1.1.2 Types of Processors

1 CPUs can be designed to take a CISC or a RISC approach.

(a) Describe the characteristics of RISC and CISC processors.

[2 marks]

- **RISC – Reduced instruction set computing**
- **CISC – Complex instruction set computing**
- **RISC processors have a smaller instruction set / CISC processors have a larger instruction set**
- **RISC processors have a faster execution speed / CISC processors have a slower execution speed**
- **Program on a RISC machine use more RAM / Programs on a CISC machine use less RAM**

(b) Identify **one** situation in which a **RISC** processor would be a more appropriate choice, and **one** situation in which a **CISC** processor would be a more appropriate choice.

[2 marks]

- **RISC is typically used in smartphones / tablets / embedded devices**
- **CISC is typically used in desktop / laptop / mainframe computers**

2 Explain why using a RISC processor rather than a CISC processor is likely to result in increased battery life.

[2 marks]

- **RISC has a smaller instruction set than CISC.**
- **Requires fewer transistors / less complex circuitry.**
- **Means less power is required.**

3 A photo frame has a RISC processor. Describe **one** advantage to the company of using a RISC processor, rather than a CISC processor.

[2 marks]

Advantage

- **Costs less to produce**

Because

- **Requires less cooling to be built in**
- **If battery powered, can run off a smaller battery**
- **Has smaller instruction set than a CISC processor**
- **Simpler circuitry to design/manufacture**
- **Fewer transistors**

4 A charity has several desktop computers in their office that use a CISC processor. They are considering buying mobile devices for their staff to use when they are not in the office. Discuss whether these mobile devices should use the same CISC processors that are used in their desktop computers or if they should use a RISC processor instead.

You should include the following in your answer:

- The difference between each processor type
- The suitability of each processor type for mobile devices.

[12 marks]

Answers may include, but are not limited to, some of the points below.

- **CISC is a complex instruction set. The traditional approach to processor design. Lots of instructions available although some instructions in CISC will rarely get used.**
- **RISC is a reduced instruction set. A smaller number of instructions available, several instructions can be combined to perform the same tasks as CISC processors. RISC instructions are used regularly.**
- **RISC has fewer transistors/less complex circuitry whereas CISC integrated circuits are more expensive/complicated.**
- **RISC instructions take one cycle whereas CISC may take several.**
- **RISC can only do complex things by combining multiple instructions whereas CISC is done in one line.**
- **Compilers for RISC need to be more complex than compilers for CISC**

- **CISC processors would run the same software as the desktop machines. Would be less power efficient and require larger battery and cooling mechanisms. More expensive to purchase.**
- **RISC processor requires software to be written specifically for it (cannot use CISC instructions). More power efficient and so requires less/no cooling and smaller battery/longer battery life.**
- **RISC devices may require greater RAM as programs tend to be larger than their CISC equivalents.**

- **Mobile use of CISC would save money on software and increase compatibility but cost more to purchase and be physically larger (heat sink/larger battery) and/or have a shorter battery life.**
- **RISC would require investment in software but be cheaper to purchase and give a better performance out of the office (lighter/longer battery life). Some compatibility issues may be reduced with emulators and translators.**

5 An architect business specialises in designing houses.

(a) The business uses high end computers with powerful GPUs.

Give two uses the business might have for GPUs.

[2 marks]

- **Rendering models of buildings**
- **Run CAD (computer aided design) software**
- **For computing modelling calculations**
- **Any sensible example related to buildings**

6 Describe **one** non-graphical use an insurance company may have for a GPU.

[2 marks]

- **Perform complex calculations**
- **E.g. modelling risk, calculating bills**

7 A game console has a CPU and GPU. It uses the GPU for 3D graphics. Explain why a GPU is more suitable than a CPU for this task.

[3 marks]

- **CPUs are general purpose processors**
- **Whereas GPUs are designed specifically for graphics**
- **So likely to have built-in circuitry for common graphics operations**
- **GPUs are built with many processors working in parallel**
- **Which is beneficial when many mathematical calculations are needed (e.g. transforming points in a polygon**
- **Meaning it can perform transformations to onscreen graphics quicker than a CPU**

8 Define the term 'multicore processor'.

[2 marks]

- **More than one processing unit in a single processor**
- **Which can independently process instructions at the same time**

9 The Government Communications Headquarters (GCHQ) is responsible for monitoring communications in order to keep the UK secure. A large part of its job involves trying to break into encrypted messages.

(a) The code breakers at GCHQ have access to supercomputers (computers with many processors).

Describe why a supercomputer will be useful to GCHQ.

[2 marks]

- **The CPUs can work in parallel**
- **… on the same problem**

- **Try to break multiple key simultaneously**
- **… to break the code**

10 Some problems require a large amount of computing power that goes well beyond a single CPU.

Discuss the different approaches that can be taken to provide increasingly larger amounts of computing power and the types of problem they are suited to.

[12 marks]

Answers may include, but are not limited to, some of the points below.

- **Processors have increasingly large clock speeds and can be overclocked.**
- **Processors can have multiple cores.**
- **Super computers can have multiple processors (and GPUs).**
- **GPUs can be applied to problems other than graphics processing. Problems can be distributed across a number of computers working together.**

- **Having multiple cores can speed up smaller problems but this will not be enough for larger problems. Supercomputers are prohibitively exceptionally expensive to buy and run for all but large organisations.**
- **GPUs are becoming a cost efficient way of tackling problems.**
- **GPUs tend to have large number of cores so can run on highly parallelisable problems**
- **…but only where the same instruction is being applied to multiple pieces of data (SIMD)**

- **Increased clock speed is limited to smaller problems. Even doubling the clock speed would only halve the time taken.**
- **Parallel processing isn't suited to all problems. Most problems are only partially parallelisable. Writing algorithms for parallel processing is more challenging**
- **GPUs suited to a subset of science/ engineering problems where the same calculation is repeated on multiple data sets**