You are being asked to design a control system using the PWM of an MC9S12. You are required to use high values for the PWMPERx register (≥100) to accomplish this task. Be sure your C code does not affect the function of any other PWM channels.

* Set up the MC9S12 to produce a 5 kHz PWM signal with a 10% duty cycle on Bit 0 of Port P.

Need to generate a 5 KHz signal so: $24 \times 10^6 / 5 \times 10^3 = 4800$

```
PWMCTL = 0x00; // Choose 8-bit mode
PWCMAE = 0x00; // Choose left-aligned
PWMPOL = 0xFF; // Choose high polarity
PWCCLK = PWCCLK | 0x01; // Clock mode 1 for Ch 0
PWMPRCLK = (PWMPRCLK & ~0x07) | 0x02; // PCKA = 2
PWMPER0 = 200; // Period for Ch 0 clock
PWMDTY0 = 20; // 10% duty cycle
PWMSCLA = 3; // Another prescaler
PWME = PWME | 0x01; // Enable PWM on Port P0
```

* Set up the MC9S12 to produce a 10 kHz PWM signal with a 20% duty cycle on Bit 2 of Port P.

Need to generate a 5 KHz signal so: $24 \times 10^6 / 10 \times 10^3 = 2400$

```
PWMCTL = 0x00; // Choose 8-bit mode
PWCMAE = 0x00; // Choose left-aligned
PWMPOL = 0xFF; // Choose high polarity
PWCCLK = PWCCLK | 0x04; // Clock mode 1 for Ch 2
PWMPRCLK = (PWMPRCLK & ~0x70) | 0x10; // PCKB = 1
PWMPER2 = 200; // Period for Ch 2 clock
PWMDTY2 = 40; // 20% duty cycle
PWMSCLB = 3; // Another prescaler
PWME = PWME | 0x04; // Enable PWM on Port P2
```

A temperature sensor TC1047A is connected to the A/D converter of an MC9S12. The VRL is connected to 0 V, and the VRH is connected to +5 V. The sensor is connected to PAD4. The TC1047A sensor has a linear response, and its voltage output is directly proportional to the measured temperature. The output voltage range for these devices is typically 100 mV at -40°C, and +1.75V at +125°C.

* What is the value of ATD0DR4 (in hex) when the sensed temperature is 40°C?

The output voltage of the sensor at 40°C is $V_{OUT} = (10\, \text{mV/°C})(\text{Temperature} \, \degree\text{C}) + 500\,\text{mV} = 0.9\,\text{V}$

So the value of ATD0DR4 is $ATD0DR4 = 0.9V \times (2^{10}-1) / 5V = 184_{10} = B8_{16}$

* After the set of eight conversions, the eight 16-bit result registers are as follows

<table>
<thead>
<tr>
<th>ADR0</th>
<th>ADR1</th>
<th>ADR2</th>
<th>ADR3</th>
<th>ADR4</th>
<th>ADR5</th>
<th>ADR6</th>
<th>ADR7</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x004F</td>
<td>0x0071</td>
<td>0x0052</td>
<td>0x0012</td>
<td>0x0045</td>
<td>0x00C2</td>
<td>0x0023</td>
<td>0x0098</td>
</tr>
</tbody>
</table>

What is the temperature being measured by the TC1047A sensor.

The temperature is $0x45_{16} = 69_{10}$

$V = 5V \times (69) / (2^8-1) = 0.337$

$T = (0.337V - 0.5V) \times 10 \text{mV/°C} = -16.27°\text{C}$

The MAX5381 is an 8-bit DAC with an IIC interface which can output an analog voltage from 0 to +4V. The spec sheet for the MAX5381 shows that the maximum SCL frequency is 400 kHz. How would you set up the MC9S12 IIC hardware to have as high of a IIC speed as possible which meets these values?

You just need to make sure the frequency is 400 kHz or lower. 24 MHz/400 kHz = 60, so the clock divider needs to be 60 or larger. You can get a clock divider of 60 by writing an 0x45 to the IBFD register: IBFD = 0x45;