

1a) to multiply by 7,  $\times 8$  then  $-1$

shl R2 R1 3                      1 cycle  
sub R2 R2 R1                      2 cycles

3 cycles total,  $\approx 1.33\times$  faster than using multiply.

b) ~~Multiply by 1024, then  $-4$~~

~~$1024 = 2^{10}$ ,  $4 = 2^2$~~

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~~shl R2 R1 10                      4c  
shl R1 R1 2                      1c  
sub R2 R2 R1                      2c~~

~~4 cycles total; same speed as using multiply instruction.~~

c)  $1020 = 111111100_2$

$= 1111111_2 \cdot 2^2$  or  $1111111$  shifted left twice

So, shift left 9 times, subtract 1, shift left twice

shl R2 R1 9                      1c  
sub R2 R2 R1                      1c  
shl R2 R2 2                      2c

4 cycles total: same as using multiply instruction

16) 1020 = 1111 1111 00

<sup>8</sup>  
and with shift 10      <sup>8</sup>  
shift 3 start

~~shl R1 R1 3~~
~~add R2~~

shl R2 R1 3

shl R1 R1 4

add R2 R2 R1

shl R1 R1 1

add R2 R2 R1

shl R1 R1 1

add R2 R2 R1

shl R1 R1 1

add R2 R2 R1

shl R1 R1 1

add R2 R2 R1

shl R1 R1 1

add R2 R2 R1

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shl R1 R1 1

add R2 R2 R1

shl R1 R1 1

add R2 R2 R1

shl R1 R1 1

add R2 R2 R1

shl R1 R1 1

add R2 R2 R1

shl R1 R1 1

add R2 R2 R1

Total = 3 \* 7 + 2 cycles = 23 cycles

5.75 times slower than mult instruction