

Name:

UID:

1. Drawing the Diagrams

For each program, create a diagram of the data dependencies.

```
a. .L1:                                ; Loop (scalar)
    imull    (%rdi,%rcx,4), %eax        ; t = t * d[i]
    addq     $1, %rcx                  ; i++
    cmpq     %rcx, %rsi                 ; Compare i:length
    jl       .L1                       ; If <, goto Loop
```

```
b. .L2:                                ; Loop
    imull    (%rdi,%rcx,4), %eax        ; t = t * d[i]
    imull    4(%rdi,%rcx,4), %eax       ; t = t * d[i+1]
    imull    8(%rdi,%rcx,4), %eax       ; t = t * d[i+2]
    imull    12(%rdi,%rcx,4), %eax      ; t = t * d[i+3]
    addq     $4, %rcx                   ; i += 4
    cmpq     %rcx, %rsi                 ; Compare i:length
    jl       .L2                       ; If <, goto Loop
```

```

c. .L3:                                ; Loop
    mov     (%rdi,%rcx,4), %e8d        ; e8d = d[i]
    imull   4(%rdi,%rcx,4), %e8d      ; e8d = d[i+1] * d[i]
    mov     8(%rdi,%rcx,4), %e9d      ; e9d = d[i+2]
    imull   12(%rdi,%rcx,4), %e9d    ; e9d = d[i+3] * d[i+2]
    imull   %e8d, %e9d                ; e9d = e8d * e9d
    imull   %e9d, %eax                ; rax = rax * e9d
    addq    $4, %rcx                  ; i += 4
    cmpq    %rcx, %rsi                ; Compare i:length
    jl      .L3                       ; If <, goto Loop

```

2. Two Bounds

Given the following table for latency table:

Instruction	Latency (Cycles)	Cycles/Issue	Count (#)
Arithmetic (except multiply)	1	1	2
Multiply	2	2	4
Load/Store	4	4	8

For each prior program, provide the Cycles per Element (CPE), Throughput Bound, and Latency Bound.

a.

b.

c.