Mersenne Numbers

```
2^(2^4) + 1
```

65 537

```
M[x_] := (2^x) - 1
```

```
Table[M[k], {k, 1, 7}]
```

{1, 3, 7, 15, 31, 63, 127}

```
Table[M[Prime[k]], {k, 1, 7}]
```

{3, 7, 31, 127, 2047, 8191, 131 071}

```
Prime[4]
M[Prime[4]]
M[M[Prime[4]]]
```

7

127

170 141 183 460 469 231 731 687 303 715 884 105 727

Interestingly M[M[Prime[4]]] = M[127] is also a Mersenne prime
How often is a Mersenne number of a Mersenne prime also a Mersenne prime?
Note that highest Mersenne number found to date is M[74 207 281] << M[M[127]], already dawrfed, so this is pretty much untested

```
Table[{n, Prime[n], M[Prime[n]], M[M[Prime[n]]]}, {n, 1, 5}] // MatrixForm
```

$$\begin{pmatrix} 1 & 2 & 3 & \\ 2 & 3 & 7 & \\ 3 & 5 & 31 & \\ 4 & 7 & 127 & \\ 5 & 11 & 2047 & 16\,158\,503\,035\,655\,503\,650\,357\,438\,344\,334\,975\,980\,222\,051\,334\,857\,742\,016\,065\,172\,713\,762\,327 \end{pmatrix}$$

Note n = 5 ⇒ Prime[5] = 11 ⇒ M[11] NOT prime, so the n = 5 seq dies out

```
n = 3;
Prime[n]
M[Prime[n]]
M[M[Prime[n]]]
```

5

31

2 147 483 647

```
n = 7;
Prime[n]
M[Prime[n]]
M[M[Prime[n]]];
```

```
17
```

```
131071
```

```
PrimeQ[M[M[Prime[6]]]]
```

```
False
```

```
PrimeQ[M[M[Prime[7]]]]
```

```
False
```

Fermat number = Mersenne number stuff

```
Log[2, 2^10]
```

```
10
```

```
2^(2^3) + 1
```

```
257
```

```
Table[{k, Log[2, 2^(2^k) + 2] // N}, {k, 0, 13}] // MatrixForm
```

$$\begin{pmatrix} 0 & 2. \\ 1 & 2.58496 \\ 2 & 4.16993 \\ 3 & 8.01123 \\ 4 & 16. \\ 5 & 32. \\ 6 & 64. \\ 7 & 128. \\ 8 & 256. \\ 9 & 512. \\ 10 & 1024. \\ 11 & 2048. \\ 12 & 4096. \\ 13 & 8192. \end{pmatrix}$$

```
Log[2, 2^(2^k) + 2] // FullSimplify
```

$$\frac{\mathrm{Log}\left[2 + 2^{2^k}\right]}{\mathrm{Log}[2]}$$

```
Log[2, 2]
```

```
1
```

```
k = 1;
Log[2, 2^(2^k) + 2] // N
Log[2, 2^(2^0) + 2] // N
Log[2, 2^(2^1) + 2] // N
Log[2, 2^(2^0) + 1] // N
Log[2, 6] // N
Log[2, 3] // N
```

```
2.58496

2.

2.58496

1.58496

2.58496

1.58496
```

```
k = 4;
Log[2, 2^(2^k) + 2] // N
```

```
16.
```