(1) Complete the following table:

<table>
<thead>
<tr>
<th>Processor</th>
<th>I/O Device</th>
<th>Processor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Interrupt</td>
<td>N.A.</td>
</tr>
<tr>
<td></td>
<td>• Polling</td>
<td>• Programmed I/O</td>
</tr>
<tr>
<td></td>
<td>• DMA</td>
<td>• Centralized DMA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• ON-Card DMA</td>
</tr>
</tbody>
</table>

(2) How many context-switching will be performed for each “interrupt”?

Two context-switching will be performed for each interrupt.
(3) What are the major problems in dealing with I/O devices using interrupts?

Any two from the below:

- Since the main processor(s) perform actual data transfers, transferring data from I/O devices to memory using interrupts will slow-down the execution of the user programs.
- Since the main processors will be unable to predict the timing of interrupt signals, hard to predict “when” user programs will be slowed-down (or stopped).
- Since each data transfer takes two transfers on the bus, transferring data from an I/O device to memory using interrupts will take long time.

**Note:** for earning full credit (five points for each of two) requires emphasis (or at least mentioning the underlined concept(s)) for demonstration of your understanding.

(4) Describe the procedure of an interrupt.

1. Incoming data arrives at an I/O device
2. The I/O device sends an interrupt signal to a processor
3. The processor performs an context switching from a user program to the I/O device (the device driver of the I/O device)
4. The processor reads the data from the I/O device to the processor
5. The processor writes the data to the memory
6. The processor performs a context-switch from the I/O device to the (interrupted) user program

**Note:** the expected details (for full credit) are underlined.

(5) What is the advantage(s) and disadvantage(s) of “polling” (compared to “interrupt”)?

**Advantage:**
- The main processor can select the time to perform data transfer from I/O device A(i.e., user programs will not be interrupted at unpredictable timing).

**Disadvantage (one of the following two):**
- Main processor(s) needs to periodically check I/O devices when nothing is happening there.
- If a processor does not check I/O devices often enough, I/O devices may lose date (overwritten).