

1 Introduction and Overview

When talking about "trike", we mean something like a HPV Scorpion or Trice Q with 406 sized tyres ("20 inch"). When talking about a "mountain bike", we mean something which has 559 sized tyres ("26 inch").

Table 1: Equation symbols

Symbol	Unit	Description
P_{\max}	W	Maximum sustained rider power
f_{\min}	min^{-1}	minimum cadence
f_{opt1}	min^{-1}	optimum cadence minimum
f_{opt}	min^{-1}	optimum cadence middle
f_{opt2}	min^{-1}	optimum cadence maximum
f_{\max}	min^{-1}	maximum cadence (pedalling without force)
m_{trl}	kg	max gross weight including heavy trailer
m_{trl}	kg	gross weight including small trailer
m_{\max}	kg	max gross weight
m_{\min}	kg	target min gross weight
s	%	slope, i.e. $s = \frac{1}{5}$ means you rise one meter for every five rolled
d	m	development, i.e. how far the wheel travels for a single pedal revolution
τ	Nm	torque, e.g. pedal torque, hub input torque
r	m	radius, e.g. of pedal or whell
c_{tyre}	m	tyre circumference ($c_{\text{tyre}} = 2 \pi r_{\text{tyre}}$)
F	N	force

$$v_{\text{foo}} = d \cdot f_{\text{foo}} \quad (1)$$

For climbing a hill at cadence f_{foo} , neglecting all losses, we arrive at a slope s_{foo}

$$s_{\text{foo}} = \frac{P_{\max}}{m \cdot g \cdot v_{\text{foo}}} = \frac{P_{\max}}{m \cdot g \cdot d \cdot f_{\text{foo}}} \quad (2)$$

Table 2: Rider dependent constant values

Rider power	$P_{\max} = 150\text{W}$
Rider cadences	$f_{\min} = 60 \frac{1}{\text{min}}, f_{\text{opt1}} = 80 \frac{1}{\text{min}}, f_{\text{opt}} = 88 \frac{1}{\text{min}}, f_{\text{opt2}} = 95 \frac{1}{\text{min}}, f_{\max} = 116 \frac{1}{\text{min}}$
Vehicle gross weight	$m_{\text{trl}} = 225\text{kg}, m_{\text{trl}} = 170\text{kg}, m_{\max} = 135\text{kg}, m_{\min} = 105\text{kg}$

Table 3: Default Units

symbol	name	default unit
circ	wheel circumference	m
d	development	m
v	velocity	$\frac{\text{km}}{\text{h}}$

9.4 icl2012-x9-30 (500%, $s_{max} = 4.8\%$, $v_{max} = 46.3 \frac{km}{h}$)

Total Range 500%. 30 gears, ratio 1.056...5.273, $d = 1.63m \dots 8.12m$, gear inches 20.4" ... 101.8"

Chainwheels Cogs: [38,48,58]. Range: 152.6%. Icletta recommended for 20" rear wheel

Cassette Cogs: [11,13,15,17,19,22,25,28,32,36]. Range: 327.3%. SRAM PG 1030 11-36 cassette

Tyre 40-406, circumference 1.54m (40-406 Schwalbe Marathon (20"))

Remarks Icletta SRAM X9 30speed stock setup.

$P_{max} = 150W$	steepest slope s_{max}				v_{road}	v_{max} (gear 30)	
	$m =$	225kg	170kg	135kg			
$f_{min} = 60 \frac{1}{min}$	4.2%	5.5%	7.0%	9.0%	$1.63 \frac{m}{s} = 5.85 \frac{km}{h}$	$f_{opt} = 88 \frac{1}{min}$	$11.9 \frac{m}{s} = 42.9 \frac{km}{h}$
$f_{opt1} = 80 \frac{1}{min}$	3.1%	4.1%	5.2%	6.7%	$2.17 \frac{m}{s} = 7.80 \frac{km}{h}$	$f_{opt2} = 95 \frac{1}{min}$	$12.9 \frac{m}{s} = 46.3 \frac{km}{h}$
$f_{opt} = 88 \frac{1}{min}$	2.9%	3.8%	4.8%	6.1%	$2.38 \frac{m}{s} = 8.58 \frac{km}{h}$	$f_{max} = 116 \frac{1}{min}$	$15.7 \frac{m}{s} = 56.5 \frac{km}{h}$
$v_{vert} =$	$245 \frac{m}{h}$	$324 \frac{m}{h}$	$408 \frac{m}{h}$	$524 \frac{m}{h}$			

Figure 66: icl2012-x9-30 40-406 bhfr gear sequence diagram

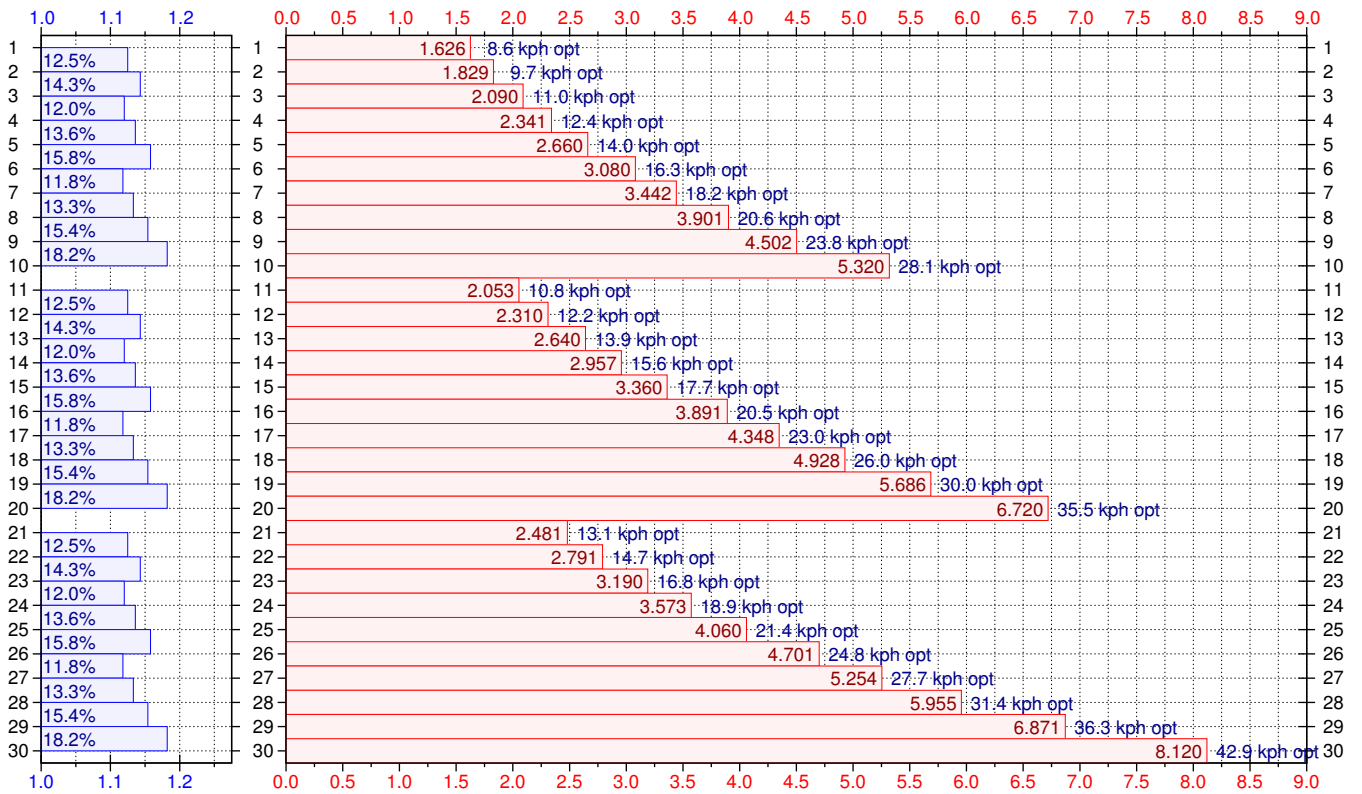


Table 75: Table of gear numbers for icl2012-x9-30 40-406 (bhfr)

n	gear			v in $\frac{m}{s}$ at $f...$					v in $\frac{km}{h}$ at $f...$					fd	rd
	d	ratio	inch	min	opt1	opt	opt2	max	min	opt1	opt	opt2	max		
1	1.626	1.056	20.4	1.63	2.17	2.38	2.57	3.14	5.9	7.8	8.6	9.3	11.3	38	36
2	1.829	1.188	22.9	1.83	2.44	2.68	2.90	3.54	6.6	8.8	9.7	10.4	12.7	38	32
3	2.090	1.357	26.2	2.09	2.79	3.07	3.31	4.04	7.5	10.0	11.0	11.9	14.5	38	28
4	2.341	1.520	29.3	2.34	3.12	3.43	3.71	4.53	8.4	11.2	12.4	13.3	16.3	38	25
5	2.660	1.727	33.3	2.66	3.55	3.90	4.21	5.14	9.6	12.8	14.0	15.2	18.5	38	22
6	3.080	2.000	38.6	3.08	4.11	4.52	4.88	5.95	11.1	14.8	16.3	17.6	21.4	38	19
7	3.442	2.235	43.1	3.44	4.59	5.05	5.45	6.66	12.4	16.5	18.2	19.6	24.0	38	17
8	3.901	2.533	48.9	3.90	5.20	5.72	6.18	7.54	14.0	18.7	20.6	22.2	27.2	38	15
9	4.502	2.923	56.4	4.50	6.00	6.60	7.13	8.70	16.2	21.6	23.8	25.7	31.3	38	13
10	5.320	3.455	66.7	5.32	7.09	7.80	8.42	10.29	19.2	25.5	28.1	30.3	37.0	38	11
11	2.053	1.333	25.7	2.05	2.74	3.01	3.25	3.97	7.4	9.9	10.8	11.7	14.3	48	36
12	2.310	1.500	28.9	2.31	3.08	3.39	3.66	4.47	8.3	11.1	12.2	13.2	16.1	48	32
13	2.640	1.714	33.1	2.64	3.52	3.87	4.18	5.10	9.5	12.7	13.9	15.0	18.4	48	28
14	2.957	1.920	37.1	2.96	3.94	4.34	4.68	5.72	10.6	14.2	15.6	16.9	20.6	48	25
15	3.360	2.182	42.1	3.36	4.48	4.93	5.32	6.50	12.1	16.1	17.7	19.2	23.4	48	22
16	3.891	2.526	48.8	3.89	5.19	5.71	6.16	7.52	14.0	18.7	20.5	22.2	27.1	48	19
17	4.348	2.824	54.5	4.35	5.80	6.38	6.88	8.41	15.7	20.9	23.0	24.8	30.3	48	17
18	4.928	3.200	61.8	4.93	6.57	7.23	7.80	9.53	17.7	23.7	26.0	28.1	34.3	48	15
19	5.686	3.692	71.3	5.69	7.58	8.34	9.00	10.99	20.5	27.3	30.0	32.4	39.6	48	13
20	6.720	4.364	84.2	6.72	8.96	9.86	10.64	12.99	24.2	32.3	35.5	38.3	46.8	48	11
21	2.481	1.611	31.1	2.48	3.31	3.64	3.93	4.80	8.9	11.9	13.1	14.1	17.3	58	36
22	2.791	1.813	35.0	2.79	3.72	4.09	4.42	5.40	10.0	13.4	14.7	15.9	19.4	58	32
23	3.190	2.071	40.0	3.19	4.25	4.68	5.05	6.17	11.5	15.3	16.8	18.2	22.2	58	28
24	3.573	2.320	44.8	3.57	4.76	5.24	5.66	6.91	12.9	17.1	18.9	20.4	24.9	58	25
25	4.060	2.636	50.9	4.06	5.41	5.95	6.43	7.85	14.6	19.5	21.4	23.1	28.3	58	22
26	4.701	3.053	58.9	4.70	6.27	6.89	7.44	9.09	16.9	22.6	24.8	26.8	32.7	58	19
27	5.254	3.412	65.8	5.25	7.01	7.71	8.32	10.16	18.9	25.2	27.7	29.9	36.6	58	17
28	5.955	3.867	74.6	5.95	7.94	8.73	9.43	11.51	21.4	28.6	31.4	33.9	41.4	58	15
29	6.871	4.462	86.1	6.87	9.16	10.08	10.88	13.28	24.7	33.0	36.3	39.2	47.8	58	13
30	8.120	5.273	101.8	8.12	10.83	11.91	12.86	15.70	29.2	39.0	42.9	46.3	56.5	58	11

9.5 icl2012-x9-30-s (567%, $s_{max} = 6.0\%$, $v_{max} = 41.5 \frac{km}{h}$)

Total Range 567%. 30 gears, ratio 0.833...4.727, $d = 1.28m \dots 7.28m$, gear inches 16.1" ... 91.2"

Chainwheels Cogs: [30,42,52]. Range: 173.3%. Icletta recommended for 26" rear wheel

Cassette Cogs: [11,13,15,17,19,22,25,28,32,36]. Range: 327.3%. SRAM PG 1030 11-36 cassette

Tyre 40-406, circumference 1.54m (40-406 Schwalbe Marathon (20"))

Remarks Icletta SRAM X9 30speed with shortened chainwheel set.

$P_{max} = 150W$	steepest slope s_{max}				v_{road}	v_{max} (gear 30)	
	$m =$	225kg	170kg	135kg			
$f_{min} = 60 \frac{1}{min}$		5.3%	7.0%	8.8%	11.3%	$1.28 \frac{m}{s} = 4.62 \frac{km}{h}$	$10.7 \frac{m}{s} = 38.4 \frac{km}{h}$
$f_{opt1} = 80 \frac{1}{min}$		4.0%	5.3%	6.6%	8.5%	$1.71 \frac{m}{s} = 6.16 \frac{km}{h}$	$11.5 \frac{m}{s} = 41.5 \frac{km}{h}$
$f_{opt} = 88 \frac{1}{min}$		3.6%	4.8%	6.0%	7.7%	$1.88 \frac{m}{s} = 6.78 \frac{km}{h}$	$14.1 \frac{m}{s} = 50.7 \frac{km}{h}$
$v_{vert} =$		$245 \frac{m}{h}$	$324 \frac{m}{h}$	$408 \frac{m}{h}$	$524 \frac{m}{h}$		

Figure 67: icl2012-x9-30-s 40-406 bhfr gear sequence diagram

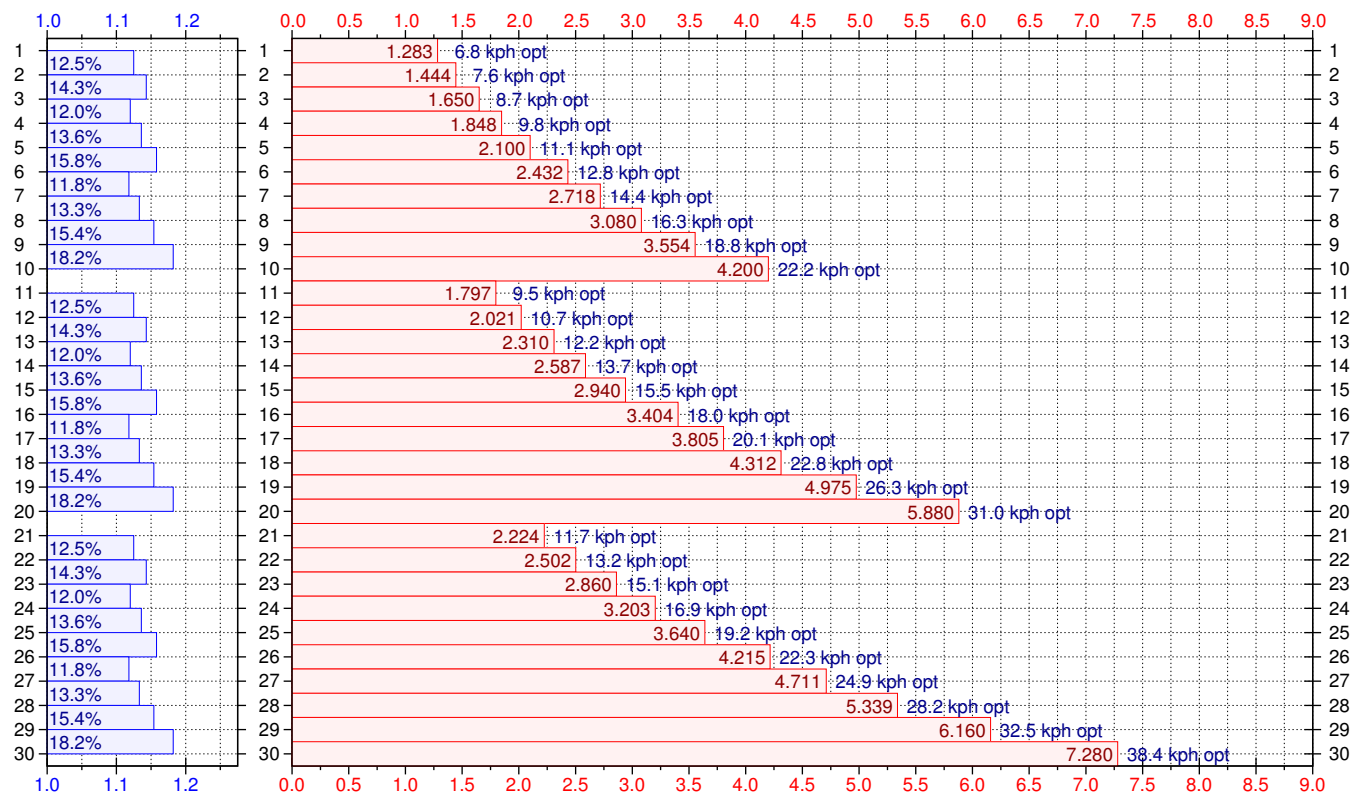


Table 76: Table of gear numbers for icl2012-x9-30-s 40-406 (bhfr)

n	gear			v in $\frac{m}{s}$ at $f...$					v in $\frac{km}{h}$ at $f...$					fd	rd
	d	ratio	inch	min	opt1	opt	opt2	max	min	opt1	opt	opt2	max		
1	1.283	0.833	16.1	1.28	1.71	1.88	2.03	2.48	4.6	6.2	6.8	7.3	8.9	30	36
2	1.444	0.938	18.1	1.44	1.93	2.12	2.29	2.79	5.2	6.9	7.6	8.2	10.0	30	32
3	1.650	1.071	20.7	1.65	2.20	2.42	2.61	3.19	5.9	7.9	8.7	9.4	11.5	30	28
4	1.848	1.200	23.2	1.85	2.46	2.71	2.93	3.57	6.7	8.9	9.8	10.5	12.9	30	25
5	2.100	1.364	26.3	2.10	2.80	3.08	3.33	4.06	7.6	10.1	11.1	12.0	14.6	30	22
6	2.432	1.579	30.5	2.43	3.24	3.57	3.85	4.70	8.8	11.7	12.8	13.9	16.9	30	19
7	2.718	1.765	34.1	2.72	3.62	3.99	4.30	5.25	9.8	13.0	14.3	15.5	18.9	30	17
8	3.080	2.000	38.6	3.08	4.11	4.52	4.88	5.95	11.1	14.8	16.3	17.6	21.4	30	15
9	3.554	2.308	44.5	3.55	4.74	5.21	5.63	6.87	12.8	17.1	18.8	20.3	24.7	30	13
10	4.200	2.727	52.6	4.20	5.60	6.16	6.65	8.12	15.1	20.2	22.2	23.9	29.2	30	11
11	1.797	1.167	22.5	1.80	2.40	2.64	2.84	3.47	6.5	8.6	9.5	10.2	12.5	42	36
12	2.021	1.313	25.3	2.02	2.70	2.96	3.20	3.91	7.3	9.7	10.7	11.5	14.1	42	32
13	2.310	1.500	28.9	2.31	3.08	3.39	3.66	4.47	8.3	11.1	12.2	13.2	16.1	42	28
14	2.587	1.680	32.4	2.59	3.45	3.79	4.10	5.00	9.3	12.4	13.7	14.7	18.0	42	25
15	2.940	1.909	36.8	2.94	3.92	4.31	4.66	5.68	10.6	14.1	15.5	16.8	20.5	42	22
16	3.404	2.211	42.7	3.40	4.54	4.99	5.39	6.58	12.3	16.3	18.0	19.4	23.7	42	19
17	3.805	2.471	47.7	3.80	5.07	5.58	6.02	7.36	13.7	18.3	20.1	21.7	26.5	42	17
18	4.312	2.800	54.0	4.31	5.75	6.32	6.83	8.34	15.5	20.7	22.8	24.6	30.0	42	15
19	4.975	3.231	62.4	4.98	6.63	7.30	7.88	9.62	17.9	23.9	26.3	28.4	34.6	42	13
20	5.880	3.818	73.7	5.88	7.84	8.62	9.31	11.37	21.2	28.2	31.0	33.5	40.9	42	11
21	2.224	1.444	27.9	2.22	2.97	3.26	3.52	4.30	8.0	10.7	11.7	12.7	15.5	52	36
22	2.502	1.625	31.4	2.50	3.34	3.67	3.96	4.84	9.0	12.0	13.2	14.3	17.4	52	32
23	2.860	1.857	35.8	2.86	3.81	4.19	4.53	5.53	10.3	13.7	15.1	16.3	19.9	52	28
24	3.203	2.080	40.1	3.20	4.27	4.70	5.07	6.19	11.5	15.4	16.9	18.3	22.3	52	25
25	3.640	2.364	45.6	3.64	4.85	5.34	5.76	7.04	13.1	17.5	19.2	20.7	25.3	52	22
26	4.215	2.737	52.8	4.21	5.62	6.18	6.67	8.15	15.2	20.2	22.3	24.0	29.3	52	19
27	4.711	3.059	59.0	4.71	6.28	6.91	7.46	9.11	17.0	22.6	24.9	26.9	32.8	52	17
28	5.339	3.467	66.9	5.34	7.12	7.83	8.45	10.32	19.2	25.6	28.2	30.4	37.2	52	15
29	6.160	4.000	77.2	6.16	8.21	9.03	9.75	11.91	22.2	29.6	32.5	35.1	42.9	52	13
30	7.280	4.727	91.2	7.28	9.71	10.68	11.53	14.07	26.2	34.9	38.4	41.5	50.7	52	11

9.6 icl2012-x9-30-S (687%, $s_{max} = 9.0\%$, $v_{max} = 33.5 \frac{km}{h}$)

Total Range 687%. 30 gears, ratio 0.556... 3.818, $d = 0.86m \dots 5.88m$, gear inches 10.7" ... 73.7"

Chainwheels Cogs: [20,32,42]. Range: 210.0%. Custom 20T min + 22T capacity chainwheels

Cassette Cogs: [11,13,15,17,19,22,25,28,32,36]. Range: 327.3%. SRAM PG 1030 11-36 cassette

Tyre 40-406, circumference 1.54m (40-406 Schwalbe Marathon (20"))

Remarks Icletta SRAM X9 30speed with very short chainwheel set.

$P_{max} = 150W$	steepest slope s_{max}					v_{road}	v_{max} (gear 30)	
	$m =$	225kg	170kg	135kg	105kg			
$f_{min} = 60 \frac{1}{min}$	7.9%	10.5%	13.2%	17.0%	$0.86 \frac{m}{s} = 3.08 \frac{km}{h}$	$f_{opt} = 88 \frac{1}{min}$	$8.6 \frac{m}{s} = 31.0 \frac{km}{h}$	
$f_{opt1} = 80 \frac{1}{min}$	6.0%	7.9%	9.9%	12.8%	$1.14 \frac{m}{s} = 4.11 \frac{km}{h}$	$f_{opt2} = 95 \frac{1}{min}$	$9.3 \frac{m}{s} = 33.5 \frac{km}{h}$	
$f_{opt} = 88 \frac{1}{min}$	5.4%	7.2%	9.0%	11.6%	$1.25 \frac{m}{s} = 4.52 \frac{km}{h}$	$f_{max} = 116 \frac{1}{min}$	$11.4 \frac{m}{s} = 40.9 \frac{km}{h}$	
$v_{vert} =$	$245 \frac{m}{h}$	$324 \frac{m}{h}$	$408 \frac{m}{h}$	$524 \frac{m}{h}$				

Figure 68: icl2012-x9-30-S 40-406 bhfr gear sequence diagram

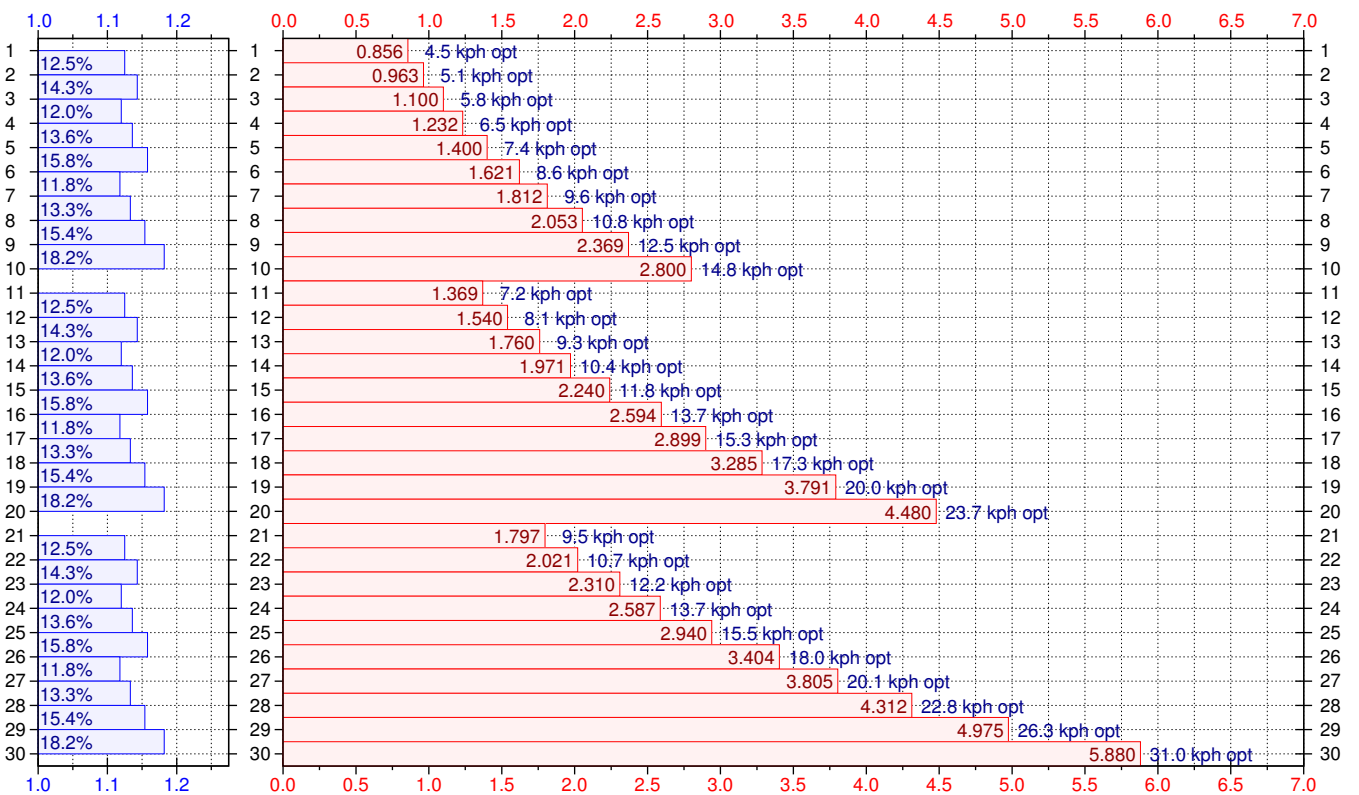


Table 77: Table of gear numbers for icl2012-x9-30-S 40-406 (bhfr)

n	gear			v in $\frac{m}{s}$ at $f...$					v in $\frac{km}{h}$ at $f...$					fd	rd
	d	ratio	inch	min	opt1	opt	opt2	max	min	opt1	opt	opt2	max		
1	0.856	0.556	10.7	0.86	1.14	1.25	1.35	1.65	3.1	4.1	4.5	4.9	6.0	20	36
2	0.963	0.625	12.1	0.96	1.28	1.41	1.52	1.86	3.5	4.6	5.1	5.5	6.7	20	32
3	1.100	0.714	13.8	1.10	1.47	1.61	1.74	2.13	4.0	5.3	5.8	6.3	7.7	20	28
4	1.232	0.800	15.4	1.23	1.64	1.81	1.95	2.38	4.4	5.9	6.5	7.0	8.6	20	25
5	1.400	0.909	17.5	1.40	1.87	2.05	2.22	2.71	5.0	6.7	7.4	8.0	9.7	20	22
6	1.621	1.053	20.3	1.62	2.16	2.38	2.57	3.13	5.8	7.8	8.6	9.2	11.3	20	19
7	1.812	1.176	22.7	1.81	2.42	2.66	2.87	3.50	6.5	8.7	9.6	10.3	12.6	20	17
8	2.053	1.333	25.7	2.05	2.74	3.01	3.25	3.97	7.4	9.9	10.8	11.7	14.3	20	15
9	2.369	1.538	29.7	2.37	3.16	3.47	3.75	4.58	8.5	11.4	12.5	13.5	16.5	20	13
10	2.800	1.818	35.1	2.80	3.73	4.11	4.43	5.41	10.1	13.4	14.8	16.0	19.5	20	11
11	1.369	0.889	17.2	1.37	1.83	2.01	2.17	2.65	4.9	6.6	7.2	7.8	9.5	32	36
12	1.540	1.000	19.3	1.54	2.05	2.26	2.44	2.98	5.5	7.4	8.1	8.8	10.7	32	32
13	1.760	1.143	22.1	1.76	2.35	2.58	2.79	3.40	6.3	8.4	9.3	10.0	12.2	32	28
14	1.971	1.280	24.7	1.97	2.63	2.89	3.12	3.81	7.1	9.5	10.4	11.2	13.7	32	25
15	2.240	1.455	28.1	2.24	2.99	3.29	3.55	4.33	8.1	10.8	11.8	12.8	15.6	32	22
16	2.594	1.684	32.5	2.59	3.46	3.80	4.11	5.01	9.3	12.4	13.7	14.8	18.1	32	19
17	2.899	1.882	36.3	2.90	3.87	4.25	4.59	5.60	10.4	13.9	15.3	16.5	20.2	32	17
18	3.285	2.133	41.2	3.29	4.38	4.82	5.20	6.35	11.8	15.8	17.3	18.7	22.9	32	15
19	3.791	2.462	47.5	3.79	5.05	5.56	6.00	7.33	13.6	18.2	20.0	21.6	26.4	32	13
20	4.480	2.909	56.1	4.48	5.97	6.57	7.09	8.66	16.1	21.5	23.7	25.5	31.2	32	11
21	1.797	1.167	22.5	1.80	2.40	2.64	2.84	3.47	6.5	8.6	9.5	10.2	12.5	42	36
22	2.021	1.313	25.3	2.02	2.70	2.96	3.20	3.91	7.3	9.7	10.7	11.5	14.1	42	32
23	2.310	1.500	28.9	2.31	3.08	3.39	3.66	4.47	8.3	11.1	12.2	13.2	16.1	42	28
24	2.587	1.680	32.4	2.59	3.45	3.79	4.10	5.00	9.3	12.4	13.7	14.7	18.0	42	25
25	2.940	1.909	36.8	2.94	3.92	4.31	4.66	5.68	10.6	14.1	15.5	16.8	20.5	42	22
26	3.404	2.211	42.7	3.40	4.54	4.99	5.39	6.58	12.3	16.3	18.0	19.4	23.7	42	19
27	3.805	2.471	47.7	3.80	5.07	5.58	6.02	7.36	13.7	18.3	20.1	21.7	26.5	42	17
28	4.312	2.800	54.0	4.31	5.75	6.32	6.83	8.34	15.5	20.7	22.8	24.6	30.0	42	15
29	4.975	3.231	62.4	4.98	6.63	7.30	7.88	9.62	17.9	23.9	26.3	28.4	34.6	42	13
30	5.880	3.818	73.7	5.88	7.84	8.62	9.31	11.37	21.2	28.2	31.0	33.5	40.9	42	11