Unit 1 · How a Computer Really Works

WORKSHEET

Full marks 30

Name _____ Class _____ Roll no. ____ Date _____ Marks _____ / 30

1 Key words [4]

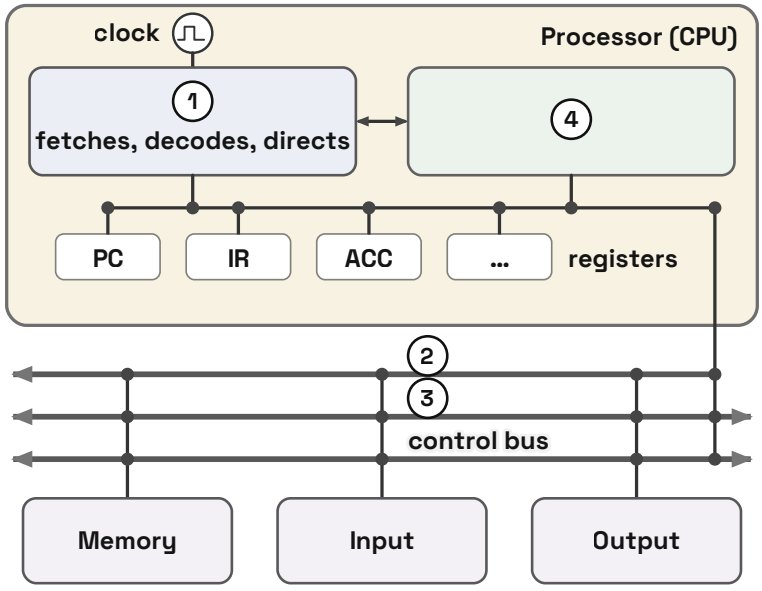
Fill in the blanks with words from the box. Two words in the box are not needed. Each blank carries 0.5 mark.

assembly language	cache	compiler	firmware	half adder	interrupt	latch
program counter	stored-program computer	system call				

A _____ adds two bits with an XOR gate and an AND gate. Two NOR gates wired into each other make a _____, which remembers one bit. Inside the processor, the _____ holds the address of the next instruction. A computer that keeps its program in memory as numbers, beside the data, is a _____. Instructions written as words, such as LOAD 14, are _____. A small, very fast memory on the processor chip that keeps copies of what is used most is the _____. A device that needs attention sends an _____, and an app asks the kernel to save a file with a _____.

2 Label the diagram [2]

The diagram shows the inside of a processor, joined to memory and to the input and output devices. Write the part that belongs in place of 1 to 4. Each carries 0.5 mark.



1. _____ 2. _____

3. _____ 4. _____

3 Multiple choice [5]

Choose the correct option for each of the following questions.

i. In a half adder, which gate gives the carry? [1]

a. XOR **b.** AND

c. OR **d.** NOT

ii. A full adder's inputs are A = 1, B = 0 and a carry in of 1. What are its outputs? [1]

a. sum 1, carry 0 **b.** sum 0, carry 1

c. sum 1, carry 1 **d.** sum 0, carry 0

iii. An 8-bit register holds 200, and the processor adds 100. What happens? [1]

a. The register holds 300.

b. The processor stops with an error message.

c. The register keeps only 8 bits, 44, unless the program checks for the overflow.

d. The register holds 255, the biggest it can.

iv. Which kind of memory must be refreshed many times a second? [1]

a. SRAM **b.** DRAM

c. ROM **d.** flash

v. Why can't a game write straight to the phone's storage, without asking the operating system? [1]

a. Games are too slow to write to storage.

b. Apps run in user mode, where instructions that touch the hardware are refused; they must ask the kernel with a system call.

c. Storage can only be written by the firmware.

d. The game would need its own processor.

4 What does it print? [3]

Write exactly what the program prints, in the box under it. Then answer.

```
1  def AND(a, b):
2      if a == 1 and b == 1:
3          return 1
4      return 0
5
6  def XOR(a, b):
7      if a != b:
8          return 1
9      return 0
10
11 for a in range(2):
12     for b in range(2):
13         print(a, b, "carry", AND(a, b), "sum", XOR(a, b))
```

OUTPUT

Which circuit does the program work out?

5 Adding with full adders [3]

Fill in the table, then answer.

A 4-bit ripple-carry adder adds 1011 and 0110. Write the sum bit and the carry out of each full adder, from the 1s column to the 8s column.

Column	A	B	Carry in	Sum	Carry out
1s	1	0	0		
2s	1	1			
4s	0	1			
8s	1	0			

What 4 bits does the adder give? Is the answer right? Why or why not?

6 Trace the program [4]

Fill in one row for each instruction carried out, in order. The first row is done for you.

The model processor's program is in cells 0 to 5; cell 14 holds 6 and cell 15 holds 3. LOAD a copies cell a into the ACC; SUB a takes cell a away from the ACC; OUT shows the ACC; JUMPZ a jumps to cell a if the ACC is 0, else carries on; JUMP a jumps to cell a; HALT stops. The program counter goes up by one at each fetch.

CELLS 0 TO 5

```
0 | LOAD 14
1 | SUB 15
2 | OUT
3 | JUMPZ 5
4 | JUMP 1
5 | HALT
```

Instruction carried out	PC after	ACC after	Output
LOAD 14	1	6	

7 Short answers [3]

Write short answers to the following questions.

a. Write JUMPZ 5 in the model processor's machine code (JUMPZ is 0111). [1]

b. How is a compiler different from an interpreter? Which one is Python usually run with? **[2]**

8 Long answer **[4]**

Write a long answer to the following question.

Describe the fetch–decode–execute cycle. Say what happens to the program counter, and which buses are used.

9 Think **[2]**

Think, then answer.

A phone has 128 GB of storage but only 6 GB of RAM. Why doesn't it just run its apps straight from the storage, with no RAM? And why isn't all 128 GB made of RAM?

10 Activity: Find a limit of your calculator (not marked)

On a phone's calculator app (or any calculator), do each test. Write what it showed, and the limit that shows.

Test	What it showed	The limit
1 ÷ 3, then × 3		
the biggest number it takes, × 1,000		
2 × 2 × 2 … : how many 2s until an E?		