Graded exercise

1) Syscalls

1.1 Wrappers.

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wrapper can do is check if p == NULL.

To check if the user space (virtual memory)
p given to it is even memory mapped thro
paging to a physical memory address (through pag
work must be done on the kernel side.
Same for read/write permission to that me
address.

-Kernel check is mandatory, Library is if
they want to do NULL check.

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To check if the user space (virtual memory) p given to it is even memory mapped through paging to a physical memory address (through paging), work must be done on the kernel side. Same for read/write permission to that memory address.

Kernel check is mandatory. Library is if they want to do NULL check.

1.2 fork

if fork==0:
inside child

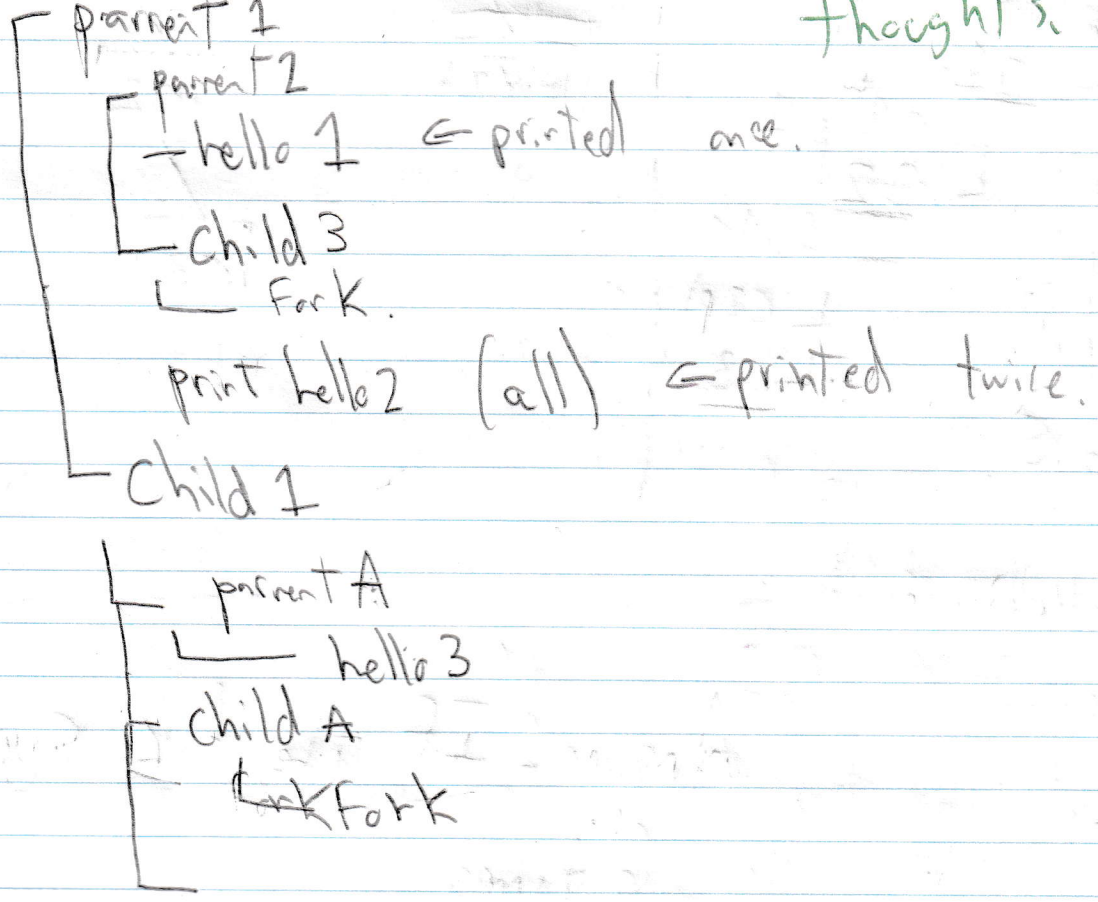
if fork!=0:
inside parent.

Assuming

fork gives pid of child.
getppid, and getpid
↑ parent pid exist.

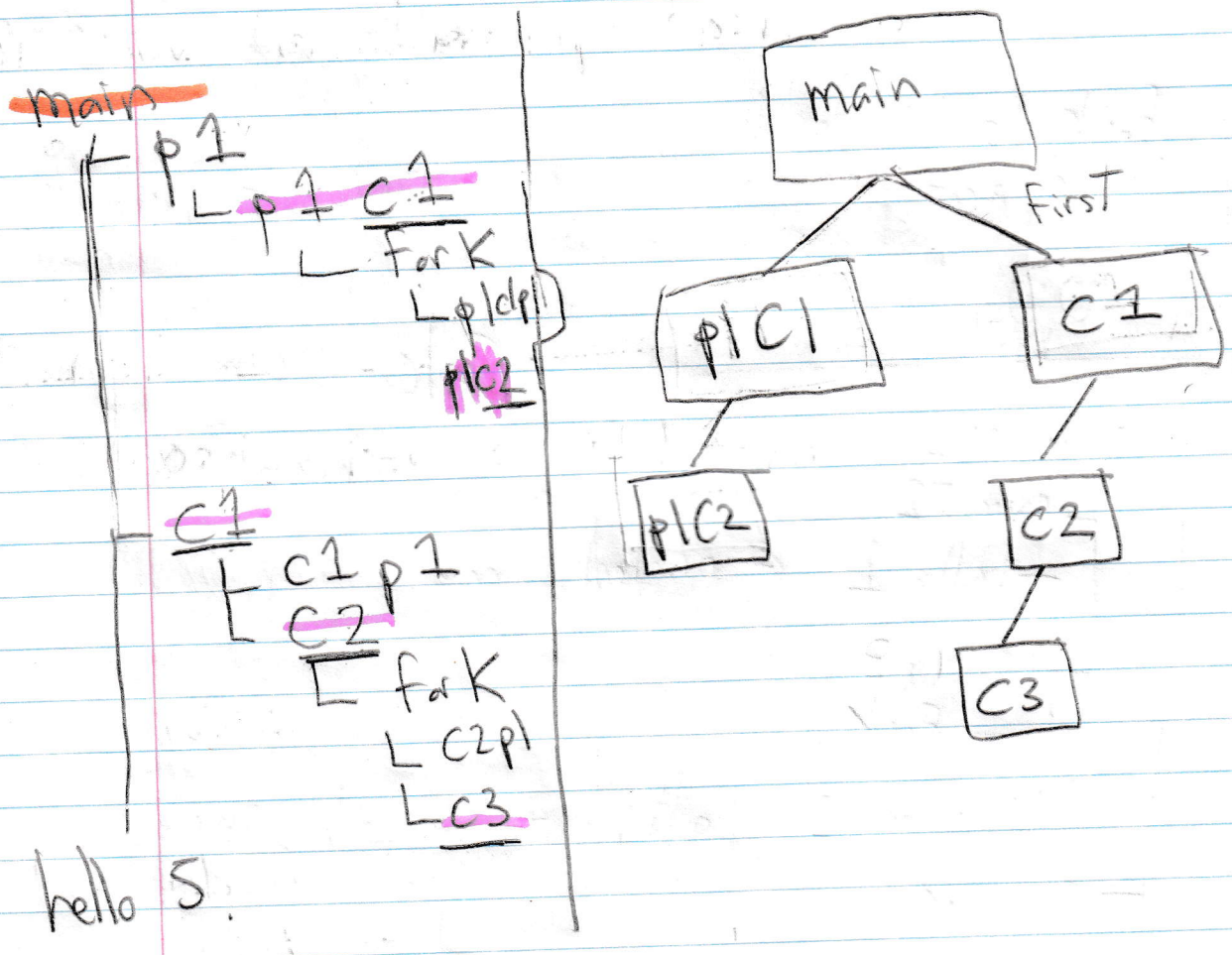
pid_t = Typedef int

Calc and thoughts.



Ah, I don't need to check every print.

Since fork runs till the end of program.



5 different child

1 parent.

6 times.

Answer: If the fork succeeded,

6 times

2: Sync.

2.1

available ressource is a global variable, it's available in all threads, is read and wrote. (access and modify).

2.2 The part where available ressource is written to / modified is by default a critical section which needs to be locked.

And here if available ressource = count.

thread one pass the if statement but does not return, thread 2 does the whole function ~~and close~~ ~~then~~, then thread 1 return: Error.

So the if and return must be locked too.

hence, both function must be block from start to finish.

2.2-2.3 (in between)

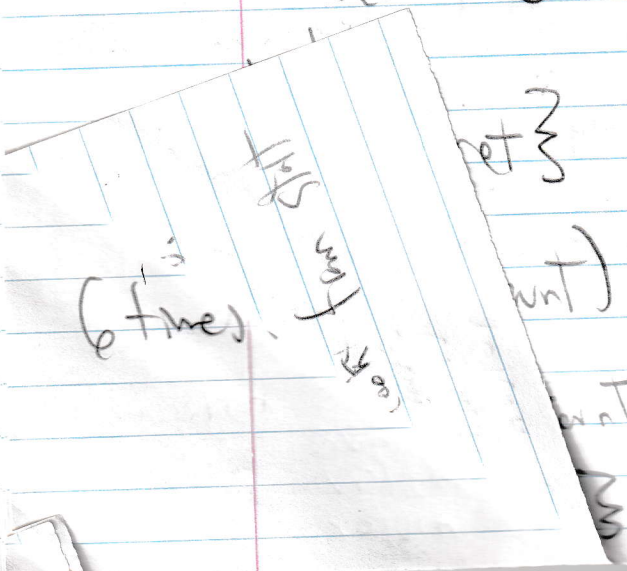
rewritting the function to allow locking and unlocking before the return statement

wrapping the function call in lock, unlock in the caller are possible solutions.

Lines with r&w access: 5, 8, 14

2.3

```
int dec (count) {
int ret;
lock;
if avail < cnt;
    ret = -1
else
    ret = 0
```



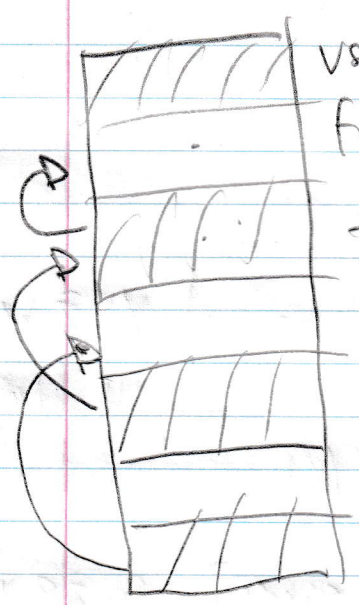
3. Compacting

3.1

$$4GB \approx \frac{\text{Trillion}}{2} = \frac{1e^9}{2} = 5e^8$$

$5e^8$ bytes $\cdot$ (8 bytes) $\cdot$ time

read + write = 4ns + 4ns.



read + write each segment.

$8ns \cdot 5e^8 = 4 \cdot 1e^9 \text{ ns} = 4s$

if we need to move the whole thing, 4s.

else. f. 4s

↑ fraction of movement space.

4. Virtual mem, Segmentation.

4.1

5 bit virtual address.

16 bytes of addressable phys mem.

$2^{10} = 1024$

$2^5 = 32$ $2^6 = 64$

64KB of ram. Ah No,

---

16 bytes of Ram. , phys = ab XYZW
↑4 address

Program has 32 bytes of VM.

biggest band is 8. max segment size is 8

max segment address is 3 is $\log_2 8$.

There's 4 segment: 2 bit for segment.

2 + 3 = 5, check. No waste.

↑ ↑
segment offset

0b | ab | x y z

↑ seg offset

V → p = Seg[ab]$_{base}$ + xyz

1. 00,000 → 0b1100 W. (perm denied).
2. 11,001 → 0b1000 + 001 = 0b1001 R (pass)

3. 01,000 → 0b0000 + 0 : Naive (perm denied).
4. 10,010 → 0b0001 + 0010 = 0b0011 RW, pass.
5. 11,010 → 1000 + 0,010 = 1010 R. (perm denied)

---

6. 00, 111 → 1100 + 0111; surpass add space. + 111 > bound = 100
   Seg fault.
7. 10,001 → 0b0001 + 0,001 = 0b0010. RW. pass.
8. 00,000 → 0b1100 W pass.

9. 11,000 → 0b1000 + 0,1100 = 0b10100 R.
Segfault. (perm denied)

10. 10,1100 → 0b0001 + 0,1000
100 > 011 = bound. Segfault.

---

1. Segfault
2. 0b1001 → 9
3. Segfault
4. 0b0011 → 3
5. Segfault
6. Segfault
7. 0b0010 → 2
8. 0b1100 → 12
9. Segfault
10. Segfault.

5. Virtual mem, Paging

5.1 Nice Answer encircled in

4KB = 12 bit address. 2 page

1024 entry page dir ⇒ 10.

Dir Index	Page Index	offset
10	10	12.

Page directory = 1 array.

&page_directory = CR3.

DirIdxA = CR3 + DirIdx · 4

PTBA = *DirIdxA.
Page table base address.

TableIdxA = PTBA + TableIdx · 4

PFBA = * TableIdxA
Page Frame Base Index.

Phys Address = PFBA + Page Offset.

32 bytes is 4bg/g

1024. 4 bytes
= 4 KB page dir.

1024 entry.
4KB = 4MB
For All page tables.

4.004 MB for the whole thing if fully allocated

5.1 answer: 1024, See Next page for Even more steps for myself.

As shown before, a page table has 2^{10} entry, so 1024.

and since they contain address of 4B size then it's memory size is 4KB

If one page frame has 4KB of phys mem,

It has $\frac{4096}{\left(\frac{\text{Arch bits (32)}}{\text{byte size (1)}}\right)}$ = 1024 32 bit words

however....

$1024 = 2^{10}$. However, we can check the bytes, not just words, as "char" is a type and there's byte size registers.

So, offset = $\log_2$(Page frame size in bytes)

$= \log_2(4096) = 12$.

The dir has 1024 entries, so 10

$32 = 10 + x + 12$

$x = 10$.

10 bits are for the page table entry.

$2^{10} = 1024$.

A page table has 1024 entries, and takes 4KB of memory.
Which by luck is the same as page frame size

5.2 Spatial locality

Assuming $[0, 18[= 0, 1, 2, \dots, 17$

0	1	2	...	17

All used.

So 18 MB is used. $\frac{18 \cdot 1024}{4} = 9 \cdot 512 = 4608$

Assuming $[90, 117[$ $\frac{1024}{4} = 256$

So $117 - 90 = 27$

$27 \cdot 256 = 6912$

$4608 + 6912 = 11520$ page frames used.

$\frac{11520 \text{ page frames}}{1024 \text{ page frame table}} = 11.25$ page tables

- 1 dir entry does $1024 \cdot 4\,KB = 4\,MB$

10 10 12 but virtual memory contiguous

$\frac{18}{4} = 4.5$, so not fully allisned,

half of the 5th page table will be filled.

- $\frac{90}{4} = 22.5$, $\frac{117}{4} = 29.27$.

but, virtual page tables can have holes, so it doesn't matter.

you can have the the first 512 (half) page tables be null / unallocated

- It doesn't need to have an entire page table, nor. up to down. so the 75% from 117 can be unused.

5.3 $64 = 2^6$ checks out

6 bit V → 6 bit Phys.

Page frame is 4 byte, 4 entry.

Page size = page frame size

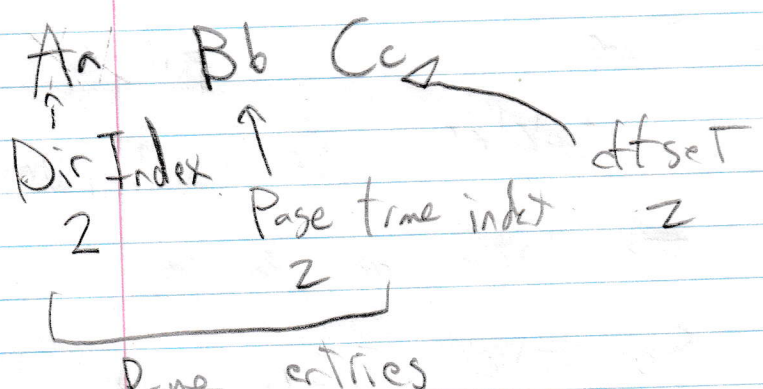
virtual physical

so the offset match.

$\log_2(4) = 2$. offset is 2 bit.

Dir size (6 bit) $= \log_2(4 \text{ entries})$

Page size (bit) $= \log_2(4) = 2$



Page dir is at frame 2 (# 3)

Page dir:

8 → invalid
9 → 0
10 → 5
11 → 13

Page table 0

0 → 0xd1
7 → 0xf7
2 → 0x6f
3 → 0xc0

4.004 MB for the whole thing if fully allocated

5.1 answer: 1024, See Next page for ☐

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```
int dec (count) {
int ret;
lock;
if avail < Cont;
    ret = -1
else
    ret = 0
vnlock;
return ret}

int inc (count) {
  lock
  avail += Count;
  Unlock
  return 0; }
```

1) 00, 00, CC → invalid (invalid) 5.3, 3

2.) 11, 00, 10 → invalid
3 ↑ invalid

3) 10, 11, 01 → 13, 11 = [illegible]
base2 13 offset
d

4). 01, 01, 11 → 7, 3 3 = [illegible]
7

5.3, 2

Page 0: invalid

Page 1:

00 → 7

01 → 7

02 → 15

03 → invalid.

Page 2

00 → [illegible]

01 → invalid.

02 → 12 (c)

03 → 13 (d)

Page 3 (Frame 3)

00 → invalid

01 → 10 (a)

02 → 4

03 → 8

5.3, 7

Pagedir:

0 → invalid
1 → frame 0
2 → frame 5
3 → frame 3

00 → invalid
01 → frame 000
10 → frame 101 (5)
11 → frame 011 (3)