# Worksheet 3 The processor instruction set Answers

# Task 1

1. A summary of the instructions available for an imaginary processor is shown below:

|  |  |  |
| --- | --- | --- |
| **Machine code** | **Instruction** | **Description** |
| 0010 01 | LOAD | Load from memory |
| 0011 01 | STORE | Write to memory |
| 0100 00 | ADD | Add value to register contents |
| 0101 00 | SUB | Subtract value from register contents |
| 0110 00 | LSHIFT | Left bit shift value |
| 0111 00 | RSHIFT | Right bit shift value |

1. What is the term used for the complete collection of all the commands in machine code that can be recognised and executed by a processor?

Instruction set

1. What might the two right hand bits of the opcode represent in the instructions above?

The addressing mode, immediate or direct.

1. Explain what may change if a different make of processor is used.  
   * The instruction set  
     The number of machine code instructions in the instruction set
   * The format of the instructions themselves
2. A processor uses six bits for the opcode. Calculate how many possible instructions can be encoded.

26 = 64

1. Describe why a program compiled on a computer with a certain type of processor cannot run on a different computer with a different make of processor. Write your answer with reference to machine code and instruction sets.  
   * When a program is compiled, machine code is created based on the instructions given
   * This is specific to the architecture of a given processor
   * Different processors can have different instruction sets
   * If machine code created on one computer is run on another with a different instruction set it will not understand the instructions

# Task 2

1. Processor instructions are made up of three components.
2. Describe what these three components are for:

Basic machine operation (part of the opcode)

* The action the processor is required to perform

Addressing mode (also part of the opcode)

* Identifies the way the operand should be interpreted

Operand

* The value or the address of the value to be processed as part of the specified operation

1. A processor uses 16 bit instructions. Assuming that the two bits used for the addressing mode are not included in the opcode, complete the table below to summarise the number of instructions and the maximum value of the operand if different instruction formats are used:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Bits used for opcode** | **Number of possible operations** | **Bits used for addressing mode** | **Bits used for operand** | **Maximum value available for operand** |
| 2 | 4 | 2 | 12 | 4095 |
| 4 | 16 | 2 | 10 | 1023 |
| 5 | 32 | 2 | 9 | 511 |
| 6 | 64 | 2 | 8 | 255 |
| 7 | 128 | 2 | 7 | 127 |
| 10 | 1024 | 2 | 4 | 15 |
| 12 | 4096 | 2 | 2 | 3 |

1. Compare direct and immediate modes of addressing.
   * Using direct addressing, the operand is a memory location which stores the data to be processed // Data has to be copied from that address to be used by the processor
   * With immediate addressing, the operand is the actual value to be used in the instruction // The operation can use it immediately as data with the instruction