

(a) The ATmega32 has 32KiB of program memory. Each memory location is 16-bits wide. How many memory addresses are there? How many bits are **required** to represent the memory addresses?

(b) Indicate the value of the status register after the following two numbers are added together:

```

  10001000
+10000111
-----
100001111

```

The Status Register:

I	T	H	S	V	N	Z	C
0	0						

How much time will the following code segment take to execute on your ATmega32 board? (Show your work)

```
        ldi  r17, 100
loop2:  ldi  r16, 200
loop1:  dec  r16
        inc  r16
        dec  r16
        brne loop1
        dec  r17
        brne loop2
```

(a) Suppose that your `delay` subroutine makes use of the following four registers: `r16`, `r17`, `r18`, and `r19`. What instructions should be performed at the beginning of your subroutine to ensure that the values stored in those registers are not lost?

(b) Given your answer to part (a), what instructions should be performed at the end of your subroutine that ensure that the register values are restored and then returns control to the code immediately after the call to the subroutine?

(a) Explain what the **resolution** of an analog to digital converter is.

(b) Suppose you had a 16 bit analog to digital converter (a completely separate circuit from the STK200 board) that operates in the range of 0 to 5V. What is the resolution for this ADC?

Bit	7	6	5	4	3	2	1	0	
	REFS1	REFS0	ADLAR	MUX4	MUX3	MUX2	MUX1	MUX0	ADMUX
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	
Bit	7	6	5	4	3	2	1	0	
	ADEN	ADSC	ADATE	ADIF	ADIE	ADPS2	ADPS1	ADPS0	ADCSRA
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

Write a function, `initADC3`, that configures the ADC subsystem such that:

- uses ADC channel 3 for input,
- places the 8 most significant bits in the same output register,
- uses a input voltage range of 0 to 5 volts,
- uses the slowest possible clock speed, and
- assumes polling (not the interrupt subsystem) will be used.



Write an assembly function, `configOPWM58`, that configures the Timer/Counter0 subsystem in phase correct PWM mode so that the waveform generated on pin 3 of **PORTB** (**OC0**) has:

- a period of approximately  $4.1 \times 10^{-3}$  seconds and
- a duty cycle of approximately 58%.

Rewrite the following C function as an assembly function.

```
uint8_t absDiff(uint8_t x, uint8_t y)
{
    uint8_t z;
    if(x>y) {
        z = x-y;
    } else {
        z = y-x;
    }
    return z;
}
```