

|      |                                                                                                          |   |   |   |   |   |   |   |   |
|------|----------------------------------------------------------------------------------------------------------|---|---|---|---|---|---|---|---|
| 4(a) | <b>1 mark</b> for:<br>LSL #2                                                                             |   |   |   |   |   |   |   |   |
| 4(b) | <table><tr><td>1</td><td>1</td><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td></tr></table> | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 |
| 1    | 1                                                                                                        | 1 | 1 | 0 | 0 | 0 | 1 |   |   |
| 4(c) | <table><tr><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td></tr></table> | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 |
| 0    | 0                                                                                                        | 1 | 0 | 0 | 0 | 1 | 1 |   |   |
| 4(d) | <table><tr><td>1</td><td>1</td><td>1</td><td>1</td><td>0</td><td>0</td><td>1</td><td>1</td></tr></table> | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 |
| 1    | 1                                                                                                        | 1 | 1 | 0 | 0 | 1 | 1 |   |   |

| 6(a)     | <b>1 mark</b> for each correct description, <b>max 2</b> marks <table border="1"> <thead> <tr> <th>Register</th><th>Role</th></tr> </thead> <tbody> <tr> <td>ACC</td><td>stores the intermediate results of arithmetic and logical operations<br/>// holds the result of a calculation</td></tr> <tr> <td>CIR</td><td>holds the instruction currently being decoded and/or executed</td></tr> </tbody> </table>                                                                                                                                                                                                  | Register | Role | ACC | stores the intermediate results of arithmetic and logical operations<br>// holds the result of a calculation | CIR | holds the instruction currently being decoded and/or executed |
|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|------|-----|--------------------------------------------------------------------------------------------------------------|-----|---------------------------------------------------------------|
| Register | Role                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |      |     |                                                                                                              |     |                                                               |
| ACC      | stores the intermediate results of arithmetic and logical operations<br>// holds the result of a calculation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |      |     |                                                                                                              |     |                                                               |
| CIR      | holds the instruction currently being decoded and/or executed                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |          |      |     |                                                                                                              |     |                                                               |
| 6(b)     | <b>1 mark</b> per bullet point, <b>max 2</b> marks<br>e.g. <ul style="list-style-type: none"> <li>• Latency may be increased</li> <li>• ... because the cores must communicate with one another</li> <li>• There is a potential for dead-lock situations</li> <li>• ... where one core may wait for information from other cores which in turn are waiting for the first one</li> <li>• Not all software is designed to use multi-cores</li> <li>• ... so some of the additional cores would be idle</li> <li>• Increased heat generation</li> <li>• ... which could cause damage to other components</li> </ul> |          |      |     |                                                                                                              |     |                                                               |
| 6(c)     | <b>1 mark</b> per bullet point, <b>max 3</b> marks <ul style="list-style-type: none"> <li>• DRAM requires to be refreshed/charged SRAM does not request a refresh</li> <li>• DRAM stores each bit as charge SRAM uses flip-flop to store each bit</li> <li>• DRAM is less expensive to manufacture SRAM is more expensive to manufacture</li> <li>• DRAM has slower access speeds SRAM has faster access times</li> <li>• DRAM has higher <u>storage/bit/data density</u> SRAM has lower storage/bit/data density</li> <li>• DRAM is used in main memory SRAM is used in cache</li> </ul>                        |          |      |     |                                                                                                              |     |                                                               |

| 3(a)(i)     | <b>1 mark</b> <ul style="list-style-type: none"> <li>The value of the operand is an offset value which is added to another base value to give the address from which the contents are loaded to the accumulator</li> </ul>                                                                                                                                                                                                                       |             |              |         |    |         |   |         |    |
|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------|---------|----|---------|---|---------|----|
| 3(a)(ii)    | <b>1 mark</b> per bullet point, <b>max 2</b> marks <ul style="list-style-type: none"> <li>Program counter (PC)</li> <li>Memory Data Register (MDR)</li> <li>Memory Address Register (MAR)</li> <li>Current Instruction Register (CIR)</li> <li>Status Register</li> </ul>                                                                                                                                                                        |             |              |         |    |         |   |         |    |
| 3(b)        | <b>1 mark</b> for each correct value, <b>max 3</b> marks <table border="1"> <thead> <tr> <th>Instruction</th><th>Value in ACC</th></tr> </thead> <tbody> <tr> <td>LDM #98</td><td>98</td></tr> <tr> <td>LDI 101</td><td>8</td></tr> <tr> <td>LDX 100</td><td>32</td></tr> </tbody> </table>                                                                                                                                                      | Instruction | Value in ACC | LDM #98 | 98 | LDI 101 | 8 | LDX 100 | 32 |
| Instruction | Value in ACC                                                                                                                                                                                                                                                                                                                                                                                                                                     |             |              |         |    |         |   |         |    |
| LDM #98     | 98                                                                                                                                                                                                                                                                                                                                                                                                                                               |             |              |         |    |         |   |         |    |
| LDI 101     | 8                                                                                                                                                                                                                                                                                                                                                                                                                                                |             |              |         |    |         |   |         |    |
| LDX 100     | 32                                                                                                                                                                                                                                                                                                                                                                                                                                               |             |              |         |    |         |   |         |    |
| 3(c)        | <b>1 mark</b> per bullet point, <b>max 2</b> marks for each <p>Clock Speed:</p> <ul style="list-style-type: none"> <li>Processor can perform more F-E cycles per second</li> <li>... so more instructions / data can be processed each second</li> </ul> <p>Cache Memory:</p> <ul style="list-style-type: none"> <li>Can store more of the most frequently used instructions</li> <li>... which reduces the need to access slower RAM</li> </ul> |             |              |         |    |         |   |         |    |

| 2(a)                               | <p><b>3 marks</b> for 6 correct ticks<br/><b>2 mark</b> for 4 or 5 correct ticks<br/><b>1 mark</b> for 2 or 3 correct ticks</p> <table><tr><th rowspan="2">Example of data</th><th colspan="7">Number of bits</th></tr><tr><th>4</th><th>8</th><th>16</th><th>24</th><th>32</th><th>64</th><th>128</th></tr><tr><td>the hexadecimal value F139</td><td></td><td></td><td>✓</td><td></td><td></td><td></td><td></td></tr><tr><td>16 000 000 unique amplitude values</td><td></td><td></td><td></td><td>✓</td><td></td><td></td><td></td></tr><tr><td>an IPv4 address</td><td></td><td></td><td></td><td></td><td>✓</td><td></td><td></td></tr><tr><td>256 unique colours</td><td></td><td>✓</td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>an IPv6 address</td><td></td><td></td><td></td><td></td><td></td><td></td><td>✓</td></tr><tr><td>the denary value 65 000</td><td></td><td></td><td>✓</td><td></td><td></td><td></td><td></td></tr></table> | Example of data | Number of bits |    |    |    |     |  |  | 4 | 8 | 16 | 24 | 32 | 64 | 128 | the hexadecimal value F139 |  |  | ✓ |  |  |  |  | 16 000 000 unique amplitude values |  |  |  | ✓ |  |  |  | an IPv4 address |  |  |  |  | ✓ |  |  | 256 unique colours |  | ✓ |  |  |  |  |  | an IPv6 address |  |  |  |  |  |  | ✓ | the denary value 65 000 |  |  | ✓ |  |  |  |  |
|------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------|----|----|----|-----|--|--|---|---|----|----|----|----|-----|----------------------------|--|--|---|--|--|--|--|------------------------------------|--|--|--|---|--|--|--|-----------------|--|--|--|--|---|--|--|--------------------|--|---|--|--|--|--|--|-----------------|--|--|--|--|--|--|---|-------------------------|--|--|---|--|--|--|--|
| Example of data                    | Number of bits                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                 |                |    |    |    |     |  |  |   |   |    |    |    |    |     |                            |  |  |   |  |  |  |  |                                    |  |  |  |   |  |  |  |                 |  |  |  |  |   |  |  |                    |  |   |  |  |  |  |  |                 |  |  |  |  |  |  |   |                         |  |  |   |  |  |  |  |
|                                    | 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 8               | 16             | 24 | 32 | 64 | 128 |  |  |   |   |    |    |    |    |     |                            |  |  |   |  |  |  |  |                                    |  |  |  |   |  |  |  |                 |  |  |  |  |   |  |  |                    |  |   |  |  |  |  |  |                 |  |  |  |  |  |  |   |                         |  |  |   |  |  |  |  |
| the hexadecimal value F139         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                 | ✓              |    |    |    |     |  |  |   |   |    |    |    |    |     |                            |  |  |   |  |  |  |  |                                    |  |  |  |   |  |  |  |                 |  |  |  |  |   |  |  |                    |  |   |  |  |  |  |  |                 |  |  |  |  |  |  |   |                         |  |  |   |  |  |  |  |
| 16 000 000 unique amplitude values |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                 |                | ✓  |    |    |     |  |  |   |   |    |    |    |    |     |                            |  |  |   |  |  |  |  |                                    |  |  |  |   |  |  |  |                 |  |  |  |  |   |  |  |                    |  |   |  |  |  |  |  |                 |  |  |  |  |  |  |   |                         |  |  |   |  |  |  |  |
| an IPv4 address                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                 |                |    | ✓  |    |     |  |  |   |   |    |    |    |    |     |                            |  |  |   |  |  |  |  |                                    |  |  |  |   |  |  |  |                 |  |  |  |  |   |  |  |                    |  |   |  |  |  |  |  |                 |  |  |  |  |  |  |   |                         |  |  |   |  |  |  |  |
| 256 unique colours                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | ✓               |                |    |    |    |     |  |  |   |   |    |    |    |    |     |                            |  |  |   |  |  |  |  |                                    |  |  |  |   |  |  |  |                 |  |  |  |  |   |  |  |                    |  |   |  |  |  |  |  |                 |  |  |  |  |  |  |   |                         |  |  |   |  |  |  |  |
| an IPv6 address                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                 |                |    |    |    | ✓   |  |  |   |   |    |    |    |    |     |                            |  |  |   |  |  |  |  |                                    |  |  |  |   |  |  |  |                 |  |  |  |  |   |  |  |                    |  |   |  |  |  |  |  |                 |  |  |  |  |  |  |   |                         |  |  |   |  |  |  |  |
| the denary value 65 000            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                 | ✓              |    |    |    |     |  |  |   |   |    |    |    |    |     |                            |  |  |   |  |  |  |  |                                    |  |  |  |   |  |  |  |                 |  |  |  |  |   |  |  |                    |  |   |  |  |  |  |  |                 |  |  |  |  |  |  |   |                         |  |  |   |  |  |  |  |
| 2(b)                               | <p><b>1 mark</b></p> <p>1111 1001 0100</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                 |                |    |    |    |     |  |  |   |   |    |    |    |    |     |                            |  |  |   |  |  |  |  |                                    |  |  |  |   |  |  |  |                 |  |  |  |  |   |  |  |                    |  |   |  |  |  |  |  |                 |  |  |  |  |  |  |   |                         |  |  |   |  |  |  |  |
| 2(c)                               | <p><b>1 mark</b></p> <p>1111 0010</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                 |                |    |    |    |     |  |  |   |   |    |    |    |    |     |                            |  |  |   |  |  |  |  |                                    |  |  |  |   |  |  |  |                 |  |  |  |  |   |  |  |                    |  |   |  |  |  |  |  |                 |  |  |  |  |  |  |   |                         |  |  |   |  |  |  |  |
| 2(d)                               | <p><b>1 mark</b></p> <p>E33B</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                 |                |    |    |    |     |  |  |   |   |    |    |    |    |     |                            |  |  |   |  |  |  |  |                                    |  |  |  |   |  |  |  |                 |  |  |  |  |   |  |  |                    |  |   |  |  |  |  |  |                 |  |  |  |  |  |  |   |                         |  |  |   |  |  |  |  |

11(a)

**One mark per mark point (Max 6)**

MP1 LDM #100 seen

MP2 Correct use of STO with labelled address (constant or answer)

MP3 Correct use of LDD 632

MP4 Correct use of SUB with labelled address (constant)

| Opcode | Operand  |
|--------|----------|
| LDM    | #100     |
| STO    | Constant |
| LDD    | 632      |
| SUB    | Constant |
| STO    | Answer   |

MP5 Storing 100 at a labelled address away from the code

MP6 Labelling both addresses away from the code.

| Label     | Contents |
|-----------|----------|
| Constant: | 100      |
| Answer:   |          |

11(b)

-55