1(a) A car has a ‘Follow Me’ system that uses a cruise control feature to allow the car to follow the car in front of it. It will keep the same speed and distance without the driver’s intervention. The cruise control system is an example of an embedded system.

Explain the reasons why the ‘Follow Me’ system is an example of an embedded system.

---

[3]

(b) The car's system has Read Only Memory (ROM) and Random Access Memory (RAM).

i. State **two** items that will be stored in the ROM for the 'Follow Me' system.

1 ---

2 --- **[2]**

ii. The RAM will store currently running data and instructions.

State **three** items of data that will be stored in the RAM for the 'Follow Me' system.

1 ---

2 ---

3 --- **[3]**

iii. Explain why the 'Follow Me' system does not need virtual memory.

--- **[2]**

2 A car comes with many embedded systems, for example parking sensors.

Identify **one** other embedded system that could be found in a car and explain why this is an embedded system.

Example embedded system ---

Explanation ---

--- **[3]**

3 Ali's tablet computer has an operating system.

Ali thinks his tablet is an embedded system.

State whether Ali is correct or incorrect, justifying your choice.

Choice _____

Justification _____

_____

_____

_____

_____

_____

[3]

4 The following paragraph describes embedded systems.

Complete the paragraph by selecting terms from the list and writing them in the correct places. Not all terms are used.

actuator	applications	change	functions	laptop	larger
lights	microprocessor	processor	range	smaller	washing machine

Embedded systems have limited ..... They are often

built into a ..... machine. Two examples of embedded

systems are a ..... and automated

..... in a car.

[4]

5(a) A satellite navigation system (Sat Nav) uses RAM and ROM.

The Sat Nav contains an embedded system. Define what is meant by an 'embedded system'.

_____

_____ [1]

(b) Identify **three** devices, other than a Sat Nav, which contain embedded systems.

1 _____

2 _____

3 _____

[3]

6 Xander's tablet computer comes with system software, including an operating system and utility system software.

Xander also has a smart watch.

i. Tick (✓) **one** box to show whether the smart watch or the laptop is an example of an embedded system.

	Is an example of an embedded system
Smart watch	
Laptop	

[1]

ii. Justify your choice to **part (i)**.

_____

_____

_____

_____

_____

_____

_____ **[2]**

7(a) Gareth's Sat Nav contains an embedded system. Define what is meant by an 'embedded system'.

---

[1]

(b) Identify **three** devices, other than a Sat Nav, that contain embedded systems.

---

[3]

END OF QUESTION PAPER

Question			Answer/Indicative content	Marks	Guidance
1	a		1 mark each to max 3 • Has a specific purpose // it only performs one/limited task // dedicated to the Follow Me system • Built within a larger device/car • Dedicated/specific/its own hardware / sensors • Has a microprocessor • Built-in operating system/software // software is all in firmware/ROM • … it's instructions/operation does not/is hard to change/update • It is a control system // it is automated	3	MP2 BOD reference to it being 'built into' 'something' reasonable Examiner's Comments This question required candidates to apply their understanding of embedded systems to a different system. Candidates were often able to identify the key features of embedded systems that were relevant to this scenario. The most common points being that the system has a single purpose. Some candidates also identified that the system is built within a larger system, being the car. Fewer candidates were able to provide a third point. Those that did most commonly identified the dedicated hardware or gave an example such as the sensors are only providing data for this system.
	b	i	1 mark each to max 2 • Start-up instructions // BIOS // bootstrap // where to find the OS • Firmware // Program/instruction to run the Follow Me system // Instructions for operation • Example of data being stored e.g. the maximum speed, the min distance • Operating System // OS	2	MP2 'programs' on its own is NE MP3, Allow two marks for examples of instructions or data. For example both marks can be given for: 1 – The maximum speed 'Follow Me' can operate 2 – The minimum distance the car in front can be Examiner's Comments Many candidates were able to identify that ROM stores the start-up instructions or gave an example of these instructions. Some candidates were also able to identify that an embedded system runs firmware, or gave a description of the program for this system being stored in the ROM.

Question			Answer/Indicative content	Marks	Guidance
		ii	1 mark each to max 3 e.g. • Current distance from car in front • Set distance from car in front • Current speed of vehicle • Current speed of vehicle in front • Reading from sensor • Driver actions (e.g. moving wheel/braking) • Direction the car (in front) is travelling (e.g. turning)	3	'speed' or 'distance' on its own is NE BOD reference to a camera taking images of what is in front <u>Examiner's Comments</u> Candidates were told that the system stores currently running data and instructions in RAM and required an application of that data to the given scenario. The most common responses related to the speed of the car and the distance between the cars. Some candidates identified that the speed of the car in front was stored as well as the current speed of that car. Some candidates identified other data that could be stored in the RAM, for example whether the driver has control, if the system is currently active as well as data that would be needed to identify which car is being followed.
		iii	1 mark each to max 2 • Only stores a small amount of data in RAM // only stores specific/few items in RAM • … unlikely to run out of RAM // there is enough space in RAM • No secondary storage to use/needed as VM • Few/one program/instructions running at a time // no memory intensive tasks • Dedicated hardware will be optimised for system // RAM is designed to meet the system's requirements	2	<u>Examiner's Comments</u> Many candidates were able to identify that VM is used when a system is short of RAM, they were then able to apply this to the given system, i.e. that the current system will not run out of RAM. Some candidates expanded this by also identifying that very few data items would be stored in RAM. Some of the stronger responses included an acknowledgement that the embedded system is unlikely to have secondary storage and therefore cannot create VM.
			Total	10	

Question			Answer/Indicative content	Marks	Guidance
2			1 mark for example: e.g. • Auto lights • Auto window wipers • Sat nav // GPS • Airconditioning // climate control • Radio/entertainment/infotainment system/media system • Lane assist • Engine management system • Auto-park • Cruise control • Auto-brake • Follow-me • Dashcam 1 mark each to max 2 for explanation. • **Limited** functions // by example e.g. the system **only** checks the light and turns lights on/off • **Dedicated** microprocessor // by example e.g. there is a microprocessor that is only checking the lights • Hard to change function // by example e.g. the user cannot make the light system do any other role	3	Allow anything that could be reasonably within a car. If example is not clear if it's an embedded system, read explanation for justification e.g. hazard lights – could be embedded if they are activated automatically when the car crashes. Award the example in the explanation if this occurs. If justification is generic features of an embedded system max 1 for explanation. Do not award 'built into the car/larger machine' because this is in the question. <u>Examiner's Comments</u> This question required candidates to consider embedded systems within a car. There were a range of possible systems, the most common being GPS or satellite navigation systems. Other common responses included automated lights, automated wipers, and parking sensors. The most common explanation was that the system has a single (or limited) purpose, but few candidates expanded beyond this. Some candidates repeated that it was built into the car but this was provided in the question. Some candidates provided examples of embedded systems such as a washing machine, a microwave and a fridge/freezer. This was not appropriate to the context of the question.
			Total	3	

Question			Answer/Indicative content	Marks	Guidance
3			1 mark per bullet to max 3 e.g. Incorrect: • Embedded system has one/few functions • …tablet has multiple functions // tablet is general purpose • Embedded system is single chip • …tablet has multiple chips combined • Embedded system is part of a larger system • … tablet is a self-contained system • You can update the software Correct: • Embedded system has one/few functions • ….the tablet may only be able to perform a small number of tasks • …tablet has a specific purpose • …tablet's hardware is fixed • …does not need/require/allow expansion • Embedded systems has firmware • ..you cannot update the OS in a tablet (usually) • Embedded system is part of a larger system • …tablet may have one microprocessor built into it	3	Max 2 if there is no application to the tablet
			Total	**3**	
4			1 mark for each completed term Embedded systems have limited **functions.** They are often built into a **larger** machine. Two examples of embedded systems are a **washing machine** and automated **lights** in a car.	4	
			Total	**4**	

Question			Answer/Indicative content	Marks	Guidance
5	a		• A computer system that is built into another device	1 (AO1 1a)	
	b		Three devices from: e.g. • Dishwasher • MP3 player • Washing machine • Mobile phone • Manufacturing equipment	3 (AO1 1a)	1 mark to be awarded for each correct example identified to a maximum of 3 marks. There are many other examples of devices with embedded systems which may be acceptable.
			Total	4	
6		i	Smart watch	1 AO2 1a (1)	CAO <u>Examiner's Comments</u> This question was answered correctly by the majority of candidates who were able to identify that a smart watch is an example of an embedded system.
		ii	1 mark per bullet for justification to max 2 • A smart watch is not a <u>general-purpose computer</u> • … which means the smart watch has one/limited/specific/dedicated function(s) • Smart watch has a microprocessor • … on a single circuit board • It is a computer system that is built within the watch • Runs firmware • Smart watch has built-in OS // difficult to change/manipulate the OS/function • Smart watch has few components all essential to its purpose • Smart watch has specific hardware required to function i.e. speaker/headphones	2 AO2 1b (2)	• Answers must be applied to scenario. Do not award generic definitions. • Allow opposite reasons for why a laptop is not an embedded system but do not allow repeated points. <u>Examiner's Comments</u> Candidates were able to gain marks for explaining why a smart watch is an embedded system or why a laptop is not or a combination of the two. The most common answers referred to the limited features of a smart watch, while a laptop is a general-purpose computer that can perform any number of tasks. Some candidates gave a generic definition of an embedded system which was insufficient because the question required candidates to apply their knowledge to the scenario.
			Total	3	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
7	a		• A computer system that is built into another device	1	
	b		Three devices from: • Dishwasher • MP3 player • Washing machine • Mobile phone • Manufacturing equipment	3	1 mark to be awarded for each correct example identified to a maximum of 3 marks. There are many other examples of devices with embedded systems which may be acceptable.
			Total	4	