a.

First Fork		**Else Fork**	
Parent	**Child1**	**Parent**	**Child2**
X=100	X=100	X=100	X=100
	X=90	X=80	X=80
			X=70

There are 3 versions of x.

At the end, parent x=80, child1 x=90, child2 x=70.

b.

With user-level threads, the kernel is not aware of the existence of the threads. This is beneficial in an OS that does not support threads. Thread management is handled exclusively by the application therefore less time is wasted on context-switching. However, if one thread becomes blocked, the whole process is blocked. A thread-table in the user space keeps track of the threads in a process. User-level threading is done in Java.

With kernel-level threads, threads are managed in the kernel space. An advantage of this is that if a thread is blocked, for example for an I/O call, the kernel does not block the whole process but rather switches to another thread. However, context switching is required to transfer control from one thread to another. Windows implements kernel-level threading.

c.

When a shared memory resource needs to be accessed, problems may arise where two processes are manipulating the same resource. To avoid complications, the Test and Set Lock Algorithm can be used, implementing the functions **enter_region** and **leave_region**.

enter_region:

```
TSL REG, FLAG
CMP REG, 0
JNE enter_region
return
```

First, the flag (lock) variable is copied to the shared memory register and set to 1. The flag is a shared variable. Secondly, a comparison is done to see if the register is locked (if set to 1). If it is locked, the program loops. Else, it returns to the caller.

leave_region

```
MOVE FLAG, 0
return
```

When the process wants to leave the critical region, it sets the flag value to zero.

c.

The main issue in this solution and Peterson’s solution is the producer-consumer problem (bounded buffer). This occurs when a producer is adding to a fixed buffer space and a consumer takes from it. If the buffer is full, the producer must sleep. Similarly, if the buffer is empty, the consumer must sleep. This can cause race conditions to arise.