Indicate the size of each of the following registers and explain what each is used for: **Program Counter**

Instruction Register

Quizzes

R3 Register

X Register

Consider the following .lst file on the back of this page:

(a) How many bytes of memory does the program occupy?

(b) Identify the items in each column below and explain what they represent.

Coll Col2

Col3 Col4

Col5

00002c ef00 ldi temp,0xf0 ; Enable pull-up resistors on PORTC4-7

Name:

```
AVRASM ver. 2.1.12 C:\Atmel\Projects\lab0.asm Wed Dec 12 10:42:08 2007
C:\Atmel\Projects\lab0.asm(21): Including file 'c:\Atmel\AVRTools\AvrAssembler2\
                        .list
                        .def temp = r16 ; Use R16 as a temp register
                        .cseq
                                          ; Begin code segment
                        .org 0
000000 c029
                        rjmp init
                                          ; Initialize restart vector
                        .org 0x2a
                init:
00002a e00f
                        ldi temp,0x0f ; Set keypad cols as output, rows as i
00002b bb04
                        out DDRC, temp
00002c ef00
                        ldi temp, 0xf0 ; Enable pull-up resistors on PORTC4-7
00002d bb05
                        out PORTC, temp
00002e ef0f
                        ldi temp, 0xff ; Configure PORTB as an output port
00002f bb07
                        out DDRB, temp
                main:
000030 b303
                             temp, PINC ; Read rows of keypad from PORTC
                        in
000031 bb08
                        out PORTB, temp ; Display results on LEDs 5-8
000032 cffd
                                         ; Repeat main
                        rjmp main
[snip]
```

ATmega32 memory use summary [bytes]:

Segment	Begin	End	Code	Data	Used	Size	Use%
[.cseg]	0x000000	0x000066	20	0	20	32768	0.1%
[.dseg]	0x000060	0x000060	0	0	0	2048	0.0%
[.eseg]	0x000000	0x000000	0	0	0	1024	0.0%

Assembly complete, 0 errors, 0 warnings

Suppose that a subroutine starting at address delay (which does nothing for 1 second) already exists. Write your own subroutine, beginning at address blink, that causes the LEDs connected to PORTB all turn on for 1 second and then turn off for 1 second. Once this is done, the subroutine should return.

You may assume that the stack has already been initialized.

(a) What I/O port is used by the Analog to Digital Converter?

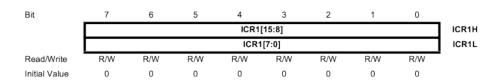
(b) What do the MUX4:0 bits of the ADMUX port do?

(c) How many bits are used to store the result of the ADC?

As best as you can, describe the various modes of operation available on the AT-mega32's analog to digital subsystem.

Show the correct values for each of the following registers (0, 1 or X (for don't care)) such that the Timer/Counter1 subsystem is configured to interrupt whenever a rising edge is encountered on the ICR1 pin. on the ATmega32's analog to digital subsystem.

Bit	7	6	5	4	3	2	1	0	_	
	TCNT1[15:8]									
	TCNT1[7:0]									
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	_
	OCIE2	TOIE2	TICIE1	OCIE1A	OCIE1B	TOIE1	OCIE0	TOIE0	TIMSK
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	
	OCF2	TOV2	ICF1	OCF1A	OCF1B	TOV1	OCF0	TOV0	TIFR
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	_
	COM1A1	COM1A0	COM1B1	COM1B0	FOC1A	FOC1B	WGM11	WGM10	TCCR1A
Read/Write	R/W	R/W	R/W	R/W	W	W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

Bit	7	6	5	4	3	2	1	0	
	ICNC1	ICES1	-	WGM13	WGM12	CS12	CS11	CS10	TCCR1B
Read/Write	R/W	R/W	R	R/W	R/W	R/W	R/W	R/W	•
Initial Value	0	0	0	0	0	0	0	0	

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Write the read_ee subroutine that will read the byte stored in EEPROM at data and return it in R24.

```
; ...
.eseg
.org 0x111
data:
        .db 17
.cseg
; ...
read_ee:
```