1	1	**Marks are for AO2 (analyse)** **Level of response question**	9

Level	Description	Mark Range
3	A line of reasoning has been followed to produce a coherent, relevant and substantiated and logically structured response. The response covers at least three of moral, ethical, legal and cultural issues. In these areas there is sufficient detail to show that the student has a good level of understanding of the issues faced by the programmers. A good level of understanding would be indicated by at least seven substantiated points being made.	7-9
2	A line of reasoning has been followed to produce a mostly coherent, relevant, substantiated and logically structured response that covers at least two of moral, ethical, legal and cultural issues. At least four valid points must have been made showing reasonable understanding of the issues faced by the programmers.	4-6
1	A few relevant points have been made but there is no evidence that a line of reasoning has been followed. At least one of moral, ethical, legal and cultural issues must be covered. Links to the programmer may be tenuous.	1-3

Note: The following notes are indicative content only and should not be used as a checklist.

Moral:

- The developers may have to take on board the responsibility should an accident occur.
- The developers may need to develop systems that cause the vehicle to make moral decisions in times of crisis e.g. if a crash is inevitable, what does the vehicle choose to crash in to.
- The developer will have to accept that they are perpetuating or increasing use of vehicles which may have a negative impact on the environment.
- The ability to keep them protected from hackers who might want to take over their controls while someone is on-board.

Ethical:

- The developer may be putting taxi drivers out of business.
- By developing self-driving taxis, other similar businesses may follow suit causing further ethical considerations.
- Customers may not realise the taxi is computer-controlled until they enter the vehicle leaving them in a dilemma.
- If a customer is taken ill the taxi may not be able to deal with the situation.

		Legal - Legal responsibility for accidents may be called into question. - If videos/images are taken during driving these may infringe the privacy of the occupants. - Passengers may find it easier to defraud or not pay the taxi company. **Cultural:** - Some cultures may dislike the assignation of human virtues on machines. - The culture of the 'cabbie' may be damaged. - As most accidents are caused by driver error and so the use of driverless cars, in theory, would improve safety. How can the public be persuaded of this? - Driverless cars would, in theory, reduce congestion and so how can this be communicated to improve uptake?	

2		**Marks are for AO2 (analyse)** **Level of response question**	9

Level	Description	Mark Range
3	A line of reasoning has been followed to produce a coherent, relevant and substantiated and logically structured response. The response covers at least four arguments, some of which have been expanded upon. Answers must cover both ethical and legal arguments.	7–9
2	A line of reasoning has been followed to produce a mostly coherent, relevant, substantiated and logically structured response that covers at least four points (any mix of arguments and expansion points). Answers must cover both ethical and legal arguments.	4–6
1	At least one argument has been made, possibly with an expansion point but there is no evidence that a line of reasoning has been followed.	1–3

Examples could include:

Ethical

- Law enforcement officers may see disturbing images/messages on the phone which could affect the way they feel.
- This may be seen as a breach of privacy.
- Personal data such as photos of family may be lost.
- Law enforcement officers may misuse the phones for their own purposes.
- Law enforcement officers may be able to use the phone to contact (potential) victims and offer support.
- Law enforcement officers may use the phones to perform “stings” on other criminals.
- The ethical issue is one of creating "a slippery slope." If the law enforcement officers are granted access in this case, where will it stop? Will foreign governments have similar access – or the right for the encrypted data to be shared
- This could cause increased conflict between law enforcement officers and the public.
- People may have private photos/data which while legal may go against their culture or the cultural beliefs of the law enforcement officer.
- Breach of trust between manufacturer and client (count as legal if contract rather than trust).

Legal

- Relevant legislation identified with reference to personal information or privacy.
- Law enforcement officers may be able to make a decision not to press charges based upon evidence on the phone // May have to let people they believe to be guilty go free if they cannot access data.
- This may be in breach of (human rights of) privacy.
- Law enforcement officers may be able to use the data to solve other crimes.
- Law enforcement officers may be able to use the data to prevent further criminal activity.
- Allowing access to encrypted information stored on the phone may undermine the very freedoms and liberty that the law is meant to protect.
- Providing access to phones may also create a vulnerability that hackers (from hostile countries) can exploit.
- A legal issue when a judge gives permission for a phone’s encrypted data to be accessed and it can’t/it is refused.
- If we have the technology to prevent terrorist attacks by gaining valuable data from the attackers’ electronic devices then access to encrypted data should be allowed.
- The police may not keep the data as secure as the user wants.
- Law enforcement officers may edit the data on the phone.
- What level of authority/who is needed to give permission to a law enforcement officer to access data?
- Manufacturers may be breaking the law by refusing to allow access.

Students may be awarded marks for individual issues or expansions upon issues.

Expansion points may include further details on how the issue may arise or the impact of the issue occurring. Examples of expansion points could include:

- Law enforcement officers may accidentally lose data through inexperience.
- While it may be a breach in human rights privacy, this may be outweighed by lives saved.
- If personal data is lost, the owner of the phone may lose income from missed business appointments.

3	1	**9 marks are for AO2 (analyse)** **Level of response question** **Examples could include:** **Note:** Some points may fit under more than one heading. These have been indicated with a #. **Moral/Ethical** • It is unethical to collect data about people without them knowing what the data is to be used for. # • It is unethical to have residents wear a device if they don't have a full understanding of its capabilities. • If the device is in testing, it may not be as reliable as the PERS devices. • The observers may watch the streams for reasons other than monitoring. # • It may not be ethical to have your actions monitored in more detail than just your essential life signs. • Could be an invasion of privacy. # • Who controls the data? Should a resident be able to press a button to stop the recording? • Need to consider exactly what data should be recorded/stored. # **Legal** • Will the data be stored securely? # • If the data is being life blogged, who will be able to see it? • Will the data be stored in compliance with the data protection regulations? • Who will be responsible if the devices go wrong and someone dies? # • Will the data be shared with doctors? • What happens if the observers see something (eg an illegal act) being carried out on the life blogger cameras? # • How long will data be stored?	9

Level	Description	Mark Range
3	A line of reasoning has been followed to produce a coherent, relevant, substantiated and logically structured response. The response covers a wide range of issues that are consistently explained and/or supported by examples. Answers may cover moral/ethical, legal and cultural arguments or examine a smaller range of arguments in depth.	7–9
2	A line of reasoning has been followed to produce a mostly coherent, relevant, substantiated and logically structured response that covers a range of issues that are sometimes explained and/or supported by examples. Answers will cover a range of arguments in some depth.	4–6
1	There is little evidence that a line of reasoning has been followed. The response covers a small number of issues that are generally not explained nor supported by examples. Answers lack range and depth.	1–3

- Can monitor staff/visitors via camera in case of abuse allegation. #
- Do visitors need to be told about cameras? #
- What happens to data when the resident dies? How long can the data be kept for?
- Can next of kin get access to data?
- Who owns the data – the company/home/residents? #
- In what country will the data be stored?

Cultural

- Some people from some cultures may not like being videoed (particularly without their knowledge).
- Residents may not want staff of the opposite gender viewing images of them in certain situations. #

Examples of points covered in depth

Issue	**Explanation/Depth**
It is unethical to collect data about people without them knowing what the data is to be used for	As it could be used for something that they do not want/agree with or make them vulnerable in some way
It is unethical to have residents wear devices if they don't have a full understanding of its capabilities	People cannot agree to wear something that records so much data if they do not know what it does
If the device is in testing, it may not be as reliable as the PERS device	System might fail or send incorrect data if there are problems

<table>
<tr><th>Qu</th><th>Pt</th><th>Marking Guidance</th><th>Marks</th></tr>
<tr><td>4</td><td></td><td>
Marks are for AO2 (analyse)

Level of response question:

<table>
<tr><th>Level</th><th>Description</th><th>Mark Range</th></tr>
<tr><td>4</td><td>A line of reasoning has been followed to produce a coherent, relevant, substantiated and logically structured response. Answers in this level will demonstrate a clear justification of the use of lossy compression and will show a developed awareness of how the benefits of lossy compression are related to one another. The response covers all four aspects (lossy, ethical, legal, cultural) of the question. A range of the points made will have been expanded upon using clear examples and references to real world implications.</td><td>10–12</td></tr>
<tr><td>3</td><td>A line of reasoning has been followed to produce a coherent, relevant, substantiated and logically structured response. Answers in this level will address the use of lossy compression but there may not always be a clearly demonstrated understanding of the benefits. The response covers at least three aspects (lossy, ethical, legal, cultural) of the question. Some of the points made will have been expanded on and some of these will have been expanded upon using examples but these might not always exemplify the points made or be lacking in references to real world implications.</td><td>7–9</td></tr>
<tr><td>2</td><td>A line of reasoning has been followed to produce a mostly coherent, relevant, substantiated and logically structured response. The response lists some issues that are likely to focus on only two or three aspects (lossy, ethical, legal, cultural) of the question. Some of the points made will have been expanded upon but are likely to be lacking in clear examples or may not wholly relate to the points being made.</td><td>4–6</td></tr>
<tr><td>1</td><td>There is no evidence that a line of reasoning has been followed. Answers in this level may identify a point relating to the use of lossy compression but this part of the question may not be addressed at all. The response will attempt to identify some issues raised by the question; points are not likely to be expanded upon but where they are, the examples will be irrelevant or not relate to the points being made.</td><td>1–3</td></tr>
</table>

Indicative Content

Justifying lossy compression:

• Scale / volume of data: the company has a large volume of audio to store (because of the number of users that could have the smart speaker).
• Size of files: lossy compression can reduce the file size (of individual audio files to be transmitted/stored) // greater compression than lossless.
• Audio quality: it is still possible for files to retain (sufficient) quality (to permit analysis) // the audio quality depends on the amount of information retained / lost after applying lossy compression // remove unnecessary / redundant data.
</td><td>12</td></tr>
</table>

Ethical, legal and cultural examples are likely to overlap; when marking student responses, credit should be given for the range and clarity of points made, regardless of category. Points could include:

Ethical:

- The company has a justifiable goal, (ie by seeking to provide voice controls and improve its algorithms, the company is benefitting its customers, particularly individuals who cannot use traditional input methods).
- The company may record activity that is illegal, raising questions about its responsibility to report the activity to the authorities and duty of care to customers.
- Company employees may misuse the recordings for their own purposes.
- Company employees may be exposed to inappropriate material, raising questions about the duty of care that the company has for its employees.
- Creating 'a slippery slope' through the recordings, ie if the company is allowed to record customers for this purpose, where will it stop?
- The company is contributing to an erosion of privacy for individuals in their home / increasing existing surveillance.
- The company should obtain permission / consent from users before recording them in clear and understandable terms so that customers are providing informed consent.
- There is the potential for increased distrust between users and the company.
- The company may use the recordings for purposes other than improving the voice recognition algorithms.

Legal:

- The company must comply with legislation specifically covering the transmission and storage of data across different countries / territories of operation, including the General Data Protection Regulation (GDPR) or the Data Protection Act.
- The company has a responsibility to ensure their security / integrity / confidentiality / availability of the customer data it stores.
- The company must introduce controls to take account of individual privacy rights / legislation across different countries / territories of operation.
- The international nature of the company means that it may have opportunities to circumvent legislation within particular / different countries / territories, eg by getting user permission to transmit data to and store data in less restrictive countries / territories.

Cultural:

- All users being recorded can have benefits for groups of users with languages / dialects / accents where data is not widely available (even within the same country / territory).
- All users being recorded can allow the algorithms to advance more quickly, potentially allowing the company to make its products available across languages / user groups / countries / territories more quickly.
- The company should consider the customs and cultural norms of its different users (religions) / countries / territories of operation, particularly with regard to respecting expectations of privacy.
- Weighing up the benefit to specific user groups who rely more heavily on voice control, (eg individuals with physical disabilities) against the compromised privacy.

		Students may be awarded marks for individual issues or expansions upon issues. Expansion points may include further details on how the issue may arise or the impact of the issue occurring. **Examples of expansion points could include:** • Company employees might lose or leak data due to coercion or inexperience. • If a personally identifiable recording is lost or leaks, there may be severe personal and/or professional consequences for the user(s) on the recording.	

<table>
<tr><th>Qu</th><th>Pt</th><th>Marking Guidance</th><th>Marks</th></tr>
<tr><td>5</td><td></td><td>

3 marks are for AO1 (understanding) and 6 marks are for AO2 (analyse)

Level of response question

<table>
<tr><th>Level</th><th>Description</th><th>Mark Range</th></tr>
<tr><td>3</td><td>A line of reasoning has been followed to produce a coherent, relevant, substantiated and logically structured response. The response covers a wide range of issues that are consistently explained and/or supported by examples.
A very good understanding of how an image is captured is shown.
The response covers a wide range of moral/ethical, legal and cultural arguments, or examines a smaller range of arguments in greater depth.</td><td>7–9</td></tr>
<tr><td>2</td><td>A line of reasoning has been followed to produce a mostly coherent, relevant, substantiated and logically structured response. The response must include some analysis of the moral, ethical, legal or cultural issues involved.
The response may include some understanding of how the image is captured.

The response will cover a range of arguments in some depth.</td><td>4–6</td></tr>
<tr><td>1</td><td>There is little evidence that a line of reasoning has been followed. The response covers a small number of points which could cover either the image capture, or the moral, ethical, legal or cultural issues, or both.

The response lacks range and depth.</td><td>1–3</td></tr>
</table>

Indicative content:

AO1

Image Capture

- Light enters through / is focussed by the lens
- on to (an array of sensors on) the sensor chip **A**. light sensors capture/record light (intensity) **A.** CCD as sensor.
- Each sensor produces an electrical current/signal.
- The signal represents a pixel.
- An (ADC) converts measurement of light intensity into binary/digital data.
- A (colour) filter is applied to generate separate data values for red, green and blue colour components.
- The pixels are recorded as a group/array.

AO2

Note: Some points may fit under more than one category. These have been indicated with a #.

</td><td>9</td></tr>
</table>

		Moral/Ethical • Could the AI or computer program include unconscious bias as a result of the dataset it has access to or the programmers? • Would the owners of the system use the system to steer customers towards more expensive/higher profit garments? • Will the owners of the system use the data collected for other purposes? # • May put pressure on users to spend more money than they have. • Application may include advertising for certain brands. • Photographs may be uploaded by third parties and the result used without knowledge / consent of the person in the photograph. # • Might the application recommend outfits which may be deemed inappropriate by some? **Legal** • Will the data be stored securely? # • Who will own copyright of the generated images? • An image identifies a living person and so can be classed as personal data under the Data Protection Act / GDPR. • How will the application authenticate that the photograph is of the person using the system or has the permission of the person whose photograph it is? • Will there be an age authentication of the user of the system? Will there be an age restriction? How is this verified? • How long will the images be made available for? **Cultural** • Some outfits suggested may be offensive to certain groups of users (eg in certain religions) • Could the AI make inappropriate decisions about what clothes to suggest based on ethnicity / gender / disability / body-size? • Developers may deliberately or unintentionally (due to the algorithm) influence fashion trends.	

6		**6 marks for AO1 (understanding)** **Area 1: How it could work:** • members could specify their interests / views and stories could be matched to these; • consider basic facts about member eg age, gender, location; • consider what stories have been read by friends of the member; • analyse the type of stories that the user has read before; • analyse the information that a member shares about themselves to identify characteristics/interests etc; • track how popular a story is to display the most popular ones; • look at member's search history; • look at member's reaction to other similar stories eg likes; • show stories viewed by others with a similar profile to this user; • display articles that have been more popular // had more hits // received more positive feedback; • compare keywords in articles with keywords in articles previously viewed by the member; • how can the algorithm avoid displaying click-bait?; **Area 2: Legal** • who owns the copyright in the story?; • is it legal for the company to reproduce a news story that someone else has written?; • is the company legally responsible for the content/accuracy of stories?; • do contracts need to be signed between the company and the organisations/ individuals that stories will be displayed from?; • do laws in some countries prevent some types of stories being displayed? // need to ensure laws in different countries are followed; • need to ensure that stores are age-appropriate; • need to notify members about how their information is being used to select stories; **Area 3: Ethical / Moral** • by choosing what news stories to display, will the service influence the views of members?; • how should the company deal with governments/organisations who might want to influence/control which stories are displayed?; • should the company accept payments to promote stories?; • how should the company deal with complaints / issues raised by members (in a timely fashion)?; • will the reproduction of news stories adversely (or positively) affect the number of people who go to read the original stories from their authors?; • how can / should reliability of stories be checked / shown (fake news)?; • how can / should the company assess bias / prevent spread of propaganda; • does the company have a duty to try to provide balance?; • should a method be provided so members can request their data is not analysed for this purpose? // importance of consent; • should the company let them know that the news they are seeing is being tailored to them / not everyone sees the same news?;	**6**

		Area 2 or 3: Legal OR Ethical / Moral • should the company have people who read/check each story?; Is it practical to do this?; • how should the company select which organisations/individuals it will display stories from?; **Max 4 if all points are from one area**	

<table>
<tr><th>Qu</th><th>Pt</th><th>Marking guidance</th><th>Total marks</th></tr>
<tr><td>7</td><td></td><td>

All marks AO1 (understanding)

<table>
<tr><th>Level</th><th>Description</th><th>Mark Range</th></tr>
<tr><td>4</td><td>A line of reasoning has been followed to produce a coherent, relevant, substantiated and logically structured response. The response covers all three areas indicated in the guidance below and in at least two of these areas there is sufficient detail to show that the student has a good level of understanding. To reach the top of this mark range, a good level of understanding must be shown of all three areas.</td><td>10–12</td></tr>
<tr><td>3</td><td>A line of reasoning has been followed to produce a coherent, relevant, substantiated and logically structured response which shows a good level of understanding of two areas indicated in the guidance below or a good level of understanding of one area and a reasonable level of understanding of the other two areas. To reach the top of this mark range, a good level of understanding must be shown of two areas.</td><td>7–9</td></tr>
<tr><td>2</td><td>A limited attempt has been made to follow a line of reasoning and the response has a mostly logical structure. A good level of understanding has been shown of at least one area or some understanding has been shown of all three areas.</td><td>4–6</td></tr>
<tr><td>1</td><td>A few relevant points have been made but there is no evidence that a line of reasoning has been followed. The points may only relate to one or two of the areas from the guidance. There is insufficient evidence of a good understanding of any of the three areas.</td><td>1–3</td></tr>
</table>

<u>Guidance – Indicative Content</u>

Area 1: What Big Data is

Overarching description: Data that can't be processed or analysed using traditional processes or tools.

<table>
<tr><th>Characteristic</th><th>Expansions / Examples</th></tr>
<tr><td>Variety of different forms of information // data may lack structure</td><td>Cannot be represented in a table // by a relational database

Email messages
Videos
Images
Web site contents
Facial recognition</td></tr>
</table>

</td><td>12</td></tr>
</table>

There is a lot / high volume of data (to process as one dataset) // data will not fit on one server	Hundreds of terabytes Large medical datasets for diagnosis Gene sequencing Predicting disease outbreaks Results of large-scale scientific experiments
The data is generated / received / must be processed at high velocity / very quickly	Thousands of items to process per second. Data must be processed as it is received – it cannot be batched and processed later Card payment fraud detection Recommendations systems

Good level of understanding = Either all three characteristics covered or two characteristics and the overarching description. Some examples or expansions covered.

Area 2: Challenges and How Overcome

Challenges:

- Data cannot be stored on one server / computer.
- Not possible to process data quickly enough with one computer.
- Data cannot be represented in a table // by a relational database.
- Some forms of data / unstructured data are difficult to analyse.

How overcome**:**

- Distributed database systems // distributed file systems // blocks of individual files distributed across multiple servers.
- Use of functional programming.
- (Massively) parallelising the execution of programs.
- MapReduce // input split into parts then mapper executed on each part then all results combined by reducer(s) // function-to-data model.
- Functional programming makes it easier to write distributable code // determine which parts of code can be run independently.
- Functional programming makes it easier to write correct code // example features of functional programming that facilitate writing correct code
- Use of many thousands of commodity servers.
- Use of servers with multiple CPUs / cores / drives.
- Machine learning can identify patterns / the value in the data // use of predictive data models.
- Use of languages such as XML or JSON to describe semi-structured data.

		• Use of fact-based model can manage bigger data sets better than relational model. *Good level of understanding = A range of challenges and how to overcome them are discussed.* **Area 3: Ethical and Legal Issues** • How can data be kept securely? • Who should have access to what data? • Will people know what data is being stored about them? • Where should / will the data be stored // concerns relating to data being stored in other countries. • What rights do people have in relation to data stored about them? • Example laws (allow two examples): Computer Misuse Act, General Data Protection Regulations / GDPR / Data Protection Act, Regulation of Investigatory Powers Act / RIPA. • Who owns data about individuals? *Good level of understanding = A range of issues described*	

Question			Marks
8		**All marks AO1 (understanding)** **12**	

Level	Description	Mark Range
4	A line of reasoning has been followed to produce a coherent, relevant, substantiated and logically structured response. The response covers all three areas indicated in the guidance below and there is sufficient detail to show that the student has a good level of understanding of at least two of these.	10–12
3	A line of reasoning has been followed to produce a coherent, relevant, substantiated and logically structured response which shows a good level of understanding of at least one area indicated in the guidance below and a satisfactory understanding of at least one other area.	7–9
2	A limited attempt has been made to follow a line of reasoning and the response has a mostly logical structure. Either a good level of understanding has been demonstrated of one area or some understanding had been demonstrated of at least two areas.	4–6
1	A few relevant points have been made but there is no evidence that a line of reasoning has been followed. The points may only relate to one or two of the areas from the guidance. There is insufficient evidence of a good understanding of any of the three areas.	1–3

Guidance – Indicative Content

Area 1: How RFID works

RFID tag contains (transmission) circuitry and antenna
Memory on tag stores (customer) data
RFID reader (at till) transmits / sends signal // emits electric / electro-magnetic field
Signal activates / energises / induces current in RFID tag
RFID tag transmits / sends data by radio (wave)
RFID reader converts radio (wave) / signal back into (binary) data
RFID tag (on a card) is a passive device
RFID transmits over very short range

Area 2: How barcode works

(reflected light method)
A light source / laser is directed at bar code // bar code is illuminated
(Moving) mirror / prism moves light beam across bar code // user moves reader across bar code // user moves the bar code across the reader
Light reflected back
Black / white bands reflect different amounts of light // black reflects less light // white reflects more light
Light sensor / photodiode / CCD (measures amount of reflected light)

		Light reflected converted into an electrical signal **A.** convert reflection to (binary) numbers / characters / ASCII
		
		(CMOS/CCD/camera method)
		Grid of (pixel) sensors // CMOS/CCD sensor
		Each sensor measures light intensity of a point
		Sensor outputs a voltage dependent upon light intensity
		Voltages turned into binary data // voltages passed through Analogue-to-Digital Converter (ADC) // voltages turned into a digitised version of the image / barcode
		Image processing software analyses image
		This identifies black / white bands in barcode (which are turned into numbers)
		
		Note: Students only need to describe one of the two methods for barcodes.
		
		Area 3: Ethical and legal issues
		
		(ethical)
		Customers may believe that data about what they buy/spend is personal // invasion of privacy
		Purchase of some items might be considered sensitive // some data might be considered to be sensitive (accept relevant examples)
		Will people fully understand what will be done with the data, even if they are told it is being collected
		Customers need to decide whether to allow the store to collect data about them (is it worth it for the return that they may get eg incentives / vouchers?) //do people feel forced to consent to benefit from offers
		Can company be sufficiently confident that any other companies they share the data with will process the data legally / fairly/for the purposes that they said they would?
		Risk of the supermarket carrying out actions that might reveal to other members of a shopper's household things that the supermarket has deduced that the householders don't know
		Should ethical consideration be given to the products promoted to people using the data collected about them or is it okay to promote a product to anyone?
		Are there some types of customers who should not be targeted with promotions at all // is it ethical to promote products to vulnerable customers?
		
		(legal)
		Naming a relevant law – GDPR, Data Protection Act
		Need to inform customers of what will be done with data // consent required to collect data **R.** customer has not consented
		Data must be kept securely
		Need to consider what purposes data should be used for
		Consideration of who should be able to access the data // there are rules about who the data can be shared with
		Possible negative impact if data stolen or leaked // information could be misused
		Limit on time-period that the data can be kept for
		Need to ensure that collected data is accurate
		Ensure data only transferred to countries it is legally allowed to go to // if transferred abroad, different laws may apply
		The supermarket should let the customers see/edit data about them
		Use of RFID might make data vulnerable to theft	