Question	Answer	Marks
10(a)	Any **one** from: – The ability to learn/adapt // machine learning abilities – The collection of data and the rules for using that data – The ability to reason // has problem solving abilities // makes predictions – Simulates intelligent/human behaviour – Analyses patterns	1
10(b)	Any **six** from: – It has an interface … – … used to input data/view output – It has a knowledge base – It has a rule base – It has an inference engine – Applies the rule base to/and the knowledge base to provide output/diagnosis/result/solution/decision – Decides what to ask next based on the data input	6

Question	Answer	Marks
11(a)	– Amount of liquid/gas/steam flowing/moving through an environment	1
11(b)	**Two** from (for benefit and matching description) e.g.: – Increases safety – …meaning that workers do not need to go into dangerous areas to collect data/make checks/do dangerous tasks – Can increase jobs/skills – …as employees are needed to learn/maintain the equipment – No need to do repetitive tasks – … so, they can use their time on other/more skilled tasks	2
11(c)	**Two** from (for drawback and matching description) e.g.: – High **set-up/installation** costs – … it would mean the company need to find a lot of money up front to pay for the equipment // employees will need training – Utility/maintenance/repair costs – … increase in bills such as electricity // skilled employees will be required to maintain the system // equipment will break/need updating – Deskilling of the workforce – … may mean that workers will no longer have the skills for some of the manufacturing jobs, should the equipment break	2

Question	Answer	Marks
10(a)	**One** mark for each correct term, in the correct order: – Knowledge base – Inference engine – Rule base // knowledge base – Knowledge base // rule base – Interface	5

Question	Answer	Marks
10(b)	Any **four** from: e.g. – It is a form of artificial intelligence – Means it can adapt/change (its own processes) // It can edit its own algorithms – It can edit its own data – It can be trained – … this can be supervised/unsupervised – … meaning it can learn with/without human interaction – Analyses patterns and stores **successful/unsuccessful** results … – … to influence future decisions – (Supervised) means a user tells the system the input and output – (Unsupervised) means the system is given the input and needs to work out the output	4

Question	Answer	Marks
9(a)	Any **two** from: • It has a **mechanical** structure/framework • It has **electrical** components // by example	2
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	2

Question	Answer	Marks
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	1

Question	Answer	Marks
9(a)	**Three** from: • Rule base • Knowledge base • Interface	3
9(b)	Any **two** from: • It makes decisions • … by **applying** the rules/logic to the facts/knowledge … • … to provide a result/diagnosis	2

6.1 – 6.3 Automated & Emerging Technologies
ANSWERS

Question	Answer	Marks
7(a)	• Interface • Knowledge base	2
7(b)	Any **two** from: • **Stores** the rules for the system • … for the inference engine to use • Used to link the facts in the knowledge base	2

Question	Answer				Marks
6(a)	One mark each				4

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

Question	Answer	Marks
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)	2

Question	Answer	Marks
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	7
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	3
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	4

6.1 – 6.3 Automated & Emerging Technologies
ANSWERS

Question	Answer	Marks
2(a)	**Six** from: • Motion/proximity/infra-red sensor is used • Sensor sends data to microprocessor • Data is converted from analogue to digital (using ADC) • Data is compared to **stored/set** value(s) • If data is **inside range/outside range/greater than/less than**, **signal** is sent to turn water tap on • If data is **outside range /inside range/less than/greater than**, tap remains off / **signal** is sent to turn water tap off • Actuator is used to turn the tap off/on • Whole process is continuous	6
2(b)	**One** mark for each correct sensor <table><tr><th>Description of system</th><th>Sensor</th></tr><tr><td>it checks the air is dry enough in a garage that spray paints cars</td><td>Moisture/humidity</td></tr><tr><td>it automatically switches on the headlights on a car when it is dark</td><td>Light</td></tr><tr><td>it checks that the soil in a greenhouse has the correct level of acidity</td><td>pH</td></tr></table>	3

Question	Answer	Marks
6	Any seven from: • (Motion) sensor sends signals to microprocessor • analogue signal is converted to digital • microprocessor compares signal to stored value … • …if it does not meet / meets the stored value (and if camera is not recording) the microprocessor sends signal (to camera) to start recording • … if it does not meet / meets the stored value the microprocessor starts/resets the **timer** • When the **timer** reaches 2 minutes the microprocessor sends signal (to camera) to stop recording • Whole process is repeated continually/until turned off	7

Question	Answer	Marks
9(a)	One mark per each correct sensor. | Task	Sensor
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checking the water is 30 °C	**Temperature**
checking the water acidity level after detergent is added	**pH**
checking the weight of the clothes to make sure that the machine is **not** overloaded	**Pressure**		3
9(b)	**Six** from: – Sensor sends data to microprocessor – Data is converted from analogue to digital (using ADC) – Data is compared to stored value (of 30) If data is below 30 then a **microprocessor sends signal** is sent to a heater to heat the water up/add hot water – if data is above 30 then a **microprocessor sends signal** is sent to turn the heater off to allow the water to cool down/add cold water – Actuator used to turn headset on/off // Actuator used to add water – If data is 30 then no action is taken – It is a continuous process	6

Question	Answer	Marks
8	**Seven** from: – Timer is started – Pressure sensor (within each mat) – Sensor sends data to microprocessor – Analogue data is converted to digital (using ADC) – Microprocessor compares data to stored value(s) – If data matches / in/out range **microprocessor** stops timer – If data matches / in/out range **microprocessor** checks if **data has come** from **correct** colour mat **sensor** – If data matches / in/out range **microprocessor** checks to see if **timer** is stopped at less than 1 second – If data matches / in/out range **microprocessor** increments counter if timer is less than 1 second and colour/mat is correct – If correct colour/mat is hit, timer is reset and the whole process is repeated – If **data has not come** from the **correct** colour mat **sensor** the game ends	7

Question	Answer	Marks
5	**Eight** from: – Sensor send data/readings/signal to microprocessor – Data is converted from analogue to digital (using ADC) – Microprocessor compares/checks data to stored values/range of values … – … If data is greater than 30 / above the range microprocessor sends **signal** to open window and to turn heater off – … If data is below 25 the microprocessor sends **signal** to turn on heater and to close window – … If data is between 25 and 30 / within the range no action taken – Actuator is used to operate heater/window – **Whole** process is continuous	8

Question	Answer	Marks
9(a)	One mark per each correct sensor | Task	Sensor | |---|---|
Check if a vehicle is too high	**Infrared/light**
Count the vehicles entering the car park	**Magnetic field // pressure**
Check if a vehicle is parked in a parking space	**Pressure // magnetic field // infrared/light**		3

Question	Answer	Marks
9(b)	**Six** from: – Sensor sends data to microprocessor – Data is converted from analogue to digital (using ADC) – Data is compared to stored value … – … If data is greater than stored value microprocessor sends signal to turn red light on and the green light off – … If data is less than stored value microprocessor sends signal to turn green light on the red light off – … If data still within range, no action taken/existing light remains on – Lights turned on/off using actuator – Process is continuous	6