For Loop Example:

```Assembly
for (j=0; j<10; j++)
{
    PORTT = j;
}
```

Assembly Code:
```
ldaa #0     ; Initialize j
Loop: cmpa #10    ; Compare j to 10
        bge EndLoop ; Else !(j<10)
        staa PTT    ; Write J to PORT T
        adda #1     ; Increment j
        bra Loop    ; Repeat Loop
EndLoop:          ; do something else
```

**How do we determine this value?**

```
$4000 $86 LDDA immediate addressing
$4001 $00 Value to be stored in A
$4002 $81 CMPA immediate addressing
$4003 $0A Compare Value 10
$4004 $2C BGE (Branch if greater than or equal to zero)
$4005 $04 PC=PC+2+Rel
$4006 $8B ADJA immediate addressing
$4007 $01 Value to add to A
$4008 $20 Branch Always
$4009 $8F PC=PC+2+Rel
```

Do the relative addresses for the BGE and BRA instructions change? Why or why not?
For Loop Example:

```assembly
for (j=0; j<1000; j++) {
    PORTT = j%256;
}
```

Assembly Code:
```
ldd #0 ; Initialize j
Loop: cpd #1000 ; Compare j to 1000
    bge EndLoop ; Else !(j<1000)
    stab PTT ; Write J to PORT T
    add #1 ; Increment j
    bra Loop ; Repeat Loop
EndLoop: ; do something else
```

Do we need to use division here?
ECE 372 – Microcontroller Design
Instruction Execution Timing – Accumulator D

- \$4000: S00 LDD immediate addressing
- \$4001: S00 MSB of value to be stored in D
- \$4002: S00 LSB of value to be stored in D
- \$4003: S0C CPD immediate addressing
- \$4004: S03 Compare to Value 1000
- \$4005: S08

ECE 372 – Microcontroller Design
Time for Fun (or maybe not?)

- 10 Gallon
- 7 Gallon
- 3 Gallon

ECE 372 – Microcontroller Design
STAA Instruction Execution Timing

- \$4000: S0C LDD immediate addressing
- \$4001: S00 MSB of value to be stored in D
- \$4002: S00 LSB of value to be stored in D
- \$4003: S0C CPD immediate addressing
- \$4004: S03 Compare to Value 1000
- \$4005: S08

ECE 372 – Microcontroller Design
CPU Internals

- Program Counter
- Instruction Register
- Memory Address Register
- Memory Data Register
- Arithmetic Logic Unit
- Temporary Register
ldaa #0 ; Initialize j
Loop: cmpa #10 ; Compare j to 10
    bg ELoop ; Else !(j<10)
    ; do something
    adda #1 ; Increment j
    bja Loop ; Repeat loop
EndLoop: ; do something else
### ECE 372 – Microcontroller Design

**CPU Internal Execution Timing**

<table>
<thead>
<tr>
<th>Instruction</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADDA</td>
<td>Value to add to A</td>
</tr>
<tr>
<td>BGE</td>
<td>Compare Value</td>
</tr>
</tbody>
</table>
Array For Loop Example:

```c
unsigned short a[10];
for(j=0; j<10; j++)
{
    if(a[j]==1) PORTT=0x04;
    else PORTT=0x00;
}
```

**Programming Steps:**
1. Initialize
2. Compare J to 10
3. If Not Less than 10,
   1. End Loop
4. Else
   1. Load a[j]
   2. If a[j] == 1
      1. PORT T = 4
   3. Else
      1. PORT T = 0
   4. Increment J
5. Repeat Loop (Step 2)