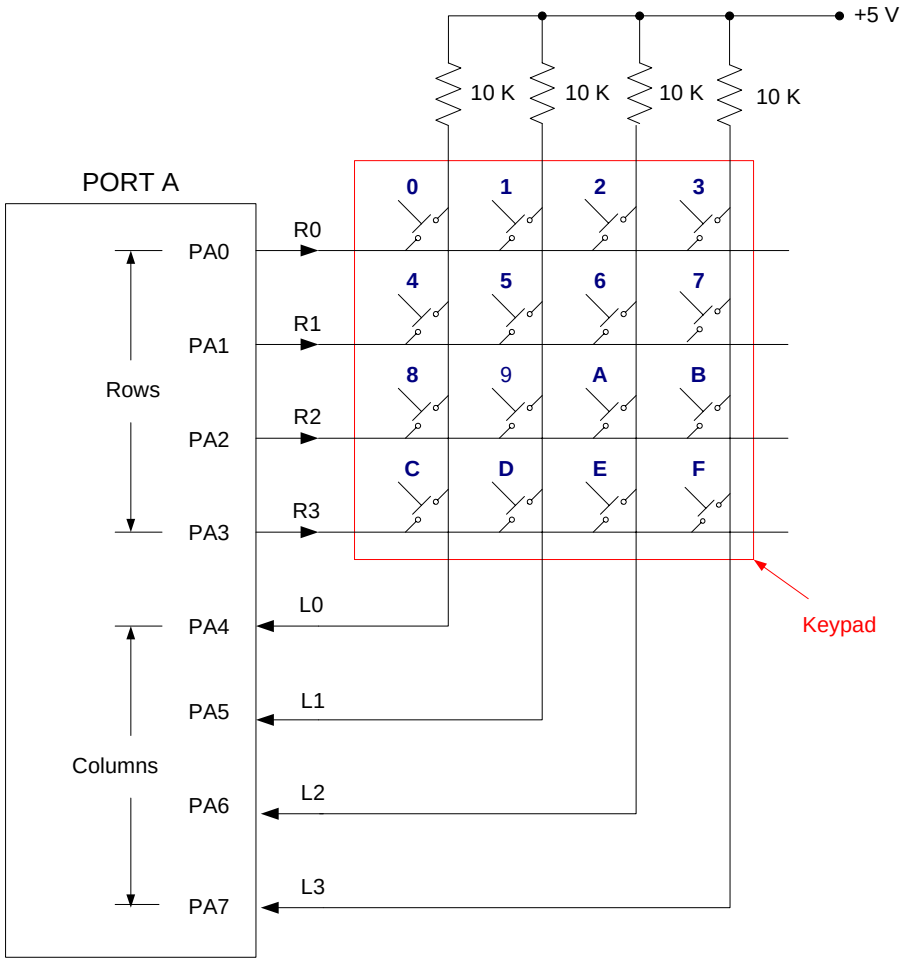
EEEN 3449
Test # 2 Spring 2007 **Name:**_____

1. Determine the unknowns in the following assembly program for the 4 by 4 keypad connected as shown below. Assume the master clock is at 24MHz. (100 pts)
Fill in the blanks for the de-bounced key (db_key□) in the same order as it is scanned.



7	6	5	4	3	2	1	0	HEX	Description
0	0	0	0	1	1	1	1	$0F	DDRA
1	1	1	1	0	1	1	1	$F7	R3
1	1	1	1	1	0	1	1	$FB	R2
1	1	1	1	1	1	0	1	$FD	R1
1	1	1	1	1	1	1	0	$FE	R0

Note: Pay attention how the program scans the keys. Please print your answer in the blank. It will be your loss if I can read your handwriting.

```
#include "d:\MiniDragon\examples\reg9s12.h"

keyboard  equ   PTA
get_char  movb  □□□□,DDRA                  Ans:   #$0F    (5 pts)
;scanning row 0
scan_r0   movb  □□□□,keyboard              Ans:   #$FE    (5 pts)
scan_k0   brclr keyboard,□□□,key0          Ans:   $10     (1 pt)
scan_k1   brclr keyboard,□□□,key1          Ans:   $20     (1 pt)
scan_k2   brclr keyboard,□□□,key2          Ans:   $40     (1 pt)
scan_k3   brclr keyboard,□□□,key3          Ans:   $80     (1 pt)
          bra   scan_R1                    ;scanning row 1

key0      jmp   db_key0
key1      jmp   db_key1
key2      jmp   db_key2
key3      jmp   db_key3

scan_R1   movb  □□□□,keyboard              Ans:   #$FD    (5 pts)
scan_k4   brclr keyboard,□□□,key4          Ans:   $10     (1 pt)
scan_k5   brclr keyboard,□□□,key5          Ans:   $20     (1 pt)
scan_k6   brclr keyboard,□□□,key6          Ans:   $40     (1 pt)
scan_k7   brclr keyboard,□□□,key7          Ans:   $80     (1 pt)
          bra   scan_R2                    ;scanning row 2

key4      jmp   db_key4
key5      jmp   db_key5
key6      jmp   db_key6
key7      jmp   db_key7

scan_R2   movb  □□□□,keyboard              Ans:   #$FB    (5 pts)
scan_k8   brclr keyboard,□□□,key8          Ans:   $10     (1 pt)
scan_k9   brclr keyboard,□□□,key9          Ans:   $20     (1 pt)
scan_kA   brclr keyboard,□□□,keyA          Ans:   $40     (1 pt)
scan_kB   brclr keyboard,□□□,keyB          Ans:   $80     (1 pt)
          bra   scan_R3                    ;scanning row 3

key8      jmp   db_key8
key9      jmp   db_key9
keyA      jmp   db_keyA
keyB      jmp   db_keyB

scan_R3   movb  □□□□,keyboard              Ans:   #$F7    (5 pts)
scan_kC   brclr keyboard,□□□,keyC          Ans:   $10     (1 pt)
scan_kD   brclr keyboard,□□□,keyD          Ans:   $20     (1 pt)
scan_kE   brclr keyboard,□□□,keyE          Ans:   $40     (1 pt)
scan_kF   brclr keyboard,□□□,keyF          Ans:   $80     (1 pt)
          jmp   scan_R0                    ;scanning row 0
```

```
keyC      jmp   db_keyC
keyD      jmp   db_keyD
keyE      jmp   db_keyE
keyF      jmp   db_keyF

db_key□   jsr   delay10ms                  Ans:    0        (½ pt)
          brclr keyboard,□□□,getc□         Ans: $10    0    (1 pt)
          jmp   scan_k□                    Ans:    1        (½ pt)
getc□     ldaa  □□□□                       Ans:  0     #$30 (1 pt)
          rts
db_key□   jsr   delay10ms                  Ans:    1        (½ pt)
          brclr keyboard,□□□,getc□         Ans: $20    1    (1 pt)
          jmp   scan_k□                    Ans:    2        (½ pt)
getc□     ldaa  □□□□                       Ans:  1     #$31 (1 pt)
          rts
db_key□   jsr   delay10ms                  Ans:    2        (½ pt)
          brclr keyboard,□□□,getc□         Ans: $40    2    (1 pt)
          jmp   scan_k□                    Ans:    3        (½ pt)
getc□     ldaa  □□□□                       Ans:  2     #$32 (1 pt)
          rts
db_key□   jsr   delay10ms                  Ans:    3        (½ pt)
          brclr keyboard,□□□,getc□         Ans: $80    3    (1 pt)
          jmp   scan_R2                    ;scan column 2
getc□     ldaa  □□□□                       Ans:  3     #$33 (1 pt)
          rts

db_key□   jsr   delay10ms                  Ans:    4        (½ pt)
          brclr keyboard,□□□,getc□         Ans: $10    4    (1 pt)
          jmp   scan_k□                    Ans:    5        (½ pt)
getc□     ldaa  □□□□                       Ans:  4     #$34 (1 pt)
          rts
db_key□   jsr   delay10ms                  Ans:    5        (½ pt)
          brclr keyboard,□□□,getc□         Ans: $20    5    (1 pt)
          jmp   scan_k□                    Ans:    6        (½ pt)
getc□     ldaa  □□□□                       Ans:  5     #$35 (1 pt)
          rts
db_key□   jsr   delay10ms                  Ans:    6        (½ pt)
          brclr keyboard,□□□,getc□         Ans: $40    6    (1 pt)
          jmp   scan_k□                    Ans:    7        (½ pt)
getc□     ldaa  □□□□                       Ans:  6     #$36 (1 pt)
          rts
db_key□   jsr   delay10ms                  Ans:    7        (½ pt)
          brclr keyboard,□□□,getc□         Ans: $80    7    (1 pt)
          jmp   scan_R1                    ;scan column 1
getc□     ldaa  □□□□                       Ans:  7     #$37 (1 pt)
          rts
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```
db_key□   jsr   delay10ms                  Ans:     8        (½ pt)
          brclr keyboard,□□□,getc□        Ans:  $10     8    (1 pt)
          jmp   scan_k□                   Ans:     9        (½ pt)
getc□     ldaa  □□□□                      Ans:   8      #$38 (1 pt)
          rts
db_key□   jsr   delay10ms                  Ans:     9        (½ pt)
          brclr keyboard,□□□,getc□        Ans:  $20     9    (1 pt)
          jmp   scan_k□                   Ans:     A        (½ pt)
getc□     ldaa  □□□□                      Ans:   9      #$39 (1 pt)
          rts
db_key□   jsr   delay10ms                  Ans:     A        (½ pt)
          brclr keyboard,□□□,getc□        Ans:  $40     A    (1 pt)
          jmp   scan_k□                   Ans:     B        (½ pt)
getc□     ldaa  □□□□                      Ans:   A      #$41 (1 pt)
          rts
db_key□   jsr   delay10ms                  Ans:     B        (½ pt)
          brclr keyboard,□□□,getc□        Ans:  $80     B    (1 pt)
          jmp   scan_R0                   ;scan column 0
getc□     ldaa  □□□□                      Ans:   B      #$42 (1 pt)
          rts

db_key□   jsr   delay10ms                  Ans:     C        (½ pt)
          brclr keyboard,□□□,getc□        Ans:  $10     C    (1 pt)
          jmp   scan_k□                   Ans:     D        (½ pt)
getc□     ldaa  □□□□                      Ans:   C      #$43 (1 pt)
          rts
db_key□   jsr   delay10ms                  Ans:     D        (½ pt)
          brclr keyboard,□□□,getc□        Ans:  $20     D    (1 pt)
          jmp   scan_k□                   Ans:     E        (½ pt)
getc□     ldaa  □□□□                      Ans:   D      #$44 (1 pt)
          rts
db_key□   jsr   delay10ms                  Ans:     E        (½ pt)
          brclr keyboard,□□□,getc□        Ans:  $40     D    (1 pt)
          jmp   scan_k□                   Ans:     F        (½ pt)
getc□     ldaa  □□□□                      Ans:   E      $45  (1 pt)
          rts
db_key□   jsr   delay10ms                  Ans:     F        (½ pt)
          brclr keyboard,□□□,getc□        Ans:  $80     F    (1 pt)
          jmp   scan_R3                   ;scan column 3
getc□     ldaa  □□□□                      Ans:   F      $46     (1
pt)
          rts
```

```
;the following subroutine creates a delay of 10 ms

delay10ms movb  #$90,TSCR1
          movb  #$03,TSCR2          ; Prescale factor =    8     (5 pts)
          movb  #$01,TIOS
          ldd   TCNT
          addd  #□□□□□             ; Ans:  30,000              (5 pts)
          std   TC0
wait_lp2  brclr TFLG1,$01,wait_lp2
          rts


Show your calculation for the # of counts:                      (3 pts)
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$$\frac{24,000,000}{8}\times 10\times 10^{-3} = 30,000$$

Registers related to the Output-compare Function

	7	6	5	4	3	2	1	0	
$0040	IOS7	IOS6	IOS5	IOS4	IOS3	IOS2	IOS1	IOS0	TIOS
$004D	TOI	0	0	0	TCRE	PR2	PR1	PR0	TSCR2
$0044	Bit 15	14	13	12	11	10	9	Bit 8	TCNT(H)
$0043	Bit 7	6	5	4	3	2	1	Bit 0	TCNT(L)
$0046	TEN	TSWAI	TSFRZ	TFFCA	0	0	0	0	TSCR1
$004E	C7F	C6F	C5F	C4F	C3F	C2F	C1F	C0F	TFLG1
$0052	Bit 15	14	13	12	11	10	9	Bit 8	TC0(H)
$0051	Bit 7	6	5	4	3	2	1	Bit 0	TC0(L)

```
TIOS:    Timer Input-capture/Output-Compare Select Register
TSCR1:   Timer System Control Register 1
TSCR2:   Timer System Control Register 2
TFLG1:   Timer Interrupt Flag 1 Register
TCNT:    Timer Counter Register
TC0:     TC register for Channel 0
```

ASCII Character Set (7–Bit Code)								
MS Dig. / LS Dig.	0	1	2	3	4	5	6	7
0	NUL	DLE	SP	0	@	P	`	p
1	SOH	DC1	!	1	A	Q	a	q
2	STX	DC2	”	2	B	R	b	r
3	ETX	DC3	#	3	C	S	c	s
4	EOT	DC4	$	4	D	T	d	t
5	ENQ	NAK	%	5	E	U	e	u
6	ACK	SYN	&	6	F	V	f	v
7	BEL	ETB	‘	7	G	W	g	w
8	BS	CAN	(	8	H	X	h	x
9	HT	EM	)	9	I	Y	i	y
A	LF	SUB	*	:	J	Z	j	z
B	VT	ESC	+	;	K	[	k	{
C	FF	FS	,	<	L	\	l	|
D	CR	GS	-	=	M	]	m	}
E	SO	RS	.	>	N	^	n	~
F	SI	US	/	?	O	_	o	DEL

Timer Counter Prescale Factor

PR[2:1:0]	Prescale Factor	PR[2:1:0]	Prescale Factor
000	1	100	16
001	2	101	32
010	4	110	64
011	8	111	128