1.

a) Add + shift-2 = 100 + 30 = 130 ps

b) IMEM + Regs + ALU + REGS = 400 + 200 + 150 + 200 = 950 ps

c) IMEM + Regs + ALU + DMEM + ALU + Sign-Extend
= 400 + 200 + 150 + 500 + 150 + 50 = 1450 ps

d) 1450 ps

e) DMEM as it is used in LW which has the longest latency and DMEM also has the longest time.

2.

a) ($8, I1, I2)
  ($8, I3, I4)
  ($9, I2, I3)

b)
```
Add    IF ID EX MEM WB
NOP       Ø
NOP          Ø
SW            IF  ID EX MEM WB
NOP              Ø
NOP                 Ø
LW                    IF  ID EX MEM WB
NOP                      Ø
NOP                        Ø
AND                          IF  ID EX MEM WB
SW                              IF ID EX MEM
                                           ^
                                           WB
```
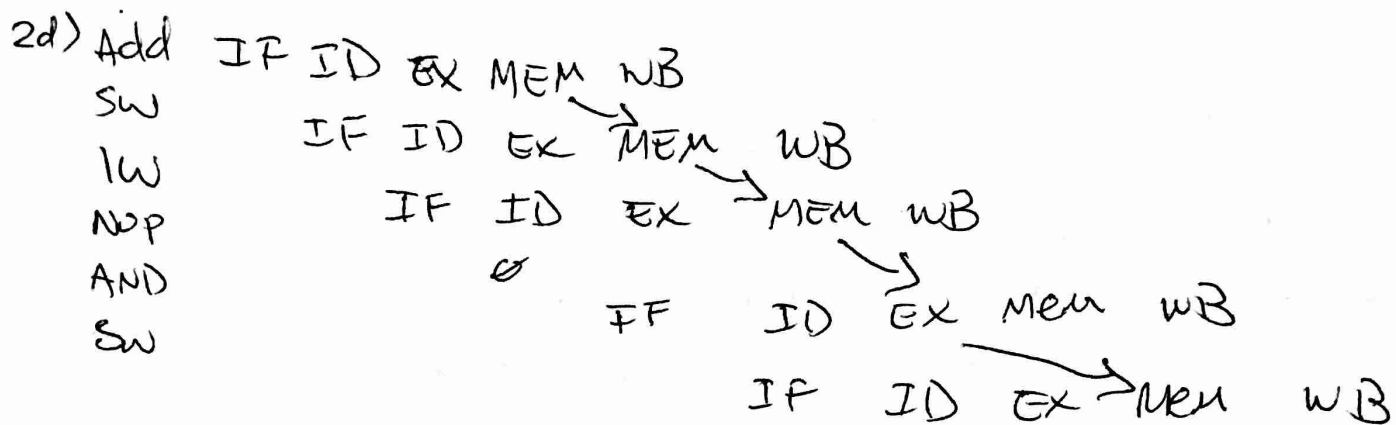
c) lw $8, 4($9)
  add $8, $12, $10
  sw $8, 0($9)
  and $12, $12, $8
  sw $9, 0($8)

2d) Add IF ID EX MEM WB
    SW   IF ID EX MEM WB
    lW   IF ID EX MEM WB
    NOP   ∅
    AND   IF ID EX MEM WB
    SW   IF ID EX MEM WB

3. a) All-taken = $4/6 = 2/3$
      All-Not-taken = $2/6 = 1/3$

   b) Actual: T T T NT T
      Predict: NT NT T T T
      Accuracy: $2/5 = 0.4$

   c) Actual: T T T NT T NT | T T T NT T NT
      Predict: NT NT T T T T | T T T T T T

      Accuracy: $4/6 = 2/3$