

Name: _____

Directions: MAKE SURE TO COPY YOUR ANSWERS TO A SEPARATE SHEET FOR SENDING ME AN ELECTRONIC COPY LATER.

1. (20) The NVIDIA GPU execution model is Single Instruction Multiple Threads, SIMT. What is the acronym for MPI?

2. (20) The process ID in MPI has a 2-level hierarchical structure, rather analogous to **blockIdx** and **threadIdx** in CUDA. What are the official MPI terms for the two levels? (Answer on one line.)

3. (20) Consider the run-length decoding examples in Secs. 10.5 and 10.6, the first in OMP and the second in Thrust. State the line number in Sec. 10.6 that is analogous to line 10 in Sec. 10.5. If there is no such line in 10.6, answer None.

4. (20) In the example titled, Removing 0s from an Array, Sec. 8.4, consider what may happen in terms of the order of the nonzero values within the **no0s** array. Which one of the following is true?

(i) The order will be the same as in the **has0s** array. For instance, if 12 and 5 were in **has0s**, with 12 in a lower-index position than 5, then the index of 12 in **no0s** will be lower than that of 5.

(ii) The order will be reversed.

(iii) The order will be random, in the sense that in several runs of the program, different orders may occur in different runs.

(iv) The order will be nonrandom, but neither (i) nor (ii) will necessarily occur.

5. (20) In this problem you will develop an OpenMP function that works like **thrust::copy_if()**. Fill in the blanks:

```
#include <stdio.h>
#include <omp.h>

int u[8] = {1,0,1,1,0,1,0,1},
    v[8] = {1,5,6,3,0,2,0,8},
    w[8];

int f(int a) {return a != 0;}

void omp_copy_if(int *x1, int *x2, int nin,
                int *y, int *nout,
                int (*boolftn)(int)) {
    blank (a)
    #pragma omp parallel
    {
        int i;
        #pragma omp for
        for (i = 0; i < nin; i++)
            if ( blank (b)
                blank (c)
                ntrue++;
                blank (d)
            }
    }
}
```

```
        #pragma omp single
        *nout = ntrue;
    }
}

main(int argc, char **argv)
{ int i,no;
  omp_copy_if(v,u,8,w,&no,f);
  // should print 1 6 3 2 8
  for (i = 0; i < no; i++) printf("%d\n",w[i]);
}
}}
```

Solutions:

1. SPMD
2. communicator, rank
3. None; Thrust does not work directly with thread number.
4. (i)
- 5.

```
#include <stdio.h>
#include <omp.h>

int u[8] = {1,0,1,1,0,1,0,1},
    v[8] = {1,5,6,3,0,2,0,8},
    w[8];

int f(int a) {return a != 0;}

void omp_copy_if(int *x1, int *x2, int nin,
                 int *y, int *nout,
                 int (*boolfn)(int)) {
    int ntrue = 0;
    #pragma omp parallel
    {
        int i;
        #pragma omp for
        for (i = 0; i < nin; i++)
            if (boolfn(x2[i])) {
                #pragma omp atomic
                ntrue++;
                y[ntrue-1] = x1[i];
            }
        #pragma omp single
        *nout = ntrue;
    }
}

main(int argc, char **argv)
{
    int i, no;
    omp_copy_if(v, u, 8, w, &no, f);
    // should print 1 6 3 2 8
    for (i = 0; i < no; i++) printf("%d\n", w[i]);
}

}}
```