank Volume. Use Figure A26.4 to determine tank volume.

Figure A26.4. Tank Volume Formula.

Formula	$V = p\, r^2 h$
where:	V= Tank Volume
	p= 3.142
	r^2= radius of tank
	h= height of tank

A26.5. Net Quantity of Gas Conversion Formula. Use Figure A26.5. to determine the net hazard of a compressed gas by converting PSI of a cylinder into pounds. Use Figure A26.6. to determine the molecular weight or specific gravity required to complete the formula.

Figure A26.5. Net Quantity of Gas Conversion Formula.

Formula (1)	P= 0.00512 x A x B x C
	or
Formula (2)	P= .0001744 x A x B x M
where:	P= weight of gas in pounds
	A= pressure in pounds per square inch
	B= volume of cylinder in cubic feet
	C= specific gravity of the gas
	M= molecular weight of the gas molecule

Note: Use Formula (1) for calculation using the specific gravity value. Use Formula (2) for calculation using the molecular weight value.

A26.5.1. Example for Determining Net Quantity of Gas. The following information is known or determined by examination of the cylinder. Measure the cylinder's height from the external base to the valve seat. Measure the external diameter (width). Assume the cylinder does not cone at the top.

A26.5.1.1. Example 1. Tank measurements:

Height: 50 inches
Diameter: 9 inches
Radius: 4.5 inches
Tank contents: CO_2
Internal Pressure: 900 psi
Tank Volume = 1.841 Ft^3
P (pounds of gas) = 0.00512 x A x B x C = {0.00512 in^2/Ft^3} x {900 psi} x {1.841 Ft^3} x {1.516}
Answer: *P = 12.9 pounds*

A26.5.1.2. Example 2. Tank measurements:

Height: 40 inches
Diameter: 12 inches
Radius = 6 inches
Tank contents: C_2H_2
Internal Pressure: 500 psi
Tank Volume = 2.618 Ft^3
P (pounds of gas) = 0.00512 x A x B x C = {0.00512 in^2/Ft^3} x {500 psi} x {2.618 Ft^3} x {0.897}
Answer: *P = 6.01 pounds*

A26.5.1.3. Example 3. Tank measurements:

Height: 50 inches
Diameter: 9 inches
Radius = 4.5 inches
Tank contents: CO_2
Internal Pressure: 900 psi
Tank Volume = 1.841 Ft^3
P = 0.0001744 x A x B x M = 0.0001744 x (900 psi) x (1.841 Ft^3) x (44.00)
Answer: *P = 12.7 pounds*

A26.5.1.4. Example 4. Tank measurements:

Height: 40 inches
Diameter: 12 inches
Radius = 6 inches
Tank contents: C_2H_2
Internal Pressure: 500 psi
Tank Volume = 2.618 Ft^3
P = 0.0001744 x A x B x C = 0.0001744 x (500 psi) x (2.618 Ft^3) x (26.00)
Answer: *P = 5.94 pounds*

A26.5.2. Examples for Determining Radioactive Shipments. A_1/A_2 values represent the maximum activity that can be shipped in a Type A package. A_1 is for Special form material and A_2 values is for Normal or Other form material. In dealing with mixtures of radionuclides if the sum of the ratios is ≤1, then use a Type A package. If the sum of the ratios is >1, then use a Type B package.

A26.5.2.1. Example 1. Determine the most appropriate packaging when shipping a mixture of 0.46 TBq of Bromine-77 (Br-77) & 0.25 TBq of Cerium-143 (Ce-143).

Activity measured / Activity allowed = sum of the ratio
0.46 TBq/3 TBq = 0.15 (A_2 for Br-77)
0.25 TBq/0.6 TBq = 0.42 (A_2 for Ce-143)
0.15 + 0.42 = 0.57 Total sum of the ratios 0.57 ≤ 1, so a Type A package is required

A26.5.2.2. Example 2. Determine if the item can be shipped as a RQ of a hazardous substance.

Shipping a mixture of 2.02 TBq of Silver-112 (Ag-112), 0.16 TBq of Tin-113 (Sn-113) & 0.21 TBq of Tungsten-185 (W-185).
Activity measured / Reportable Quantity = RQ
2.02 TBq/3.7 TBq = 0.546 (RQ for Ag-112)
0.16 TBq/0.37 TBq = 0.432 (RQ for Sn-113)
0.21 TBq/0.37 TBq = 0.568 (RQ for W-185)
Total RQ of 1.576 > 1 Therefore, mixture would be regulated as a hazardous substance.

A26.5.2.3. Example 3. Determine the most appropriate packaging when shipping the following:

1.45 TBq of Terbium-160 (Tb-160)
A_2 value for Tb-160 is 0. 6 TBq.
1.45 TBq > 0.6 TBq Since the amount shipped is greater than the A_2 value; a Type B package is required.

A26.5.2.4. Example 4. Determine the most appropriate packaging when shipping the following:

0.45 GBq of solid Niobium (Nb-95) internationally
0.45 GBq converted is 0.00045 TBq
A_2 value for Nb-95 = 1 TBq
$10^{-3}A_2$ = 0.001 TBq > 0.00045 TBq
A26.5.2.4.1. Since the maximum activity allowed is greater than amount being shipped, the item can be shipped in an Excepted package.

A26.6. Properties of Common Gases. Figure A26.6. is a list of the molecular weight and specific gravity of common gases.

Figure A26.6. Properties of Common Gases.

GAS	SYMBOL	MOLECULAR WEIGHT	SPECIFIC GRAVITY
Helium	He	4.00	0.138
Argon	A	40.00	1.377
Air	-	29.00	1.000
Oxygen	O_2	32.00	1.103
Nitrogen	N_2	28.00	0.966
Hydrogen	H_2	2.00	0.0695
Nitric Oxide	NO	30.00	1.034
Carbon Monoxide	CO	28.00	0.965
Hydrochloric Acid	HCl	36.50	1.256
Steam	H_2O	18.00	0.623
Carbon Dioxide	CO_2	44.00	1.516
Nitrous Oxide	N_2O	44.00	1.518
Sulfur Dioxide	SO_2	64.00	2.208
Ammonia	NH_3	17.00	0.587
Acetylene	C_2H_2	26.00	0.897
Methyl Chloride	CH_2Cl	50.50	1.738
Methane	Ch_4	16.00	0.553
Ethylene	$C2H_4$	28.00	0.967

A26.7. Lithium Content. Rechargeable lithium batteries are manufactured without lithium metals. There are two methods to determine equivalent lithium content.

A26.7.1. The rated capacity, in ampere-hours, of each cell times 0.3 expressed in grams (g). Example: A battery with 9 cells each having a rated capacity of 2.2 ampere-hours contains 5.94 grams of equivalent lithium content (2.2 X 0.3 X 9 = 5.94g)

A26.7.2. Dividing the stated volts (V) on a battery pack by 3.7 (rounded to nearest whole number), multiplying the results by the stated ampere-hours (Ah) times 0.3. Example: Battery marked with 14.8 (V) and 4.8 (Ah) contains 5.76 grams of equivalent lithium content (14.8 divided by 3.7 = 4, 4 X 4.8 = 19.2, 19.2 X 0.3 = 5.76 grams)

A26.8. Lithium batteries. The watt-hour (Wh) rating is a measure by which lithium ion batteries are regulated. Lithium Ion batteries manufactured after 31 December 2011 are required to be marked with their watt-hour rating.

A26.8.1. To arrive at the number of watt-hours the battery provides multiply the battery's nominal voltage (V) by the capacity in ampere-hours (Ah): Ah x V = Wh. A battery of 14.8 V with a capacity of 2 Ah is 29.6 Wh normally rounded to 30 Wh