

5(a)	Any three from: • A mechanical structure/framework • Electrical components • ... such as sensors/microprocessor/actuators • Programmable • Has the ability to move
5(b)	Two from (one for benefit and one for matching explanation): For example: • Supermarket may gain more customers • ... as elderly people who could not previously make it to the store can now shop there • ... which will increase their sales/profits • Supermarket can serve customers more efficiently • ... as multiple orders can be delivered at the same time
5(c)	Two from (one for drawback and one for matching explanation): For example: • They may get less exercise • ... as they no longer need to walk to/round the store to get their shopping • ... that could negatively affect their health • They may struggle to use technology // may mistrust technology // would prefer an employee/person to deliver it • ... and this may cause additional stress/anxiety • ... leading to making mistakes in receiving the delivery
5(d)	A
5(e)	Any three from: For example: • It could learn the route to a customer's house • It could learn where there are obstacles on a route • It could learn to deal with obstacles more effectively • It could reason which parts of the route are paths and which are roads • It can use machine learning • To identify patterns in the route data

8(a)	Any one from: • It has electrical components. // by example • It is programmable. • It can move.
8(b)	Any one from: • Permanent instructions/software that are programmed into/stored in the ROM. • Instructions/software that allow hardware to be controlled/managed. • Instructions/software that provides the operating system with a platform to run on.
8(c)	Any two from: Examples: • user input // by example • encountering an obstacle • emergency stop • hardware error • software error • battery low • component overheating • two processes accessing the same location
8(d)	Any two from: Examples: • Workers don't need to lift heavy machinery • The workers are less likely to injure themselves • The workers don't need to be in any dangerous environments in the factory • The workers don't need to perform boring/repetitive tasks such as moving car parts • Workers can focus on having higher expertise skills • Create new jobs for workers to maintain the robots.
8(e)	Machine learning

8(a)	The robot can perform actions without human intervention
8(b)	Any three from: - It has a mechanical structure/framework - It has electrical components - It is programmable - It can move
8(c)	Any six from: - A proximity sensor is used - The sensor continuously sends digitised data to the microprocessor - The microprocessor compares the data to a stored value/range of values - If the value is within the range/matches the robot continues planting - If the value is above/below/outside the range a signal is sent by the microprocessor to turn/stop the robot ... using an actuator to turn/stop the robot - This process repeats until the robot is turned off
8(d)	Any two from: Example: - The robot is more accurate when planting seeds - The robot does not need to take breaks // works 24/7 - The robot will not get bored of performing a repetitive task - The farmer can perform other tasks whilst the robot is planting the seeds - The robot may be faster/more efficient (at planting seeds) - Safer as the robot can work in a more dangerous environments (e.g. with animals in a field) - Doesn't need to pay labour costs/wages
8(e)	Any two from: Example: - The robot may have been expensive to purchase - The robot may need maintenance and this may be costly - The robot may take away jobs from humans that previously planted the seeds - Farmer/workers may be deskilled - Farmer may need training in how to use the robot - If it breaks the farmer will need to manually plant - If faulty it may cause damage to farm/seeds - Cannot adapt to a new/unexpected event
8(f)	Any two from: Example: - The robot can now adapt itself by changing its own rules/data/ processes - The robot will become more efficient ... as it has a greater knowledge of its surroundings/environment ... as it can remember where a fence is ... as it can remember the route it needs to take ... as it can remember where any obstacles are to avoid ... as it can remember where to start and stop sowing seeds ... as it may make fewer errors

9(a)	Any two from: - It has a mechanical structure/framework - It has electrical components // by example
9(b)	Any two from: e.g. - Employees don't need to lift heavy furniture - Employees can be protected from dangerous tasks - Employees can utilise their skills in other tasks - Employees don't need to perform repetitive/mundane tasks

9(c)

Any **one** from:

e.g.

- Expensive to **install/purchase/setup**
- High ongoing costs/maintenance costs
- May deskill the workforce
- If they malfunction, production may stop

6(a)	One mark each			
	Movement	Binary	Denary	Hexadecimal
	forward 1 step	00011111	31	1F
	back 1 step	10001100	140	8C
	turn right	01011010	90	5A
	turn left	(0)1111000	120	78
6(b)	Any two from: • The design of robots (to perform tasks/operations/functions) • The construction of robots (to perform tasks/operations/functions) • The operation of robots (to perform tasks/operations/functions)			

6(c)	Seven from: • Uses an infra-red/proximity sensor • Sensor continuously sends the digitised value/reading/distance to the microprocessor • Microprocessor compares the data/signal to the stored value of 10(cm) • If the data/signal is greater than the stored value/10 ... • ...a signal is sent to make the robot move forward • If the data/signal is less than or equal to the stored value/10 ... • ...a signal is sent to make robot turn • An actuator is used to make the robot turn/move forward • The whole process repeats continuously until turned off/stopped
6(d)(i)	Any three from: e.g. • Collects data • Stores rules for using the data • The ability to reason • The ability to learn // uses machine learning • ... by adapting what it does • ... for example, from mistakes to not make them again // result from previous decisions impacts future • ... by changing its own rules • ...by changing its own data • ...by being trained • Makes one or more predictions (to make a decision) • Find/analyse patterns
6(d)(ii)	Four from: e.g. • Use machine learning algorithms • Collects data about where it has been • Collect data about obstacles/problems • Store successful actions • Stores unsuccessful actions • Identify/store patterns • ... to make sure it does not repeat the same incorrect route • ... so, it knows how to react to obstacles next time • ...so, it knows what is most likely to work next time