

# Markscheme

November 2017

**Information technology  
in a global society**

**Higher level**

**Paper 1**

33 pages

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Examiners should be aware that in some cases, candidates may take a different approach, which if appropriate should be rewarded. If in doubt, check with your team leader.

In the case of an “identify” question read all answers and mark positively up to the maximum marks. Disregard incorrect answers. In all other cases where a question asks for a certain number of facts eg “describe two kinds”, mark the **first two** correct answers. This could include two descriptions, one description and one identification, or two identifications.

It should be recognized that, given time constraints, answers for part (c) questions are likely to include a much narrower range of issues and concepts than identified in the markband. There is no “correct” answer. Examiners must be prepared to award full marks to answers which synthesize and evaluate even if they do not examine all the stimulus material.

## Section A

### 1. Voice biometrics technology in banking

*Note to examiners.*

- All part a and b questions are marked using ticks and annotations where appropriate
- Part c is marked using markbands. Use annotations and text comments to provide a rationale behind the marks you awarded. **Do not use ticks.**

- (a) (i) Identify **two** forms of biometric identification other than voice. [2]

*Answers may include:*

- DNA
- iris
- retina
- facial
- fingerprint
- hand / palm print
- gait
- odour
- ear
- signature
- keystroke.

*Do not accept “eye recognition” – this is too vague. Iris or retina is required for marks.*

*Award [1] for identifying each form of biometric identification up to a maximum of [2].*

- (ii) Identify the steps used by the voiceprint biometric technology to authenticate a customer calling *CBR Bank*. [4]

*Answers may include:*

- biometric voice feature is initially recorded
- voice is converted from analogue to digital
- voice is stored in database together with other personal information
- voice is re-scanned when person needs to be authenticated over the phone
- voice is matched with information in database
- if a match then it is authenticated
- if no match then the customer is asked to repeat the phrase and is rejected after a certain number of attempts.

*Award [1] for identifying each of the steps used to authenticate a customer calling *CBR Bank* up to a maximum of [4].*

- (b) *CBR Bank* holds a large amount of information on its customers. Some customers are concerned about the security, privacy **and** anonymity of their data.

For **each** of the concerns above, explain **one** policy that *CBR Bank* could use to address the concerns of its customers.

[6]

*Answers may include:*

**Security:**

- user access to data is limited to authorized personnel – to ensure data is secure during storage
- username and password access is implemented – to ensure data is secure during storage
- a password policy is implemented (*eg* minimum length, mix of characters, changed after a given number of days *etc*)
- two factor / two-step authentication is implemented (*eg* one-time password/PIN to a mobile phone, code generating device supplied by the bank, confirmation email *etc*)
- data is encrypted – to ensure data is secure during transmission
- a firewall is used to protect the bank's server
- bank servers are kept updated with the latest software / security patches
- bank employees are prohibited from accessing customer data on personal devices / devices outside the company network – to ensure that all devices are protected by the bank's security measures.

**Privacy:**

- customers are informed to specify how the data may be used – if/how it may be shared with third parties
- only authorized personnel will have access to bank database – not all employees will be able to view data.

**Anonymity:**

- ensure the customer's anonymity is maintained – when data is shared with third parties, the data that could give the identity of a customer must be detached
- reports are kept anonymous – reports cannot allow individuals to be identified.

**N.B.:** *the response requires an explanation of a policy and not a discussion of the problems themselves. There must be a policy for **each** kind of concern: security, privacy and anonymity and reason(s).*

*Award [1] for identifying a policy that CBR Bank could use to address the security, privacy and anonymity concerns of its customers and [1] for a development of the policy identified up to a maximum of [2].*

*Mark as [2] + [2] + [2].*

- (c) The chief executive officer (CEO) of *CBR Bank*, Alice McEwan, said in a recent interview, “*CBR Bank* will be replacing all passwords, PINs and personal verification questions for our online banking and mobile banking with voice biometric recognition.”

Discuss whether the changes proposed by Alice are beneficial for **both** *CBR Bank*’s customers and *CBR Bank*’s IT support.

[8]

*Answers may include:*

**For customers:**

**Advantages of replacing passwords with biometric voice recognition:**

- don’t have to remember a password or PIN code
- more secure as voice characteristics are unique
- verification time is within a few seconds
- harder for others to hack online banking with biometric voice recognition
- some customers may have physical conditions that make entering PINs/passwords difficult – voice recognition will avoid having to type.

**Disadvantages of replacing passwords with biometric voice recognition:**

- voice recognition system may not accept foreign accents, or range of voices
- illness (such as a cold) can change a person’s voice, making identification difficult
- a person’s voice can be easily recorded and used for unauthorized access
- someone with very similar voices (*eg* a member of the same family) may be able to gain access to the bank account.

**For IT support:**

**Advantages of replacing passwords with biometric voice recognition:**

- more secure, less likely to be hacked – less problems for IT staff to deal with
- easy to record by customers themselves – no IT staff required to setup
- IT staff do not have to deal with lost password/PIN.

**Disadvantages of replacing passwords with biometric voice recognition:**

- voice recognition system may not accept particular accents – customers cannot access their online banking and will need support
- a person’s voice can be easily recorded and used for unauthorized access – customers may complain of unauthorized access, IT staff will have to investigate hacked accounts
- illness (such as a cold) can change a person’s voice, making identification difficult – a greater number of customers might need to call support to access their own account
- when the new system is implemented, *CBR*’s IT support could be overwhelmed with overlooked bugs *etc*
- audio files / biometric templates will require more storage space than passwords / PINs – this may make backing-up data more time consuming / require IT support to increase available storage space *etc*
- Initial implementation of the new system may require additional IT support staff
- IT support staff may face an increased workload (*eg* if the old system initially has to run parallel to the new system).

***Please see generic markband information sheet on page 35.***

## 2. Goal-line technology in football (soccer)

*Note to examiners.*

- All part a and b questions are marked using ticks and annotations where appropriate
- Part c is marked using markbands. Use annotations and text comments to provide a rationale behind the marks you awarded. **Do not use ticks.**

(a) (i) Define the term *resolution*.

[2]

*Answers may include:*

- the density of the pixels in the image / the number of dots, or pixels, used to create or display an image
- the sharpness and clarity of an image
- higher resolution means that more pixels are used to create the image
- describes the detail in a picture
- is measured in pixels per inch (ppi) or dots per inch (dpi)
- used to describe monitors, printers, and bit-mapped graphic images.

*Award [1] for identifying each appropriate statement up to a maximum of [2].*

(ii) Using the following assumptions:

- 1 pixel is made of 24 bits
- 1 kilobyte (KB) = 1000 bytes
- 1 megabyte (MB) = 1000 KB

Calculate in megabytes (MB) the storage requirements for an image size of 2000 pixels by 4000 pixels.

[2]

- Image size = 8 000 000 pixels
- Images size = 8 000 000 \* 24 bits
- = 192 000 000 bits
- = 192 000 000 / 8 bytes
- = 24 000 000 bytes
- = 24 MB

*Award [1] for converting bits to bytes correctly or using the correct logic and missing out this conversion.*

*Award [2] for the correct answer.*

- (iii) The system records the ball's flight path into a database.

Identify **two** fields that would be found in the goal-line technology database. **[2]**

*Answers may include:*

- the coordinates of the sensors
- time of the event
- position of ball (triangulation)
- height / elevation of the ball
- speed of the ball
- line of sight to the goal-line (angle)
- images of ball
- camera number
- camera location
- a Boolean / Yes-No field to record if the ball crossed the line or not
- which goal line the ball went over.

*Award **[1]** for identifying each appropriate field that would be found in the goal-line technology database up to a maximum of **[2]**.*



- (b) The goal-line technology is capable of collecting vast quantities of data. To make this manageable three policies are needed: for the collection, storage **and** sharing of data.

Explain how **each** of these **three** policies could be implemented so that the quantity of data is manageable.

[6]

*Answers may include:*

**Collection:**

- data would only be collected when the ball is within several meters of the goal-line – this would reduce the amount of data collected
- the cameras can create lower resolution images
- after the flight path of the ball is calculated, the original images of the ball are not saved.

**Storage:**

- data would only be stored for a finite period of time – this would reduce the amount of storage space required
- access to stored data would be limited – only authorized individuals will have access to the vast amount of data – data not shared with third party, unless authorized
- data would only be stored if there was a need to store it – for example it may refer to controversial decisions or those that may be used to set a precedent
- data will be stored in compressed form to minimise storage space required
- use of storage capacity regularly / continuously reviewed to ensure adequate storage is always available.

**Sharing:**

- data would only be shared with specified organizations who would not be able to share it with third parties – (*ie* controlling access to the data)
- the amount of data shared would be limited to the minimum necessary (*eg* the image of the ball crossing the line, the relevant statistical data about the goal *etc*) in order to make the amount of data manageable.
- access to data would be limited to authorized personnel – to the minimum amount of data necessary for their position.
- exporting/sending images using lossy compression to reduce the size of images.

*Award [1] for identifying the policy and [1] for a development of the policy identified that makes a feasible proposal about how the quantity of data held is manageable up to a maximum of [2].*

*Mark as [2] + [2] + [2].*

- (c) Many sports have introduced technology to assist officials with their decision-making at critical moments. These include whether to award a goal in football, whether a shot in tennis is in, or whether a sprinter has made a false start.

To what extent do the advantages of introducing technology in sport outweigh the disadvantages?

[8]

*Answers may include:*

- should ensure the correct decision is made by the officials
- reduce the burden on the officials so they know any critical decisions are being checked during the game
- can be used where the human eye is unable to detect whether the critical event has taken place or not (eg a false start)
- installation costs and ongoing costs of the technology will be high so it may only be found at certain venues
- time consuming – too much time could be taken when showing replays / stopping the game to review the data from the cameras
- may require changes to the equipment that may have unintended results
- the algorithms within the software may not be a 100% accurate
- the technology may not be 100% reliable
- the role of the official is reduced considerably and is subservient to the technology
- the human element, getting decisions wrong, is part of the game.

***Please see generic markband information sheet on page 35.***

### 3. Social media and political tension

*Note to examiners.*

- All part a questions are marked using ticks and annotations where appropriate
- Part b and part c are marked using markbands. Use annotations and text comments to provide a rationale behind the marks you awarded. **Do not use ticks.**

- (a) (i) In addition to providing access to the Internet, identify **two** functions of an internet service provider (ISP). [2]

*Answers may include:*

- provides an IP address
- provides various bandwidth options
- email accounts
- customer service
- spam filtering
- domain registration
- web hosting
- blocking sites
- firewall
- parental controls
- VPN
- set-up / installation (eg for new customers)
- routing data / data packets
- load balancing
- provide DNS servers
- provide anti-virus protection / software
- control the amount of data transfer / data usage allowed
- provide cloud storage services.

*Award [1] for identifying each characteristic of an internet service provider up to a maximum of [2].*

- (ii) Identify **two** characteristics of a proxy server. [2]

*Answers may include:*

- acts as a gateway between the local network computer and a larger network (such as the internet)
- provide increased performance and security
- can be hardware or software
- connecting through a proxy server can slow down the connection
- changes the IP address used to access websites
- allows users to access websites banned/blocked in their home country or by organisations (eg employers)
- allows users to keep their location information private
- allows users to appear to be accessing the internet from the country the proxy server is located in.

*Award [1] for identifying each characteristic of a proxy server up to a maximum of [2].*

- (iii) Identify **two** ways that the government could have determined the identity of the person responsible for posting the offending images on the social media. [2]

*Answers may include:*

- IP address
- MAC address
- unique serial number
- personal identifying data stored on the device and included with the photo (eg in the photo's EXIF metadata)
- GPS location data stored with the photo.

*Information from the social media provider*

- login credentials to the social media account (eg username).

**N.B.:** *Some students may take the alternative perspective that the identity of the person cannot be determined, only the device, for the same reasons as above.*

*Award [1] for identifying each way that a government can determine the identity of the person responsible for posting the offending images on the social media up to a maximum of [2].*

- (b) Many schools block access to social networking websites such as *Twitter*, *Facebook* and YouTube. However, other schools are investigating two different options:
- monitoring the network to view what websites the students are viewing, or
  - giving different ages of students different levels of access to social media sites.

Analyse these **two** options.

[6]

*Answers may include:*

**Monitoring the network:**

- prevent cyberbullying – keep students safe
- teach student responsibility – digital citizenship
- protect students from sharing inappropriate information and images about themselves
- identifies any inappropriate content that students can access on these sites
- gather information for future policies for the use (or not) of social media
- students of all ages would have access to the same websites, regardless of age – younger students could have access to inappropriate content for their age
- privacy of students – school would have access to see what the students are viewing.

**Giving different ages different levels of access:**

- some websites have age restrictions – should only be accessed if age appropriate
- younger students should not be exposed to some content that is acceptable for older students
- schools have responsibility to ensure the use of the network is appropriate to various ages
- younger students may not be able to differentiate between true intentions of online friendships
- older students need to learn responsible digital citizenship and take responsibility for their actions
- awareness of the benefits and drawbacks of social media sites is gathered as the student matures
- blocking sites by age could cause issues – block content that is needed by older students
- granting different levels of access may be more cost effective than implementing an ongoing monitoring system.

Marks	Level descriptor
0	No knowledge or understanding of ITGS issues and concepts. No use of appropriate ITGS terminology.
1–2	A limited response that indicates very little understanding of the topic or the reason is not clear. Uses little or no appropriate ITGS terminology. No reference is made to the scenario in the stimulus material. The response is theoretical.
3–4	A description, unbalanced or partial analysis of whether network monitoring or providing different access levels is appropriate within a school. There is some use of appropriate ITGS terminology in the response.
5–6	A balanced and detailed analysis of whether network monitoring or providing different access levels is appropriate within a school. Explicit and relevant references are made to the scenario in the stimulus material. There is appropriate ITGS terminology throughout the response.

- (c) Many citizens have raised concerns about the surveillance of their web browsing history or censorship of selected websites by their national government.

To what extent is it appropriate for national governments to use surveillance and censorship to control citizens' access to websites?

[8]

*Answers may include:*

**Reasons that surveillance and censorship to control citizens' access to websites is acceptable:**

- can keep children from being victims of cyberbullying, sex trafficking and pornography
- can control/monitor various illegal activities
- helps strengthen national security with laws against hacking and impose large fines and punishments
- can lessen the incidence of identity theft
- governments may be best informed to determine what may, or may not, be appropriate for their citizens.

**Reasons that surveillance and censorship to control citizens' access to websites is not acceptable:**

- removes citizens' freedom of expression
- can be used to keep relevant information from citizens
- it can be expensive for the government or may require too many resources for the benefits it brings
- may accidentally block sites that should not be blocked
- knowledge is power
- can be used to identify people who oppose the government.

***Please see generic markband information sheet on page 35.***

#### 4. Sports watches used in physical education lessons

*Note to examiners.*

- All part a and b questions are marked using ticks and annotations where appropriate
- Part c is marked using markbands. Use annotations and text comments to provide a rationale behind the marks you awarded. **Do not use ticks.**

- (a) (i) Apart from heart rate, identify **two** possible vital signs that could be recorded by the sports watch. [2]

*Answers may include:*

- blood sugar / glucose levels
- blood pressure
- oxygen levels
- body temperature
- hydration levels
- ECG / pulse rate / heart rate
- stress levels
- sleep patterns
- calories burned
- body fat
- respiratory rate/breathing rate.

**N.B.:** In the context of an ITGS course it is not expected that candidates know the medical definition of a “vital sign”.

Should **not** be accepted as they are measurements to do with the activities, not the students:

- calories
- steps taken
- distance tracking
- speed.

Award [1] for identifying each vital sign that could be monitored by the teachers up to a maximum of [2].



- (ii) At the start of each lesson the student is asked to set their maximum heart rate on the watch to  $220 \text{ bpm} - \text{their age}$ ; so in the case of a 15-year-old it would be  $220 \text{ bpm} - 15 = 205 \text{ bpm}$ .

Identify the steps used by the software in the sports watch to encourage students not to exceed their maximum heart rate.

**[4]**

*Answers may include:*

- device takes the measurement of the student's heart rate
- data is converted from analog signals to digital data / analysed by the device
- heart rate value is compared with the "normal" value stored in device for student
- if value is outside accepted range, then signal / alert is sent
- if value is inside accepted range, then no signal / alert is sent
- device waits for next time interval to take new measurement.

*Award **[1]** for identifying each of the steps used by the sports watch to ensure that students stay within their recommended heart rate zone up to a maximum of **[4]**.*

- (b) (i) Explain **one** advantage for the student of using these monitoring devices. [2]

*Answers may include:*

- can act as a personal coach for the student – motivate students to be more active, help keep students within healthy range
- recording of activity levels and frequency – can motivate students to reach healthy goals, be more active
- device can easily store information and it is emailed to the students – students can keep a copy on file to follow their progress – no need to write it down
- students can evaluate their personal fitness such as cardiovascular system – this may lead to early notification of health issues.

*Award [1] for identifying an advantage for the student of using these monitoring devices and [1] for a development of the policy identified up to a maximum of [2].*

- (ii) Explain **one** advantage for the teacher if their students are using these monitoring devices. [2]

*Answers may include:*

- personalized learning – teachers can modify lessons according to students' fitness level and needs
- determining grades – results are recorded and teachers can use this data to create grades
- motivating students – students may work harder in class if they are motivated to work harder and improve their fitness
- avoid risks associated with extreme exercise – monitoring students' vital signs can help prevent excessive exercise, or indicate health problems in advance
- teachers can monitor the students heart rates without stopping the activity the students are doing
- data from the watch may be more accurate than manually checking heart rates – gives the teacher more reliable data.

*Award [1] for identifying an advantage for the teacher if their students are using these monitoring devices and [1] for a development of the policy identified up to a maximum of [2].*

- (iii) Explain why the reliability of the sports watches may be a concern for the teachers. [2]

*Answers may include:*

- recorded results may be inconsistent – this would make it difficult to determine if a student is improving or not – would also make it difficult to determine if there is a health issue
- may push students' limits too far if data is incorrect – students may overexert themselves if the device does not indicate they are over their heart rate limit
- student progress may not be accurate – teachers may think the students are improving and grade them accordingly
- data may not be received by teacher – due to network issues
- student's watch may malfunction – if it is not working this may delay the lesson – hardware is not reliable
- students might find a way to fool the watch into recording activities when none are taking place (eg swinging an arm rapidly to simulate running) - teachers would get unreliable data
- teachers are concerned that a summary of unreliable results may be sent to students' parents and cause them to worry.

*Award [1] for identifying a reason why the reliability of the sports watches may be a concern for the teachers and [1] for a development of the reason identified up to a maximum of [2].*

- (c) The Principal at Collège Earlet has been discussing arrangements for sharing data from the students' watches with a third party, *Fitness World*.

Discuss whether the Principal at Collège Earlet should agree to share data that has been collected by the students' watches with *Fitness World*. [8]

*Answers may include:*

**Reasons for sharing the data with *Fitness World*:**

- can do further analysis of student performance
- can provide data that can help improve performance of overall population
- can benchmark student with other students from other schools
- may motivate students to do better if they know data is shared
- company may provide other resources to the school if they share data
- students may be able to upload their data to the *Fitness World* site and communicate with students from other schools who use the same watches
- students may be invited to take part in regional or national competitions (eg if they perform well compared to students from other schools).

**Reasons for not sharing the data with *Fitness World*:**

- students may be under 18 and data sharing may be inappropriate, unethical or illegal
- privacy of student data may be compromised
- security of data – could be stolen or shared without permission
- could put pressure on students if data is being shared, or compared with others
- school policies may not allow student information to be shared with third party.

***Please see generic markband information sheet on page 35.***

## Section B

### 4. Expert systems in healthcare

*Note to examiners.*

- All part a questions are marked using ticks and annotations where appropriate
- Part b and part c are marked using markbands. Use annotations and text comments to provide a rationale behind the marks you awarded. **Do not use ticks.**

- (a) (i) Identify **two** features of the user interface of the new medical expert system that would make it easy to use. [2]

*Answers may include:*

- question mode
- fields to enter patient name/age/weight/sex
- diagram of the human body allowing doctor to highlight location of pain
- use of drop-down menus
- use of alternative text (that hovers over a field to provide more information)
- use of diagrams to allow patients to indicate area affected
- use of icons to make navigation easier.

*Award [1] for identifying each possible feature of the user interface of the new medical expert system up to a maximum of [2].*

- (ii) In addition to gathering information from patients, identify **two** tasks that a systems analyst would carry out. [2]

*Answers may include:*

- analyse system requirements
- assist in the preparation of documentation for the new system
- liaise with internal and external stakeholders.

*Award [1] for identifying each task that would be completed by the systems analyst up to a maximum of [2].*

- (iii) Identify **two** characteristics of an expert system. [2]

*Answers may include:*

- uses databases of expert knowledge to offer advice or make decisions in such areas as medical diagnosis
- an expert system is a computer system that emulates the decision-making ability of a human expert
- an expert system has a knowledge base and inference engine
- uses rules to make decisions
- has a user interface so the doctor can communicate with it.

*Award [1] for identifying each characteristic of an expert system up to a maximum of [2].*

- (b) Kai Tuikka is considering using either questionnaires or interviews to gather information from patients that will be used to help design the new medical expert system.

Analyse **both** questionnaires and interviews as methods of data collection to gather information from patients that will be used to help design the new medical expert system.

[6]

*Answers may include:*

**Advantages of a questionnaire/survey:**

- can be used with a large number of patients
- easy to analyse results graphically and/or statistically
- questions may be framed in a way that they elicit responses that will “fit” the architecture of the expert system
- can be done online and will take less time to gather the information / practical – patients can fill out questionnaires in their own time
- large amounts of information can be collected from a large number of people in a short period of time and in a relatively cost-effective way
- the results of the questionnaires can usually be quickly and easily quantified by either a researcher or through the use of a software package.

**Disadvantages of a questionnaire/survey:**

- may give generalized results if the questionnaire has not been developed with the full involvement of medical experts
- quality of the information may be compromised by the design of the questionnaire especially as it is medical and highly specialized
- is argued to be inadequate to understand some forms of information – *ie* changes of emotions, behaviour, feelings *etc*
- the respondent may not appreciate the ramifications of their answer not being sufficiently precise / responses may be vague and unusable in extended text fields which could cause significant problems because of the nature of the medical information required
- people may read differently into each question and therefore reply based on their own interpretation of the question, there is no way to ask to rephrase the question if not understood
- questionnaires may not be returned.

**Advantages of an interview:**

- you can use indications of verbal and nonverbal behaviour to decide whether to develop a line of questioning further
- provides the possibility for the patient to ask questions and engage in a much more thorough data gathering process, especially as medical conditions are rarely simple yes/no answers
- will provide far more qualitative data that may lead to refinements in the development of the new expert medical system.

**Disadvantages of an interview:**

- interviewers will need to have a medical background to be able to discuss the patient responses and place them
- the increased quantity of qualitative data may require far more time to process and require experts to synthesize this information to make it meaningful
- the success of the interview will be heavily dependent on the interviewers, and there may be inconsistencies in the way the interviewers perform
- the increased time required for the interview makes the sample size of patients too small to be representative, or not provide significant outcomes
- outcomes of the interview will all have to be manually entered, either during the interview which will slow the process, or have to be transcribed which may lead to errors if entered by the person who did not carry out the interview.

Marks	Level descriptor
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1–2	A limited response that indicates very little understanding of the topic or the reason is not clear. Uses little or no appropriate ITGS terminology. No reference is made to the scenario in the stimulus material. The response is theoretical.
3–4	A description, unbalanced or partial analysis of the relative advantages and disadvantages of using both questionnaires and interviews. There is some use of appropriate ITGS terminology in the response.
5–6	A balanced and detailed analysis of the relative advantages and disadvantages of using both questionnaires and interviews. Explicit and relevant references are made to the scenario in the stimulus material. There is appropriate ITGS terminology throughout the response.

- (c) For this new medical expert system to be effective Kai Tuikka must ensure it will enable the best quality care for each patient, as well as meeting the requirements of the administrators and doctors.

To what extent is it possible to develop a new medical expert system that will achieve these goals for these **three** different stakeholders?

[8]

*Answers may include:*

- all new IT systems are constrained by a number of factors such as cost, project length. Some of these may be in direct conflict and inhibit the development of the new expert medical expert system
- the skill sets (or lack of) of various stakeholders involved in the development of the new expert medical expert system which may prevent the project fulfilling all of the intended aims
- the overriding goal of the new medical expert system may be to introduce the system with the minimum of costs and in the shortest timescale which may make the full involvement of some key groups such as patients and doctors impossible
- it may be necessary to prioritize one stakeholder over another so it may be acceptable that the expert medical system is optimized for one particular group of end users at the expense of others
- it may be hard to determine what achieving the goals actually means, so making any judgment about the effectiveness of the new expert medical system may be no more than conjecture or speculation
- medical decision-making is not simple and the effectiveness of the new medical expert system will be determined by the ability of the doctors to interpret the data or use their intuition as much as the ability of the expert system to diagnose a condition and recommend a course of treatment
- advances in medicine may mean that the new medical expert system will never be able to achieve the goals as it will not be able to be updated to keep pace with this new knowledge
- the success of the project may be determined by the ability of the Project Manager to manage the process as much as the skills of the other key groups
- the success of the project will be determined by the people management skills of the Project Manager as much as his ability to manage processes
- there may be legal constraints, requirements or disclaimers associated with the development of a new medical expert system and this may lead to possible delays in the implementation of the new expert medical system or may lead to a sub-optimal version being developed
- the involvement of the patients in the system may add to additional costs and complications, such as increasing the number of meetings required, in its development
- the poor quality of patient data may mean that they are involved but are not playing any meaningful role in the development of the new medical expert system.

***Please see generic markband information sheet on page 35.***

## 5. Patrolling train stations with a Segway

*Note to examiners.*

- All part a questions are marked using ticks and annotations where appropriate
- Part b and part c are marked using markbands. Use annotations and text comments to provide a rationale behind the marks you awarded. **Do not use ticks.**

- (a) (i) Identify **two** pieces of data that the customized Segway Patroller would automatically collect. [2]

*Answers may include:*

- location
- speed
- temperature
- background noise level
- battery usage
- distance travelled
- proximity of objects/people around it.

*Award [1] for identifying each piece of data that the customized Segway Patroller would automatically collect up to a maximum of [2].*

- (ii) Outline **two** reasons why it is necessary to test the added features of the prototype. [4]

*Answers may include:*

- evaluate effectiveness of the prototype in order to determine whether the proposed upgrades provide the intended benefits
- to ensure that the added features are able to function with the existing IT systems so that there are not unforeseen issues when it is launched / released
- use employees to provide an in-depth analysis of the performance of the product in a real environment so that the managers can be sure that the product will function as intended when released for staff use.

*Award [1] for identifying reasons why it is necessary to test the added features of the prototype and [1] for a development of it up to a maximum of [2].*

*Mark as [2] + [2].*

*Maximum [4].*



- (b) The prototype underwent both alpha and beta testing. Explain why **both** were necessary before releasing the customized Segway Patroller for sale.

[6]

*Answers may include:*

- alpha testing is always performed by test engineers, and other employees, not in real world
- beta testing is done under real-world conditions
- alpha testing ensures that the product is ready for beta testing
- beta testing is often performed by the customers at their own site
- alpha testing is sometimes performed by an Independent Testing Team which is never the case in beta testing
- alpha testing is always performed when developers test the product and project to check whether it meets the user requirements, or not, and whether it functions properly
- beta testing goes beyond the functioning of the product and can include marketing, support and documentation as well.

Marks	Level descriptor
0	No knowledge or understanding of ITGS issues and concepts. No use of appropriate ITGS terminology.
1–2	A limited response that provides a superficial understanding of the need for both alpha testing and beta testing. Minimal reference is made to the scenario, the answer may be based purely on definitions of the two terms and use some appropriate ITGS terminology.
3–4	A reasonable description, lacking either detail or balance, of the need for both alpha testing and beta testing using appropriate ITGS terminology. Some relevant examples are used in the response. Some reference is made to the scenario.
5–6	A clear, detailed and balanced explanation of the need for both alpha and beta testing. Relevant examples are used throughout the response. Explicit and relevant references are made to the scenario in the stimulus material. There is appropriate use of ITGS terminology throughout the response.

- (c) Segway Patrollers have been very successful in other areas, including airports and city centres (downtown). If these Segway Patrollers are successful in Oliverstadt train station, the managers are considering whether to introduce a new version of the Segway that uses machine learning. This will allow employees to enter the GPS coordinates of the location within the train station they want to go to and the new Segway will navigate itself to that location.

Over a period of time it is hoped that the new Segway will be able to navigate Oliverstadt train station with little or no human input, having “learned” the most efficient routes.

Discuss whether the managers of Oliverstadt train station should upgrade the Segway to include machine learning capabilities.

[8]

*Answers may include:*

**Reasons for upgrading the Segway to include machine learning capabilities:**

- this will not require staff to have such a good knowledge of the geography of the train station and will reduce staff training costs
- the routes selected by the Segway will be the most efficient routes
- routes can be predetermined and the route finding algorithm can be programmed to avoid possible collisions / create a one way system / accommodate peculiarities in the flow of passengers in the train station
- if a platform changes at very short notice the user only has to type in the new location and the route finding algorithm will be able to adapt the route used
- management would be able to monitor the location of the staff because the Segway will be constantly communicating with the navigation centre and may make cost savings.

**Reasons for not upgrading the Segway to include machine learning capabilities:**

- the software costs may be considerably greater than the potential rewards
- the constant upgrading of the software may not have been tested thoroughly, so the autonomous nature of the Segway may not be as effective as intended
- the particular nature of Oliverstadt train station may mean that the algorithms used in route finding could conflict with the movement of passengers and may cause potential problems that can be avoided by having a human in control
- the movement of passengers within the train station may not fit clearly defined patterns so matching the patterns of passenger movements may be problematic
- train stations have to change the platforms that the trains leave at very short notice, will the route finding algorithm be able to respond immediately to these changes
- there may be considerable costs in terms of time and costs in determining the most appropriate algorithms which are not compensated for by the reduction in staff costs / or efficiencies gained by autonomous Segways
- the human “pilots” of the Segway may have particular skills such as linguistic abilities that are not utilized when the despatching of the Segway is more automated.

***Please see generic markband information sheet on page 35.***

## 6. Student counselling

*Note to examiners.*

- All part a questions are marked using ticks and annotations where appropriate
- Part b and part c are marked using markbands. Use annotations and text comments to provide a rationale behind the marks you awarded. **Do not use ticks.**

- (a) (i) Identify **two** reasons why the network manager is involved in the feasibility study. [2]

*Answers may include:*

- the Network Manager can assess the likelihood of any compatibility problems with the SIMS
- the Network Manager can advise the Principal about any potential issues with the ongoing support of the system
- the Network Manager has appropriate technical knowledge about the school's IT infrastructure and can advise about whether the proposals are feasible.

*Award [1] for identifying a reason why the Network Manager is involved in the feasibility study up to a maximum of [2].*

- (ii) Outline **two** reasons why the feasibility study should be carried out before any decision is made to purchase the Student Counselling System. [4]

*Answers may include:*

- it may help to identify potential problems with the implementation of the new system / it helps to make sure the idea of integrating the system is possible
- it may provide a risk assessment of introducing a new system which may reduce unnecessary costs
- enables the school to decide if it has the necessary technology and operational requirements.

*Award [1] for reason identified why the feasibility study should be carried out before any decision is made to purchase the Student Counselling System and [1] for a development of it up to a maximum of [2].*

*Mark as [2] + [2].*

*Maximum [4].*

- (b) Explain **three** reasons why fuzzy logic would be used in the development of the Student Counselling System, rather than relying solely on inference rules.

[6]

*Answers may include:*

**Definitions:**

- a fuzzy logic is a form of mathematical logic in which truth can assume a continuum of values between 0 and 1
- inference engine is a software that matches the users' input with data contained in the knowledge base to reach appropriate answers. This is done using inference rules eg If–Then rules.

**Development:**

- student responses to the questions are unlikely to elicit straight yes/no responses so there may be a need for some flexibility in the system to accommodate this
- pattern recognition associated with machine learning will allow the Student Counselling System to evolve and become more appropriate for the school
- the Student Counselling System (SCS) may be connected to the *EduSolve* database and this could provide information that would help develop the SCS further
- fuzzy logic may be integrated with developments in AI such as deep learning so will be more responsive to information provided by students.

*Award [1] for a reason why fuzzy logic would be used in the development of the Student Counselling System rather than relying solely on inference rules and [1] for a development of it up to a maximum of [2].*

- (c) The Principal at Muscat High School has decided to use the Student Counselling System from *EduSolve* that uses fuzzy logic.

To what extent should Savannah rely on the recommendations of the Student Counselling System, rather than relying on her own professional judgment and intuition, when advising students about what subjects to study in the DP?

[8]

*Answers may include:*

**Reasons why Savannah should rely on the recommendations of the Student Counselling System from *EduSolve*:**

- many factors were taken into account when making decisions for the students because they are programmed into the expert system
- she is making use of the knowledge of many scenarios in determining the subjects students need to take
- they have data about university requirements for each major
- in many cases the student may be relatively straightforward and the Student Counselling System may be able to provide the same information that Savannah would have in a fraction of the time allowing her to focus on the students who did have atypical requirements.

**Reasons why Savannah should rely on her judgment:**

- she knows special circumstances/family issues / personal information that can have an impact on the decision
- may encounter conditions that are not part of the system
- Savannah might be aware of new subjects/majors that have not been updated into the system
- personal intuition as she knows students
- students may have multiple interests and system cannot give accurate recommendations
- giving career advice is too important to be left at the algorithms that exist within the Student Counselling System.

***Please see generic markband information sheet on page 35.***

## 7. Social robots

*Note to examiners.*

- All part a questions are marked using ticks and annotations where appropriate
- Part b and part c are marked using markbands. Use annotations and text comments to provide a rationale behind the marks you awarded. **Do not use ticks.**

- (a) (i) Identify **two** sensors that Jibo could use. [2]

*Answers may include:*

- obstacle sensor
- temperature sensor / heat sensor
- light sensor
- proximity sensor
- humidity sensor
- sound sensor.

*Award [1] for identifying each sensor that Jibo could use up to a maximum of [2].*

- (ii) Identify the steps Jibo would take in order to turn the air conditioning on and off. [4]

*Answers may include:*

- detect room temperature / senses the change in temperature
- compare temperature to pre-set value
- if temperature detected more than pre-set value, switch on AC
- if temperature detected less than pre-set value, switch off AC
- Jibo collects data from temperature sensors at a set interval, and when a room reaches a desired temperature, Jibo lowers the intensity or turns the AC off
- if the owners have set a time for the air conditioner to be turned off, then Jibo sends a signal for all the air conditioners to be turned off.

*Award [1] for identifying each step Jibo would take in order to turn on and off the air conditioning up to a maximum of [4].*

- (b) It has been decided to provide only online access to documentation for Jibo. There will be no downloadable PDFs.

Analyse this decision.

[6]

*Answers may include:*

- only producing online data may mean that there is only one master copy of the information which means that it will be more straight forward to update the information than if it is stored in more than one place
- having information in more than one place may lead to issues such as version control and staff may find that even relatively minor amendments require a significant amount of staff time (and cost)
- the rapid rate of evolution of Jibo may mean that by the time the PDFs are produced, the next iteration will be released making their production surplus to requirements
- the design of the website will be critical to the updating of the content. A poorly designed website may not be appropriate for using this method of updating documentation
- many users will prefer to have PDF documentation that they can download and use when they are not connected to the internet. Online documentation will require that the user is connected to the internet and may be less convenient to use
- using PDFs may require a well-organized library system where the previous versions of the PDF are stored, whereas meta-data trails may be used to show when the website is updated
- some functions of Jibo work without access to the internet (using the local network), so if the internet goes down, there is no access to the documentation.

Marks	Level descriptor
0	No knowledge or understanding of ITGS issues and concepts or use of appropriate ITGS terminology.
1–2	A limited response that indicates very little understanding of the topic or the reason why only online documentation with no PDFs for Jibo is not clear. Uses little or no appropriate ITGS terminology. No reference is made to the scenario in the stimulus material.
3–4	A description, unbalanced or partial analysis of the relative advantages and disadvantages of only producing online documentation with no PDFs for Jibo. There is some use of appropriate ITGS terminology in the response.
5–6	A balanced and detailed analysis of why only online documentation would be produced for Jibo. The answer will focus on the scenario and will make reference to the speed at which new iterations of Jibo will be developed. There is appropriate ITGS terminology throughout the response.

- (c) Jibo’s website claims that “Jibo is friendly, helpful and intelligent. He can sense and respond, and learns as you engage with him”. Some of the customers who own Jibo are considering whether they could extend the range of tasks Jibo could perform, or whether they should allow Jibo to make decisions for them.

To what extent should individuals rely on robots such as Jibo to act as decision-makers for them?

[8]

*Answers may include:*

**Reasons why individuals could rely on robots such as Jibo to act as decision makers for them:**

- customers can log into Jibo from their internet or their mobile that will give them a feeling of security that they have control over events/activities that are occurring remotely
- with greater decision making Jibo can free up individuals so they can concentrate on less mundane activities
- Jibo is reflecting on the development of society as a whole. If the delegation of decision making to robots such as Jibo is more common, this should not be an issue.

**Reasons why individuals should not rely on robots such as Jibo to act as decision makers for them:**

- Jibo may not be connected at all times, for example power outages or a router failure
- Jibo does not have human intuition so customers could find Jibo is making decisions that are not appropriate for the situation
- if Jibo makes a bad decision there may legal issues that may arise should there be a problem/accident *etc*
- Jibo could eventually reduce the decision-making capabilities of the customer
- Jibo may not be seen as neutral by customers, if used to supervise others Jibo could be seen as a method of surveillance
- the data that is associated with Jibo may be highly sensitive and there may be concerns about its security if it is easily accessible
- decision making can take place at a number of levels. Jibo may be appropriate for some tasks, but not for others. Customers must use their judgement when determining what constitutes an appropriate task for Jibo
- Jibo cannot make ethical decisions.

***Please see generic markband information sheet on page 35.***



**SL and HL paper 1 part (c) and HL paper 3 question 3 markband**

<b>Marks</b>	<b>Level descriptor</b>
<p><b>No marks</b></p>	<ul style="list-style-type: none"> <li>• <i>A response with no knowledge or understanding of the relevant ITGS issues and concepts.</i></li> <li>• <i>A response that includes no appropriate ITGS terminology.</i></li> </ul>
<p><b>Basic 1–2 marks</b></p>	<ul style="list-style-type: none"> <li>• <i>A response with minimal knowledge and understanding of the relevant ITGS issues and concepts.</i></li> <li>• <i>A response that includes minimal use of appropriate ITGS terminology.</i></li> <li>• <i>A response that has no evidence of judgments and/or conclusions.</i></li> <li>• <i>No reference is made to the scenario in the stimulus material in the response.</i></li> <li>• <i>The response may be no more than a list.</i></li> </ul>
<p><b>Adequate 3–4 marks</b></p>	<ul style="list-style-type: none"> <li>• <i>A descriptive response with limited knowledge and/or understanding of the relevant ITGS issues and/or concepts.</i></li> <li>• <i>A response that includes limited use of appropriate ITGS terminology.</i></li> <li>• <i>A response that has evidence of conclusions and/or judgments that are no more than unsubstantiated statements. The analysis underpinning them may also be partial or unbalanced.</i></li> <li>• <i>Implicit references are made to the scenario in the stimulus material in the response.</i></li> </ul>
<p><b>Competent 5–6 marks</b></p>	<ul style="list-style-type: none"> <li>• <i>A response with knowledge and understanding of the relevant ITGS issues and/or concepts.</i></li> <li>• <i>A response that uses ITGS terminology appropriately in places.</i></li> <li>• <i>A response that includes conclusions and/or judgments that have limited support and are underpinned by a balanced analysis.</i></li> <li>• <i>Explicit references to the scenario in the stimulus material are made at places in the response.</i></li> </ul>
<p><b>Proficient 7–8 marks</b></p>	<ul style="list-style-type: none"> <li>• <i>A response with a detailed knowledge and understanding of the relevant ITGS issues and/or concepts.</i></li> <li>• <i>A response that uses ITGS terminology appropriately throughout.</i></li> <li>• <i>A response that includes conclusions and/or judgments that are well supported and underpinned by a balanced analysis.</i></li> <li>• <i>Explicit references are made appropriately to the scenario in the stimulus material throughout the response.</i></li> </ul>