

Free Marks!

1. Have you opened the link to the form to ask questions at <https://forms.gle/uaPkwSXwhBzgZ1ok7> ?

Have you opened the Google Sheet where the setters reply to questions, and TAs attempt to contact you? The sheet is at <https://docs.google.com/spreadsheets/d/153dtcVgoR-dBx2WfuT2DaMPSZdkzE4VOq4FwCfsob4g/edit?usp=sharing>

NOTE: If you get a "resource unavailable" error while opening that sheet, open this one instead:

https://docs.google.com/spreadsheets/d/1DFMQT21MGegYWNWqsHoyz2-S7_CRC-3obo4JBZ-KzEw/edit?usp=sharing

(1 mark)

☒ Yes (Open the files and choose this to get ONE FREE MARK!!)

☐ No

MCQ Questions

2. In Direct Memory Access, a separate piece of hardware called a Direct Memory Access Controller (DMAC) performs all the transfers between the device and memory without the CPU playing any part. However the CPU must first set up the DMAC to perform the transfer and then command it to start, and this may take some time to do.

Which ONE of the following statements is true?

(1 mark)

☐ Polling is more efficient than interrupts when data comes infrequently.

☐ Interrupts are the best method available when needing to transfer large blocks of data.

☐ DMA is superior to interrupts when data comes infrequently or in small chunks.

☐ DMA is ideal for transferring large amounts of data between the ATMega328P and other devices.

☒

None of the other statements are true.

3.

Kenyu would like to programme Timer0 that triggers the `TIMER0_COMPA_vect` interrupt every 750 microseconds in CTC mode. The processor's clock rate is 16 MHz.

Which combination gives the most accurate timing? `TCNT0 = 0` in all cases, so if `OCR0A` contains a value of X , the counter will count $X+1$ steps before triggering the interrupt.

(1 mark)

☐`TCCR0A = 0x2, TCCR0B = 0x1, OCR0A = 12000`☐`TCCR0A = 0x2, TCCR0B = 0x2, OCR0A = 1500`☒`TCCR0A = 0x2, TCCR0B = 0x3, OCR0A = 187`☐`TCCR0A = 0x2, TCCR0B = 0x4, OCR0A = 47`☐`TCCR0A = 0x2, TCCR0B = 0x5, OCR0A = 11`

4.

Kenyu decides to use Timer1 to trigger the `TIMER1_COMPA_vect` interrupt every 750 microseconds in CTC mode. Which combination gives the most accurate timing? `TCNT1 = 0` in all cases, so if `OCR1A` contains a value of X , the counter will count $X+1$ steps before triggering the interrupt.

The CPU's clock rate is 16 MHz.

(1 mark)

☐`TCCR1A = 0x2, TCCR1B = 0x1, OCR1A = 11999`☒`TCCR1A = 0x0, TCCR1B = 0x0A, OCR1A = 1499`☐`TCCR1A = 0x0, TCCR1B = 0x13, OCR1A = 187`



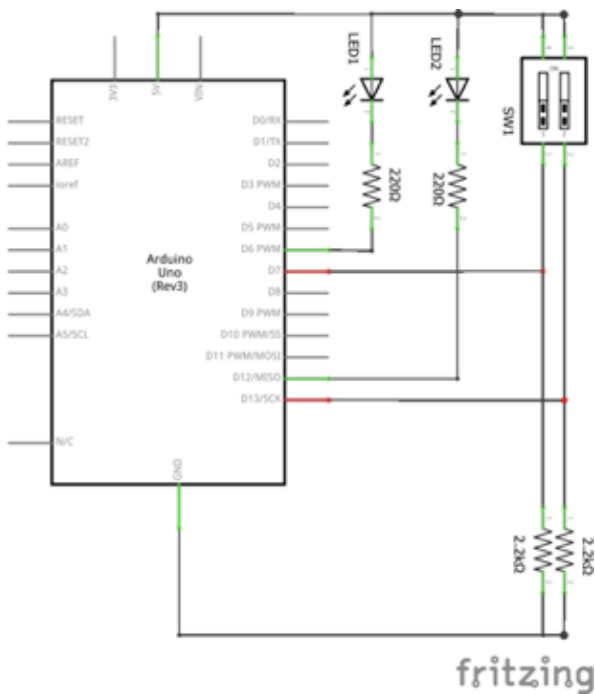
TCCR1A = 0x2, TCCR1B = 0x4, OCR1A = 47



TCCR1A = 0x0, TCCR1B = 0x5, OCR1A = 11

5.

A two-way DIP switch and two Red LED's are connected to the AT328P as shown below. When the DIP switch pins are switched to the ON position, we want to light up the appropriate LED's. The Left Switch will map to LED 1 and the Right Switch will map to LED 2.



These are the Pin to Port Mappings.

Arduino Pin	AT328 Port, Pin
6	Port D, pin 6
7	Port D, Pin 7
12	Port B, Pin 4
13	Port B, Pin 5

You are given the following C function.

```
char MASK(unsigned char bit_position)
{
    if(bit_position < 8)
        return (1 << bit_position);
    else
        return 0;
}
```

*Note: 0x is prefix for Hexadecimal and B is prefix for binary.

Which of the following code snippets configures DDRB register correctly?

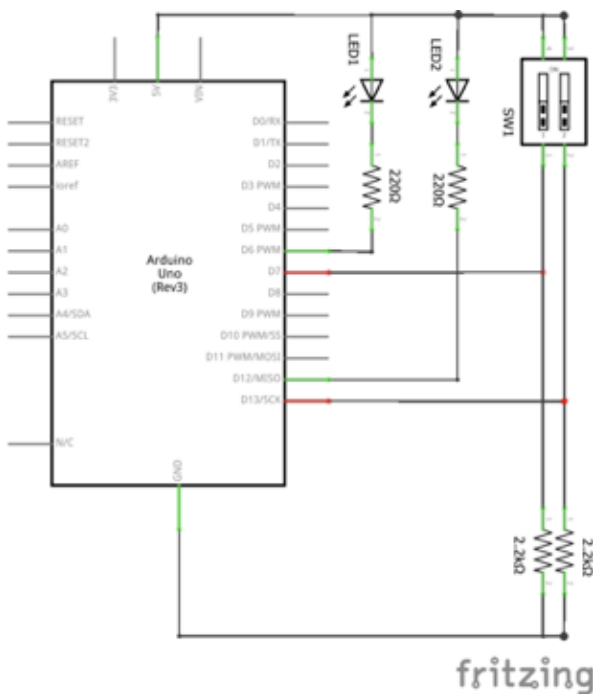
DDR bit configuration: '1' : Output, '0' : Input

Note: You **CANNOT** assume any default value for the bits in the registers.

(1 mark)

- ☐ DDRB = MASK(0x10);
- ☐ DDRB = MASK(B00010000);
- ☒ DDRB = (MASK(4) & ~ MASK(5));
- ☒ DDRB = (MASK(4) | ~MASK(5));
- ☐ DDRB = (~MASK(4) & MASK(5));

6. A two-way DIP switch and two Red LED's are connected to the AT328P as shown below. When the DIP switch pins are switched to the ON position, we want to light up the appropriate LED's. The Left Switch will map to LED 1 and the Right Switch will map to LED 2.



These are the Pin to Port Mappings.

Arduino Pin	AT328 Port, Pin
6	Port D, pin 6

7	Port D, Pin 7
12	Port B, Pin 4
13	Port B, Pin 5

Which of the following code snippets configures DDRD register correctly?

DDR bit configuration: '1' : Output, '0' : Input

Note: You **CANNOT** assume any default value for the bits in the registers.

(1 mark)

- ☐ DDRD = MASK(0x40);
- ☐ DDRD = MASK(B01000000);
- ☐ DDRD = (~MASK(6) & MASK(7));
- ☒ DDRD = (MASK(6) | ~MASK(7));
- ☒ DDRD = (MASK(6) & ~MASK(7));

7. The following code snippet shows the setup() for the Timer 0 block to generate a PWM signal to control an LED connected in Active-Low configuration to Port D Pin 6.

```
#include "Arduino.h"

#include

#include

void setup() {
  TCNT0 = 0; // LINE 1
  TCCR0A = 0b10000001; // LINE 2
  TIMSK0 |= 0b10; // LINE 3
  OCR0A = 25; // LINE 4
  TCCR0B = 0b00000011; // LINE 5
  DDRD |= (1 << 6); // LINE 6
  sei(); // LINE 7
}
```

```

ISR(TIMER0_COMPA_vect)
{
  OCR0A++; // LINE 8
}

void loop()
{
}

```

How will the LED behave? (Note: "Fade-in" means that the LED becomes brighter and brighter. "Fade-out" means that the LED becomes dimmer and dimmer.)

(1 mark)

☐

We will observe a continuous Fade-In/Fade-Out effect for the LED.

☐

We will observe a continuous Fade-In effect for the LED.

☐

We will observe a single Fade-In effect for the LED. After that, the LED will remain constantly ON.

☒

We will observe a continuous Fade-out effect for the LED.

☐

We will observe a single Fade-Out effect. After that, the LED will remain constantly OFF.

8.

The code shown here is used to generate PWM signals on Port D Pin6 and Pin 5 using Timer0. Both these pins are connected to the Motor through the DRV8833 chip, similar to the way it was done in Week 4 Studio 2. Assume that all connections for the power, motor driver and motor are correct.

```

#include "Arduino.h"
#include
#include

#define PIN6 (1 << 6)
#define PIN5 (1 << 5)

unsigned int interval = 500;
unsigned long prevMillis;

void setup() {

  DDRD |= (PIN6 | PIN5);
  TCNT0 = 0;
  TIMSK0 |= 0b110;
  OCR0A = 128;
  OCR0B = 128;
  TCCR0B = 0b00000011;
}

```

```

prevMillis = millis();
sei();
}

ISR(TIMER0_COMPA_vect)
{
OCR0A = 128;
}

ISR(TIMER0_COMPB_vect)
{
OCR0B = 128;
}

void funcA (void)
{
TCCR0A = ((1 << 7) | (1 << 0));
}

void funcB (void)
{
TCCR0A |= (1 << 0);
}

void loop() {
funcA();
while(millis() - prevMillis < 500);
prevMillis = millis();

funcB();

while(millis() - prevMillis < 500);

prevMillis = millis();

}

```

Which option describes the correct behaviour of the motor?

(1 mark)

- ☐ The motor will only spin in a particular direction. After 500ms, it will change to the other direction. The process keeps repeating.
- ☐ The motor will spin in a particular direction for 500ms. After that, it will stop for 500ms. The process keeps repeating in the SAME direction.
- ☒ The motor will spin in only ONE particular direction continuously without stopping.
- ☐ The motor will spin ONCE for 500ms in a particular direction. After that, it will stop spinning.
- ☐ The motor will not spin at all.

9. Consider the following program excerpt:

```
for (i = 0; i < 3; i++) {  
    for (j = 0; j < N; j++) {  
        doTask(N);  
    }  
}
```

You may assume that doTask has a time complexity of $O(N^2)$. What is the strictest big-O bound on the program excerpt?

(1 mark)

☐ $O(\log N)$

☐ $O(N \log N)$

☐ $O(N^2)$

☒ $O(N^3)$

☐ $O(2^N)$

10.

In orders of growth, $O(2^n)$ is related to $O(n)$ in the same way as $O(n)$ is related to:

(1 mark)

☐ $O(2^{-n})$

☐ $O(n^{0.5})$

☒ $O(\log n)$

☐

 $O(1)$  $O(N^2)$ **11.**

Consider the following program excerpt:

```
void call_me(N) {  
    if (N == 0) {  
        doTask(N);  
    } else {  
        call_me(N-1);  
        doTask(N);  
    }  
}
```

You may assume that doTask has a time complexity of $O(\log N)$. What is the strictest big-O bound on the program excerpt?

(1 mark)

 $O(\log N)$  $O(N \log N)$  $O(N^2 \log N)$  $O(N^3 \log N)$  $O(\log^2 N)$

MRQ Questions

12. Which of the following statements (there may be more than one) is/are true about the `volatile` keyword in C?

(2 marks)

<input checked="" type="checkbox"/>	Using the <code>volatile</code> keyword can slow down execution of a program.
<input type="checkbox"/>	Declaring a local variable as <code>volatile</code> will trigger a compilation error.
<input type="checkbox"/>	The <code>volatile</code> keyword will always produce slightly larger code.
<input checked="" type="checkbox"/>	The <code>volatile</code> keyword must be used when a global variable is read in one routine but modified in another.
<input type="checkbox"/>	None of the statements listed here are true.

13. Aiken and Dueet are building a circuit on an Arduino, and connect a pushbutton between VCC and pin PD3 on the ATmega328P, with proper grounding to prevent floating inputs. They write a program to switch on an LED when the button is pressed, and to switch it off when the button is pressed again, etc. The code fragments below show the relevant parts of their program. The ellipses (...) indicate irrelevant code.

Note that the prefix '0x' means that the number is in hexadecimal (e.g. `EICRA = 0xC` means assign value hexadecimal C to EICRA)

```
...  
  
volatile int flag = 0;  
  
...  
  
void setupISR() {  
  
    cli();  
  
    EICRA = 0x0;  
  
    EIMSK = 0x1;  
  
}  
  
...
```

```

ISR(INT1_vect){
    flag = !flag;
    if flag:
        switchOnLED(); // Declared elsewhere to switch on LED.
    else:
        switchOffLED(); // Declared elsewhere to switch off LED.
    }
    ...

```

Having become best friends with them in CS1231, you wish to help them fix their code. Choose all the fixes below that are necessary to make their program work.

(2 marks)

☒

Change `EICRA = 0x0;` to `EICRA = 0xC;`

☐

Change `EICRA = 0x0;` to `EICRA = 0x3;`

☐

Change `ISR(INT1_vect)` to `ISR(INT0_vect)`

☒

Change `EIMSK = 0x1;` to `EIMSK = 0x2;`

☐

Change `flag = !flag` to `flag = 1 - flag;`

14.

The following code snippet shows the `setup()` for the Timer 0 block to generate a PWM signal to control an LED connected in Active-Low configuration to Port D Pin 6. A continuous PWM signal with a Duty Cycle of approximately 10% is observed.

```

#include "Arduino.h"

#include

#include

void setup() {
    TCNT0 = 0; // LINE 1
    TCCR0A = 0b10000001; // LINE 2

```

```

TIMSK0 |= 0b10; // LINE 3

OCR0A = 25; // LINE 4

TCCR0B = 0b00000011; // LINE 5

DDRD |= (1 << 6); // LINE 6

sei(); // LINE 7

}

ISR(TIMER0_COMPA_vect)

{

OCR0A = 25; // LINE 8

}

void loop()

{

}

```

Which of the following statements are TRUE (can be more than one)?

(2 marks)

☐

The OCR0A register value determines the Period of the PWM.

☐

LINE 8 in the ISR is needed to ensure that the PWM signal maintains a constant Duty Cycle.

☒

Removing LINE 3 from the code will NOT affect the PWM output.

☒

Removing LINE 7 from the code WILL NOT affect the PWM output.

☐

Changing LINE 5 to: TCCR0B = 0b00000100; changes the Duty Cycle of the PWM signal.

15.

Some of the git operations you have used in your studio required a remote repository, whilst others could be performed without a remote repository. Which of the following git operations (there may be more than one) require communication with a remote repository?

(2 marks)

☒

<input type="checkbox"/>	pull
<input checked="" type="checkbox"/>	push
<input checked="" type="checkbox"/>	clone
<input type="checkbox"/>	commit
<input type="checkbox"/>	diff

16. Which of the following statements (there may be more than one) is/are true about git?

(2 marks)

<input checked="" type="checkbox"/>	The .gitignore file is used to tell git what files to automatically ignore.
<input type="checkbox"/>	A github account is required to use git.
<input type="checkbox"/>	Committing files will automatically upload those files to a remote repository.
<input checked="" type="checkbox"/>	A commit is like a snapshot of the current state of your code base.
<input checked="" type="checkbox"/>	Git can allow multiple programmers to collaborate on a single code base.

Finish Quiz

Save For Later