Useful Tidbits

Magnifying Glass:

Magnification

$M_{25} = 25 / f + 1$ – from lens equation with focal length of f (cm), and virtual image distance of 25 cm (10" from eye)

Dioptres	f (cm)	M_{25}	
0.5	200	1.125	
1	100	1.25	
2	50	1.5	
3	33	1.75	
4	25	2.0	
5	20	2.25	
10	10	3.5	
100	1	26.0	(about time for a microscope!)

* note for interest that the eye's lens focal length (f) ranges from about 1.59 to 1.70 cm (58.8 to 62.9 dioptres)

Guitar Strings:

Neck Relief

Adjust neck, via tension rod, for slight concavity of fret board, for (Gibson standard) 0.005 to 0.015 inches clearance at the 8th fret, with string pressed to the 1st fret via capo, and manually holding on the 20th fret (like you are fretting to play 21st). Be sure to re-tune between rod adjustments before remeasuring. Note that it seems the rod/neck adjustment can take time to settle; might check again the next day. It is normal to have High E a bit closer than Low E.

String Height

Gibson targets 1st fret Low E clearance of 2/64 inches (0.8 mm) and High E of 1/64 inches (0.4 mm); controlled by the nut of course.
Nominal clearance at 12th fret is targeted for Low E of 5/64 inches (2.0 mm) and High E of 3/64 (1.2 mm); adjusted at the bridge.

String Gauges

Electric Light: 10 13 17 26 36 46 (thousands of an inch diameter)
Electric Extra Light: 9 11 16 24 32 42

Disk Storage Capacity:

74 min / 650 MB CD

CD-A format: 333,000 sectors x 2353 bytes/sector ≈ 747.3 MB ≈ **74m:02s**
CD-R format: 333,000 sectors x 2048 bytes/sector ≈ **650.4 MB**

80 min / 700 MB CD

CD-A format: 360,000 sectors x 2353 bytes/sector ≈ 807.8 MB ≈ **80m:02s**
CD-R format: 360,000 sectors x 2048 bytes/sector ≈ **703.1 MB**

120 min / 4.7 GB_{10} DVD

DVD–R/-RW disk & format: 2,294,922 sectors x 2048 bytes/sector ≈ **4.38 GB**
DVD+R/+RW disk & format: 2,295,104 sectors x 2048 bytes/sector ≈ 4.38 GB

Furnace Power:

*Home Gas Furnace Specification – **Small Size, 80% Efficiency, Two-Speed***

Low Speed Burn: 39000 Btu/h In, 31000 Btu/h Out, Temp rise range: 15 – 45 F (fan dependent)
High Speed Burn: 60000 Btu/h In, 48000 Btu/h Out, Temp rise range: 25 – 55 F (fan dependent)

– heating power is then about 9 – 14 kW; **4.5 – 7.0 kW @ 50% duty** (1 kW ≈ 3413 Btu/h)

Useful Tidbits

Medium Size, 93% Efficiency, Three-Speed

```
   Low:  32000 Btu/h In,  30000 Btu/h Out,  Temp rise: 35 – 65 F (fan dependent)
Medium:  52000 Btu/h In,  49000 Btu/h Out,  Temp rise: 50 – 80 F (fan dependent)
  High:  80000 Btu/h In,  74000 Btu/h Out,  Temp rise: 40 – 70 F (fan dependent)
```

– heating power is then about 9 – 22 kW; **4.4 – 10.8 kW @ 50% duty**

Law:

Contracts

– can be verbal or written
– must be written for land, or for debt, or arrangements that extend beyond one year
– A contract may be found void if any of the following five criteria are not met:
- offer and acceptance must be made
- intent must be shown specifically to enter into a contract
- consideration; something must be gained by each party, such as money or property
- capacity; i.e. sometimes unenforceable with minors or 'lunatics'
- legality; must not contravene statutory or common laws

Patents, Trademarks, Designs and Copyright

– patents must be novel and useful, and ingenuity must have been applied; 20 years
– industrial designs must be only ornamental or aesthetic, for things manufactured; 10 years
– trademarks must be distinctive, and must include an indication they are owned; indefinite
– copyright is automatic, but won't protect mass produced useful articles; owner life + 50 years
– a patent will normally be owned by (assigned to) an employer if done in course of work
– copyright for plans or designs will normally be owned by an employer; but not by a client

Tort Liability for an 'Injury' (proof needed)

– defendant must have owed the plaintiff a duty of care
– defendant must have breached that duty by his conduct
– defendant's conduct must have caused the injury to the plaintiff

---

Light:

c = 299 792 458 m/s ≈ 30 cm/ns (3.34 ns/m)

Visible Light Level Units

1 lumen (lm) *luminous power (flux) = 1/683 W @ 555 nm, differs over frequency*
1 candela (cd) = lm/sr *Iv, luminous intensity (angular power density)*
1 nit (cd/m^2) *luminance (angular power density per area of emitting surface)*
1 lux (lm/m^2) *Ev, illuminance (power density at receiving surface)*

Ev (lx) = Iv (cd) / R^2 *spherical surface illuminance at sphere radius R*

Solid Angle = $2\pi (1 - \cos\theta)$ *conical solid angle (sr); angular half-width θ*
Spherical Area = $2\pi R^2 (1 - \cos\theta)$ *spherical cap area*
Flat Area 1 = $\pi R^2 \sin^2\theta$ *flat area under cap (perpendicular distance < R)*
Flat Area 2 = $\pi R^2 \tan^2\theta$ *projected flat area (perpendicular distance = R)*

full width(2θ)	solid angle(sr); or spherical area(m^2) @ R=1m
10°	0.0239
15°	0.0538
20°	0.0955
30°	0.2141

Useful Tidbits

```
 45°              0.4783
 60°              0.8403
 65.54°           1.0000
 90°              1.8403
120°              π
```

0.07 W LED (bright white)	~ 1 lm	~ 14 lm/W
100 W incandescent bulb radiates	~ 1760 lm	~ 18 lm/W
60 W halogen car lamp radiates	~ 1600 lm	~ 27 lm/W
33 W High Intensity Discharge car lamp	~ 5200 lm	~ 158 lm/W

100 W bulb radiating about 1760 lm, at about 140 cd over 4π sr, yields:
14000 lx @ 10cm, 560 lx @ 50cm, 140 lx @ 1m, 35 lx @ 2m, 1.4 lx @ 10m

Typical Illumination Levels

~ 10 lux – low light
~ 100 lux – normal indoors
~ 1000 lux – very bright indoors
~ 10000 lux – normal outdoors
~ 100000 lux – very bright outdoors

Desk/Work Lamp Illumination Example

Nominal values for white painted reflective metal shades, typical incandescent bulbs, shade height 50cm, bulb centroid height 55-60cm, expect say +25% to -50% (dirty).

```
bulb power    illuminance
7.5 W          15 lux  \
 15 W         100 lux   \  maybe looks contrived, but
 25 W         200 lux    \ does represent findings;
 40 W         400 lux    / just remember +25%/-50%
 60 W         800 lux   /
```

White LED Illumination Example

3mm clear package, blue with white phosphor, beam width (2θ) ~ 30°, distance = 50cm
(Lumex PN: SSL-LX3054UWC/A, Digikey PN: 67-1606)

```
power input                 axial illuminance
64 mW (20mA @ 3.18V)               6.5 lx
98 mW (30mA @ 3.26V)               8.7 lx
```

C.I.E. Standard Observer Primary Colours:

red – 700 nm
green – 546.1 nm
blue – 435.8 nm

Field of View:

FOV = 2 $\tan^{-1}$ (x / 2f)   x = focal plane dimension   f = focal length
Examples:

f = 75mm & 1/2" CCD array (6.4mm x 4.8mm): FOV ≈ 4.9° × 3.7°
f = 50mm (standard) & 35 mm film (36mm x 24mm): FOV ≈ 39.6° × 27.0°

Imaging:

Pixel Array Size / Aspect Ratio / Imaging Resolution

```
    3000 x 2000  /     3:2     /  1400   6Mpx still camera
    1600 x 1200  /     4:3     /  840    UXGA (2Mpx camera)
    1920 x 1080  /    16:9     /  756    DTV (HDTV)
    1280 x 1024  /     5:4     /  717    SXGA
```

Useful Tidbits

1024 x 768	4:3	538	*XGA*
1280 x 720	16:9	504	*DTV (HDTV)*
800 x 600	4:3	420	*SVGA*
768 x 485	4:3	403	*Sony XC-75 b/w video camera*
720 x 480	4:3	**378**	***DV camera***
704 x 480	4:3	370	*DTV (4:3 catch-all)*
640 x 480	4:3	**336**	*VGA/DTV (NTSC comparable)*
704 x 480	16:9	277	*DTV (believe it or not)*
(480 x 360)	4:3	252	*VHS (effective)*

Resolution quoted is for the horizontal axis, in Lines per Picture Height (L/PH), computed here as:

L/PH = horizontal pixel count × 0.7 (Kell factor) / aspect ratio (w/h)
Note that vertical resolution is then: vertical pixel count × 0.7 (L/PH)
A Line infers half of a b&w Line Pair, such that 336 L/PH infers 168 LP/PH, and that the Kell factor de-rates expected resolution based on probability of inter-pixel alignments of lines.

TV Lines (TVL) is 'properly' a measured resolution, performed by imaging a calibrated chart, essentially in units of L/PH. Readings should observe the points of blurring and artefacts/aliasing. If one does not measure, then a reasonable method for digital imaging is to compute the resolution using the above approach. Frequently, however, one encounters quoted horizontal resolutions that although apparently comzputed, seem to either ignore aspect ratio, or the Kell factor. For example, one computes a 4:3 aspect ratio DV camera image, at 720 x 480 pixels, to be about 378 L/PH, which accounts for aspect ratio, and Kell. Ignoring aspect ratio, but accounting for Kell, one computes horizontal resolution to be 720 x 0.7 = 504 TVL. Ignoring Kell, but still accounting for aspect ratio, one computes 720 / (4/3) = 540 TVL. Indeed one finds DV TVL quoted at and between these numbers.

Typical Integrated Colour Pixel Array:

G R G B G R G B G R G B G R G B ...
For say a 768 pixel horizontal line, this is 384 G, 192 R and 192 B pixels across.
Horizontal resolutions (for 4:3 display) are then about 202 (G), 101 (R) and 101 (B) L/PH, and 404 L/PH mono.

NTSC tidbits:

Vertical Resolution (discrete): ~ 483 (active scan lines) × 0.7 (Kell) = 338 L/PH
Horizontal Resolution (continuous):

bandwidth × active line time / aspect ratio =
(4.2MHz) (52.45us) / (4/3) = 165 cycles/PH, or LP/PH = 330 L/PH
For an compatible pixel count, using the Kell factor and aspect ratio,
we have 330 / 0.7 x 4/3 = 629 pixels horizontal

Raw Video Image Data:

16 bit × 640 × 480 = 600 KB
8 bit × 320 × 240 = 75 KB
10 bit × 720 × 480 ≈ 422 KB (High-End SMPTE 4:2:2 standard, with luminance for all pixels, and Cr and Cb only on half)

Digital Video Data Rates:

Assume the standard 4:3 DV format with 720 x 480 pixel frame (non-'square' spaced pixels), 8 bits/sample, and 30 fps

image colour sub-sampling:
4:4:4 RGB – (720 x 480 + 720 x 480 + 720 x 480) x 8 x 30 ≈ 249 Mbps (1.74 GB/min) – raw
4:2:2 YUV – (720 x 480 + 360 x 480 + 360 x 480) x 8 x 30 ≈ 166 Mbps (1.16 GB/min) – high-end
4:1:1 YUV – (720 x 480 + 180 x 480 + 180 x 480) x 8 x 30 ≈ 124 Mbps (890 MB/min) – common
4:2:0 YUV – (720 x 480 + 360 x 240 + 360 x 240) x 8 x 30 ≈ 124 Mbps (890 MB/min) – common
compression:
4:2:2 YUV with 3.3:1 DCT ≈ 50 Mbps (360 MB per minute) – high-end DV camcorder

Useful Tidbits

4:1:1 YUV with 5:1 DCT ≈ **25 Mbps (178 MB per minute)** – typical DV camcorder
4:2:0 YUV with 25:1 MPEG2 ≈ 5.0 Mbps (35.6 MB per minute) – low compression DVD (2h~4.3GB)
4:2:0 YUV with 36:1 MPEG2 ≈ 3.5 Mbps (24.7 MB per minute) – high comp. DVD (2h~2.9GB)

Photonics (DWDM):

ITU Grid channel frequency ranges:
L band : 186 – 190.95 THz (~ 1611.79 – 1570.01 nm)
C band : 191 – 195.95 THz (~ 1569.59 – 1529.94 nm)
ref. chan. centre-frequency: 193.1 THz (~1552.52 nm)
S band : 196 – 200.95 THz (~ 1529.55 – 1491.88 nm)

typical single mode (1550nm) fiber:
125 um diameter
8.2 um core
n_{eff} ≈ 1.468
E = 70 GPa *modulus of elasticity of glass fiber*
ultimate strength ≈ 14 GPa
typical breakage ≈ 0.7 - 3.5 GPa

Battery Power:

Lead-Acid Sustained Discharge Rates

2 C	0.5 h discharge	excessive; ex. 36 A for an 18 Ah battery
1 C	1 h discharge	very high rate; 18 A for 18 Ah unit
0.5 C	**2 h** discharge	***high*** charge/discharge rate; 9 A for 18 Ah
0.05 C	**20 h** discharge	***medium*** rate; standard for Ah specification
0.005 C	**200 h** discharge	***low*** rate
0.0005 C	2000 h discharge	very low rate

Lead-Acid Voltages

13.4 V – fixed voltage for trickle charging (≈0.001 C; limit const. cur. to 0.02 – 0.2 C)
13.1 V – unloaded terminals (fully charged)
12.8 V - full charge at medium fixed resistive discharge (0.05 C rate)
11.5 V - endpoint of linear voltage drop at medium fixed resistive discharge
10.5 V - end-point for standard 0.05 C constant discharge rate for Ah rating

---

Miscellaneous:

N 45° 23' 26.37" W 75° 44' 32.39" ~ UTM 18T 0441 892 5026 617

200/min ≈ 3.3/s

1 decade ≈ 3.322 octaves

1/12 octave (1 semitone) = $2^{1/12}$ ≈ 1.0595 *1/1200 octave = 1 cent ≈ 1.0005778)*
1/3 octave ≈ 1.26 1/2 octave ≈ 1.414 1/3 decade ≈ 2.154 1/2 decade ≈ 3.162

hex: 33 / 66 / 99 / CC dec: 51 / 102 / 153 / 204 frac. of 255: 20% / 40% / 60% / 80%

360° = 6400 mil (1° ≈ 17.45 mrad ≈ 17.78 mil)

1 m/s = 3.6 kph ≈ 3.28 ft/s ≈ 2.24 mph ≈ 1.94 knots

1 atm = 101325 Pa ≈ 29.92" Hg ≈ 14.7 psi ≈ 33.93 ft H_2O

1 Curie = 3.7×10^{10} disintegrations / s

Useful Tidbits

ionizing radiation, absorbed dose (actual energy absorbed per unit mass):
1 Gray (Gy) = 1 J/kg (= 100 RAD)

ionizing radiation, equivalent dose (weighted for damage by particular particle type and tissue):
0.1 Sv ~ future cancer possibility
1 Sv ~10% fatality in 1 month (note: 1 Sievert = 100 REM)
10 Sv ~100% fatality in 2 weeks
100 Sv ~100% fatality in minutes to hours

background ionizing radiation:
~ 3.5 mSv/yr ~ 0.4 uSv/h

1 lbf = 16 oz ≈ 4.448 N (1 ft-lbf = 92 in-oz ≈ 1.356 Nm)

1 acre = 43560 ft^2 ~ 4047 m^2 (~63.6 m or ~208.7 ft square)

1 year ≈ 365.2425 days based on calendar (365.24219 based on earth/sun motion)
≈ 52.18 weeks (1 Month ≈ 30.44 days ≈ 4.35 weeks)
Assuming 52 weeks/year we have 364 days or 8736 hours;
for a 5d x 7.5h work week we have 260 days and 1950 hours.

Volume:

```
          1 oz CA ~ 28.41 mL
          1 oz US ~ 29.57 mL
          1 oz US ~ 1.041 oz CA
 1 gal CA (160oz) ~ 1.2 gal US (128oz)

        say: 1 oz ~ 29 mL
         so: 1 oz ~ 29 g water @ 4 C

              Density
           water ~ 0.9982 g/mL @ 20 C
   ethyl alcohol ~ 0.7892 g/mL @ 20 C

           40% Shot Weight
            1 oz ~ 26.5 g
        1 1/4 oz ~ 33.2 g
        1 1/2 oz ~ 39.8 g
            2 oz ~ 53.0 g

 12 oz CA  ~ 341 mL
 12 oz US  ~ 355 mL
 16 oz US  ~ 473 mL (US pint)
 20 oz CA  ~ 568 mL (Cdn pint)

 341 ml Bottle  @ 5%   ~   1.5 oz  @ 40%
      Cdn Pint  @ 5%   ~   2 x 1.25 oz  @ 40%
```

Power/Weight:

```
Sup'd-Up Car:             1000 HP  / 1450 kg  =  514 W/kg
Psycho Snowmobile:        110 HP   / 539 lb   =  336 W/kg
typical road car:         134 HP   / 1000 kg  =  100 W/kg
Landscaping Tractor:      15 kW    / 600 kg   =  25 W/kg
Abrams Tank:              1100 kW  / 55 t     =  20 W/kg
Bradley APC:              450 kW   / 30 t     =  15 W/kg
```

Useful Tidbits

```
Light Armoured Vehicle:  200 kW   / 13 t      =  15 W/kg
Human Working Out:       100 W    / 70 kg     ~  1.4 W/kg
Little Martian Rover:    16 W     / 11.5 kg   =  1.4 W/kg
Big Martian Rover:       500 W    / 1000 kg   =  0.5 W/kg
```

Human Energy Consumption:
Nominal burn rate (for heat & work): ~100 W ~86 kcal/h ~2064 kcal/day
Additional rate for hard work (say cycling @ 25% efficiency): ~400 W (100W work) ~344 kcal/h
Total high burn rate: 86 + 344 = 430 kcal/h.

Normal Distribution PDF: +/- 1σ ≈ 68.3% +/- 2σ ≈ 95.4% +/- 3σ ≈ 99.7%

2nd-Order Systems:

$t_r \times w_n \approx 1.8$ *product of rise time (10-90%) and natural frequency*

$t_r \times w_{bw} \approx \pi$ *product of rise time and bandwidth (-3dB)*
handy: $t_r \times f_{bw} \approx 0.5$ $f_{bw} \approx 1.7 \times f_n$

$t_s \approx 4.6 / (\zeta \times w_n)$ *settling time (1% error)*

$w_d = w_n (1 - \zeta^2)^{1/2}$ *damped natural frequency*

$\delta = \ln (y_1/y_2)$ *logarithmic decrement*

$\zeta = \delta / (4\pi^2 + \delta^2)^{1/2}$ *damping ratio*

Sinusoidal Motion: $v_{peak} = 2\pi \times f \times d_{peak}$ $a_{peak} = 4\pi^2 \times f^2 \times d_{peak}$

1st-Order Systems:

$\tau \times 2\pi f_{bw} = 1$ *product of time constant (τ = 1-1/e ≈ 0.632 of change to steady state) and bandwidth (f_{bw} ~ -3.01dB; G ≈ 0.707)*
handy: $\tau \times f_{bw} \approx 0.16$ $t_r \times f_{bw} \approx 0.35$ $t_s \times f_{bw} \approx 0.73$ ($t_r \approx 2.2\tau$, $t_s \approx 4.6\tau$)

Low-Pass (RC) Filter Signal Levels ($2\pi f_{bw} = 1/\tau$, τ = RC):

0.1 f_{bw}	~ 0.995	< -0.05 dB	(HP: 10 f_{bw})
0.5 f_{bw}	~ 0.894	~ -1 dB	(HP: 2 f_{bw})
1 f_{bw}	~ 0.707	~ -3 dB	(HP: 1 f_{bw})
2 f_{bw}	~ 0.447	~ -7 dB	(HP: 0.5 f_{bw})
10 f_{bw}	~ 0.096	~ -20 dB	(HP: 0.1 f_{bw})

Assorted 1st-Order Responses:

τ	t_r	t_s	f_{bw}	
1 ms	2.2 ms	4.6 ms	159 Hz	
3.2 ms	7 ms	14.6 ms	50 Hz	
61 ms	*10 ms*	*36 ms*	*50 Hz*	*2nd-Ord; ζ = 0.7*
35 ms	77 ms	161 ms	4.55 Hz	
100 ms	220 ms	459 ms	1.59 Hz	
125 ms	275 ms	573 ms	1.27 Hz	
1 s	2.2 s	4.6 s	0.16 Hz	
8 s	17.6 s	36.7 s	0.02 Hz	

Useful Tidbits

Measurement Settling Times

```
- 1st-Order System, Tc = τ = 1 sec
- to within specified level

1.0 dB      2.219 s
10%         2.303 s

0.5 dB      2.883 s
5%          2.996 s

0.1 dB      4.470 s
1%          4.605 s

0.05 dB     5.160 s
0.5%        5.298 s

Examples:
* for 1dB rounded display wait for at least +/-0.5dB settling: ~2.883s
* for 0.1 dB display with Tc = 8s wait ~ 5.16 x 8 = 41.28 s
```

Vibration:

Transverse Fundamental Frequency of Thin-Walled Tube with Free Ends (Free-Free Euler Formula)

$w \sim 7.9 \times d / L^2 \times (E/p)^{1/2}$ ($w = 2\pi f$)

– d = mean diameter, L = length, E = elastic modulus, p = material density
– nodes are 0.224 L from each end
– note: does not depend on wall thickness!

Fluid Properties:

SAE Oil Viscosity Grades:

SAE Grade	Kinematic Viscosity (cSt) @ 100C
20	5.6 – 9.3
30	9.3 – 12.5
40	12.5 – 16.3
50	16.3 – 21.9
60	21.9 – 26.1

SAE Low Temperature Grades (1999):

SAE Grade	Absolute Viscosity (cP)	*Kinematic Viscosity (cSt) @ 100C*
0W	6200 @ -35C	*3.8 – 4.1*
5W	6600 @ -30C	
10W	7000 @ -25C	*4.1 – 5.6*
15W	7000 @ -20C	*5.6 – 9.3*
20W	9500 @ -15C	
25W	13000 @ -10C	*9.3 – 12.5*

Kinematic viscosity, in units of mm^2/s, referred to as centistokes, cSt
Absolute viscosity, in units of mPa·s, referred to as centpoise, cP

Useful Tidbits

Miscellaneous Properties:

Air Properties at NTP:

$p \approx 1.2$ kg/m^3 *density*
$u \approx 1.8 \times 10^{-5}$ Ns/m^2 *dynamic viscosity*
$v = u/p \approx 1.5 \times 10^{-5}$ m^2/s *kinematic viscosity*

Speed of Sound:

$c_{air} \approx 20.05 \times T^{1/2}$ where T is in K
c_{air} (15°C) ≈ 340.3 m/s (≈1225km/h) delta ≈ 1.74% per 10°C

Elastic Modulus (E), nominal values in GPa:
Glass: 63 Glass Fibre: 70 Fibreglass: 31 Wilburt Mast composite: 79
Steel: 200 Wood (bending): 11 Aluminum: 70

Density (p), nominal values in kg/m^3:
Glass: 2600 Steel: 7850 Pine/Spruce: 450 Aluminum: 2700

Earth Gravitational Acc. = $GM/R^2 \approx (6.672 \times 10^{-11})(5.974 \times 10^{24}$ kg$) / (6378$ km$)^2$
≈ 9.8 m/s^2 *avg. at surface*

Martian Gravitational Acceleration ≈ 3.76 m/s^2 *average at surface* (≈ 3/8 of earth)

Maximum Building Acc. ~ 0.15 m/s^2 *keep buildings below this for peoples' comfort*

INS error rates:

10 °/hr (3 mrad/min) *low performance gyro drift rate*

0.1 °/hr (0.03 mrad/min) *high performance gyro drift rate*

< 0.001 °/hr (0.3 urad/min) *optical fibre 'gyro' drift rate*

1 to 10 cm/s (0.6 to 6 m/min) *typical linear drift rate (int of accelerometer)*

Digital Signals:

FSS *Full Scale Signal; dc or sinusoid*
QN *Quantization Noise*
q *quantization step size; say 1, 1/1024, 5mV, etc.*
n *total bit count; so n=10 for 10-bit samples*

FSS Range $q2^n$ *say dc, or a sinusoid peak-to-peak*
FSS Amp $q2^{n-1}$ *sinusoid amplitude*
FSS RMS $q2^{n-1}/2^{1/2}$ *sinusoid RMS*
QN RMS $q/12^{1/2}$
SNR $20\log(FSS_{RMS}/QN_{RMS}) \approx 6.02n + 1.76$ dB

Effective Number Of Bits ≈ (SNR − 1.76) / 6.02

Useful Tidbits

1.0% measurement error (<0.09dB) due to noise is SNR = 40dB,
requiring a minimum signal size of ENOB ≈ 6.35 bits (6.35 q rms)

Audio & Acoustics:

Signal Levels

+19 dBu ≈ 6.904 Vrms ≈ +/-9.8 Vp
+14 dBu ≈ 3.882 Vrms ≈ +/-5.5 Vp
+4 dBu ≈ 1.228 Vrms ≈ +/-1.7 Vp
0 dBV = 1.000 Vrms
0 dBu ≈ 0.775 Vrms (600ohm x 1mW)$^{1/2}$
-10 dBV ≈ 0.316 Vrms ≈ +/-0.45 Vp

10dB ≈ 3.2 sigma & 15dB ≈ 5.6 sigma, on RMS of white noise

-10 dBV + 11.8 dB ≈ +4 dBu

(Note also, 0 dBm = 1 mW)

Acoustic Levels

0 dB = 1 pW *sound power (source) standard reference*
(whisper ≈ 50dB = 0.1uW Saturn Rocket ≈ 195dB ≈ 32MW)

0 dB SPL = 20 uPa *Sound Press. Lev. (RMS) reference*
(just audible at 1 kHz)

0 dBA = 20 uPa *Sound Level reference*
(SPL measured with A-weighed 'contour' filter)

140 dBA *instant hearing damage*
130 dBA *auditory pain and damage*

dangerous sound level *- loud live 'music', stop it already*
120 dBA <9s (85 dBA criterion, 3 dB exchange)
115 dBA 28s
110 dBA 90s

very loud sound level *- typ. live scene, but really too loud*
105 dBA <5m
100 dBA 15m
95 dBA 48m

typical loud/noisy working environment
90 dBA 2.5h
85 dBA 8h
80 dBA >24h

Sound (Noise) Dose Standard Limits

** criterion level / exchange rate; sensor time constant = 1s*

NIOSH (85/3) exposure limit:
85dBA for 8h, allowable time is half per +3dB

Useful Tidbits

OSHA (90/5) exposure limit:
90dBA for 8h, time is half per +5dB

Exposure Limits (hours) at Fixed Levels

Crtn/ER	*90 dBA*	*100 dBA*	
90/5	8	2	OSHA
90/3	8	0.79	
85/5	4	1	
87/3	4	0.4	Cdn Fed
85/3	2.5	0.25	NIOSH

Guitar Fundamental Range:
6th string (E) ≈ 82.4 Hz
1st string (E) ≈ 329.6 Hz
1st string, 22nd fret (D) ≈ 1174.7 Hz

Cable/Wire Loss:

RG-174 coax (50 ohm characteristic impedance) loss ≈ 2dB/100ft

Copper Wire Resistance:

12 AWG - 1.62 ohms / 1000 ft
14 AWG - 2.58 ohms / 1000 ft
16 AWG - 4.09 ohms / 1000 ft
18 AWG - 6.51 ohms / 1000 ft
20 AWG - 10.4 ohms / 1000 ft
22 AWG - 16.5 ohms / 1000 ft
24 AWG - 26.2 ohms / 1000 ft
26 AWG - 41.6 ohms / 1000 ft

Hill Grade / Slope:

grade = rise / run × 100%
10% grade ≈ 5.7°
20% grade ≈ 11.3°
35% grade ≈ 19.3°
60% grade ≈ 31.0°

Elastic Column Buckling Critical Force (Euler's formula):
fixed – free: $F_{cr} = EI\,\pi^2 / 4L^2$ <<< this is a free-end cantilever beam (and is lowest)
pinned – pinned: $F_{cr} = EI\,\pi^2 / L^2$
fixed – pinned: $F_{cr} = EI\,\pi^2 / 0.5L^2$
fixed – fixed: $F_{cr} = EI\,\pi^2 / 0.25L^2$

Wheel / Ground Contact Area:
$A = 2 \times b \times R \times \cos^{-1}[(R - z_0) / R]$
-- where R is the wheel radius, z_0 is sinkage and b is the wheel width

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Useful Tidbits

Yes, it's the Greek Alphabet:

Α	α	alpha
Β	β	beta
Γ	γ	gamma
Δ	δ	delta
Ε	ε	epsilon
Ζ	ζ	zeta
Η	η	eta
Θ	θ	theta
Ι	ι	iota
Κ	κ	kappa
Λ	λ	lambda
Μ	μ	mu
Ν	ν	nu
Ξ	ξ	xi
Ο	ο	omicron
Π	π	pi
Ρ	ρ	rho
Σ	σ, ς	sigma
Τ	τ	tau
Υ	υ	upsilon
Φ	φ	phi
Χ	χ	chi
Ψ	ψ	psi
Ω	ω	omega

CD Jewel Cases:

occupy about 10.3 mm shelf width each (you can get 29 CD's per foot of shelf space)

Thermometer Errors (° C)

B+K multimeter thermocouple: $u = -0.13$ $\sigma = 0.43$
Bionaire tabletop unit: $u = 0.78$ $\sigma = 0.29$
Honeywell "34" furnace thermostat: $u = 0.52$ $\sigma = 0.41$
L.L.Bean tabletop unit: $u = -0.69$ $\sigma = 0.33$
Digi-Temp Outdoor (thermistor?): $u = 1.3$ $\sigma = 0.2$
Enerstat furnace thermostat: $u = 0.11$ $\sigma = 0.21$

experimentally found mean and standard deviation

Binocular Selection:

Useful Tidbits

Good binoculars for star and planet gazing are 40mm to 50mm diameter lenses, and have magnifications of 7x to 10x. Examples are 7× 42, 8× 40, 7× 50 and 10× 50. Avoid Zoom models and permanent focus. Other good features that come at the cost of money and weight and size are wider FOV, greater eye relief, better optical coatings, waterproof construction and tripod mounting. BaK-4 prisms are better than BK-7 prisms. You should not see much white reflection in the objective; dim green and purple are to be expected.

Dark Ale Brewing Example:

Use a dark ale beer kit, which typically consists of say a 1.25L can of hopped malt and a packet of yeast. Mix in 1kg more of malt for sugar, using say a 1.0kg or 1.3kg container of malt. Mix this stuff together with a few liters of hot water and stir. Mix more cold water, up to the standard 5Cdn gallon (≈ 6US gallon ≈ 22.7L) brew quantity. Add the yeast when the mix is below 30° C. Stir. Close container. Wait.

The 1kg-1.3kg of extra malt is used in place of the 1kg regular fine sugar that is otherwise generally recommended. Using (unhopped) malt in place of regular sugar makes the brew even darker than the base kit. (Really, a kit in this case, and many others, is just barley malt with hops already mixed in. The kit may not need boiling either, which is more traditionally done to get the hops flavour to come out into the malt.) The 0.3kg of malt sugar that wasn't added initially if you use the 1.3 kg-size extra malt package, is intended to be added to the mixture immediately prior to bottling (a few weeks after you started this mess). This is enough to give 5Cdn gallons a bit of a head, and a bit more alcohol. If you don't have the extra 0.3 kg of extra malt for priming the bottles, then use a fine powdered sugar. This seems to mix much better anyway, and you don't really need more flavour after all that initial malt. (Note: Wine is usually done in 5US gallon ≈ 18.9L batches.)

Bread Baking Example:

- Mix
- yeast package
- 1/4 cup 110° (warm) water
- teaspoon sugar
- let sit a few minutes, swirl a bit
- Mix
- 1 cup milk
- 1 cup water
- 2 tablespoons sugar
- 1 tablespoon salt
- 1 tablespoon oil/lard/shortening (optional)
- 1 tablespoon butter (optional)
- Add Yeast Mixture and stir
- Add 3 cups Flour
- Add Extra Stuff, like Caraway seeds
- Mix it all up
- Add 3.5 cups more Flour
- Knead (a lot) and Let Rise in warm spot for 30 minutes
- Knead (quite a bit) and Let Rise in warm spot once again for 30 minutes
- Bake at 450° F for 10 minutes, let cool in oven

Bread Machine Baking (note: **1 table**spoon = **3 tea**spoons):

Useful Tidbits

White Bread:

- **1 1/3 Cups Water or Milk**; use milk to make softer crust and innards
- **2 2/3 TEA Spoon Sugar**
- **1 1/3 TEA Spoon Salt**; don't use too much more or won't rise
- **3 1/2 Cups Flour**; use a bit more if US flour
- **1 1/4 TEA Spoons Yeast**
- **2 TABLE Spoons Caraway Seeds**

Brown Bread:

- **2 Cups Milk** use water to make harder crust and bread less 'soft'
- **5 TABLE Spoons Sugar** could use less to make less sweet
- **2 TEA Spoons Salt** don't use much more or won't rise
- **4.5 Cups Flour** whole wheat flour for bread making
- **2 TEA Spoons Yeast**
- **3 TABLE Spoons Caraway Seeds**

Mystery Use:

Solenoid(s)
Surveyor(s), Surveillor(s), Surveillance