Diploma Programme
Programme du diplôme
Programa del Diploma

Information technology in a global society
Higher level
Paper 1

Wednesday 17 May 2017 (afternoon)

2 hours 15 minutes

Instructions to candidates

- Do not open this examination paper until instructed to do so.
- Section A: answer two questions.
- Section B: answer one question.
- Each question is worth **[20 marks]**.
- The maximum mark for this examination paper is **[60 marks]**.

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International Baccalaureate
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Section A

Answer **two** questions. Each question is worth [20 marks].

1. **Airport luggage control**

    Large airports need to handle thousands of pieces of luggage (including suitcases and other types of baggage) from the moment passengers check them in at the counter until the moment they arrive at their final destination. Sometimes a passenger will change airplanes during their journey, so their bags will need to be transferred by conveyor belt from one plane to another.

    When the passenger checks in at the airline counter, a tag is printed and attached to each piece of luggage (see **Figure 1**). This tag has information about the passenger and their journey printed on it and also shows both a barcode and a ten-digit number that are unique to each piece of luggage.

    Figure 1: A luggage tag
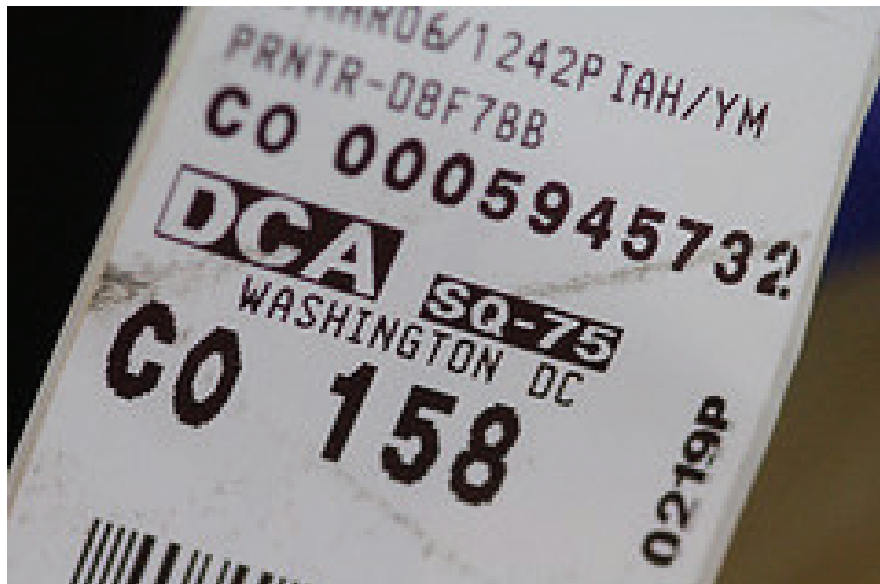
    [Source: https://en.wikipedia.org/wiki/Bag_tag#/media/File:Dca-baggage-tag.jpg]

    The luggage then goes on to a number of conveyor belts that take each bag to where it needs to go. Conveyor belts connect to other conveyor belts that direct luggage from the airport building to the correct airplane, or from one airplane to the next if the passenger changes airplanes during the journey, or to the baggage reclaim area at the end of the journey. The airport luggage control system will know when to push the bag from one conveyor belt to another to ensure it gets to the correct destination.

    [Source: adapted from: http://science.howstuffworks.com/transport/flight/modern/baggage-handling.htm/printable]

(This question continues on the following page)

(Question 1 continued)

(a)   The barcode allows the airport's luggage control system to access a database containing information about each piece of luggage.

     (i)   Identify **two** pieces of information about the luggage that may be obtained from this database. [2]

     (ii)   Identify the steps taken by the luggage control system to decide which conveyor belt to choose when a bag reaches a junction between two conveyor belts. [4]

(b)   Analyse the decision by some airports to attach radio frequency identification (RFID) tags to luggage when it is checked in by the passenger, instead of barcode paper printed tags. [6]

(c)   Airlines have databases that contain data about passengers when tickets are booked. This data includes travel dates, itineraries, contact details, passport details and passengers' home addresses. When passengers purchase a ticket online from an airline company, they have to accept the airline's terms and conditions by clicking "Agree" (see **Figure 2**).

Figure 2: Acceptance of airline terms and conditions
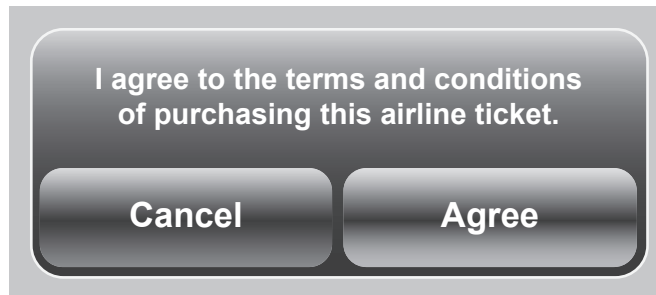
[Source: © International Baccalaureate Organization 2017]

Within these terms and conditions, it states that the airline may receive a request to share this data with the government of the country to which the passenger is flying.

Discuss whether airlines should share passengers' data with the governments of the countries to which they are flying. [8]

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2.   Apurimac Health Centre

Apurimac, a village in the mountains of Peru, is five hours away from the nearest hospital in Cusco. Apurimac Health Centre is equipped to attend to basic medical needs, such as minor surgery and delivering babies.

Juan Orams is a young doctor and also the manager of Apurimac Health Centre, and has been requesting computers for a long time. The doctors at the health centre have been using Juan's personal laptop to store patient records and write medical reports. Apurimac Health Centre has recently received a donation of six desktop computers and a small black-and-white laser printer from the Association for Rural Health (ARH).

The ARH has sent an IT specialist to install the six computers and make sure they work. Each computer has four gigabytes (GB) of RAM, a 300 GB hard disk, a DVD reader, an antivirus program, a word processor, a spreadsheet and a simple database program.

The local telephone company has offered to install an internet connection at the centre in the near future, but the health centre will have to pay a monthly fee for this to an internet service provider (ISP).

(a)   All computers have input and output devices.

   (i)   Identify **one** input device.   [1]

   (ii)   In addition to a printer, identify **one** output device.   [1]

   (iii)   Identify **one** characteristic of random access memory (RAM).   [1]

   (iv)   Identify **one** activity carried out by the health centre that would be easier to do with spreadsheet software.   [1]

   (v)   Identify **two** characteristics of an internet service provider (ISP).   [2]

(b)   Medical students in Peru must spend six months training in rural areas during their medical studies. Apurimac Health Centre has been selected by the medical school in Cusco as a place to send students for training every year.

   Analyse the impact on the medical student of spending six months training in a health centre with limited Internet access.   [6]

(c)   Juan has a limited budget and has two options:
   • install a network and pay for an Internet connection, or
   • spend the money on training the doctors to use the IT system, acquiring modern software and installing diagnostic tools on the standalone computers.

   Evaluate these **two** options.   [8]

Turn over

3. **Updating the Wisconsin High School (WHS) database**

Wisconsin High School (WHS) uses ColegiumWise, a management information system (MIS). The MIS contains a relational database that stores information about students and parents.

The administrators of WHS have found that some of the information about students and parents is not correct, so they have asked parents to ensure their information is updated or corrected when necessary by using an online form (see **Figure 3**).

It is important that the information stored in ColegiumWise is correct because some of this information, such as the students' names, will be sent to the One-to-Seven exam board, which will use it on the students' diploma certificates.

One way to ensure that the correct data has been entered into the ColegiumWise MIS is to use data validation.

Figure 3: An example of a record from the ColegiumWise MIS

Status:	Parent
Father's surname:	Presley
First name:	John
Nationality:	Canadian
Date of birth:	Day 12 Mon 01 Year 1970
Mother-tongue:	French
Education:	Master's Degree
Profession:	Industrial Engineer
Email:	J_PRESLEY@gmail.com

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[Source: © International Baccalaureate Organization 2017]

The school's administrators would like to ask parents for additional information to that which is already stored in the MIS. This is not possible with the current version of ColegiumWise. They will need to ask the developers of ColegiumWise to include these new fields in the MIS, as well as in some queries and reports.

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(Question 3 continued)

(a) (i) Identify **two** ways of preventing parents from making mistakes when entering data on the online form. [2]

(ii) Identify **two** characteristics of a relational database. [2]

(iii) The school wants to consult a lawyer about the documentation that would be needed to send students to France during the summer holidays. They would like to search the database to find a parent who is a lawyer who has French as their mother-tongue (first language).

Outline the query that could be used to search for this information. [2]

(b) The developers of ColegiumWise may accept requests from clients such as schools for additions or changes to the system. The developers send out system upgrades and updated user manuals on a regular basis with the changes that have been requested by the schools and other clients.

Explain **three** different ways the upgraded version of ColegiumWise could be tested before it is sent to the schools and other clients. [6]

(c) ColegiumWise has several key functions that cannot be changed. The contract with the developers of ColegiumWise is due to expire in 2018 and the administrators at WHS have two options:
• continue with ColegiumWise, knowing that it will not have the specific functions required by the school
• not renew the contract and develop their own school management information system (MIS) for the school.

Evaluate these options. [8]

Section B

Answer **one** question. Each question is worth [20 marks].
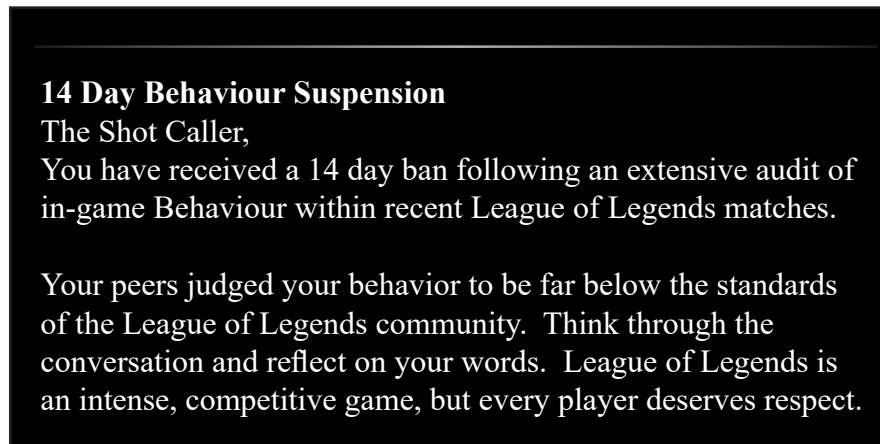
4.   **Artificial intelligence (AI) and cyber-bullying**

Players of online video games often engage in bullying and other types of abusive behaviour.
Riot Games, maker of League of Legends, is using artificial intelligence (AI) to stop that behaviour.

Riot Games collected millions of examples from previous gameplay of behaviour that had been
reported as abusive. This data was qualitative data. These examples of abusive behaviour were
presented to the game's players (the end-users), who voted on whether or not the behaviour
was acceptable. The examples that players voted as abusive were saved in a database.
The company then applied machine learning techniques, including pattern recognition, to analyse
these examples and identify the characteristics of abusive behaviour.

Based on these characteristics, *Riot Games* has developed an artificial intelligence program that
can identify gamers who are behaving abusively within five minutes of the offence and send them
notification of punishment. Punishments vary with the seriousness of the offence.

Once the AI algorithm began sending almost instant feedback, there was a significant decrease in
abusive behaviour.

Figure 4: Sample response to serious offence

14 Day Behaviour Suspension
The Shot Caller,
You have received a 14 day ban following an extensive audit of
in-game Behaviour within recent League of Legends matches.

Your peers judged your behavior to be far below the standards
of the League of Legends community. Think through the
conversation and reflect on your words. League of Legends is
an intense, competitive game, but every player deserves respect.

[Sources: www.the-vital-edge.com, www.technologyreview.com, www.engineering.com,
www.recode.net, www.nature.com]

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(Question 4 continued)

(a)   (i)   Identify **two** characteristics of machine learning. [2]

       (ii)   Apart from recognizing bullying, identify **two** uses of pattern recognition. [2]

       (iii)   *Riot Games* collected examples of behaviour that players had reported as abusive. A committee decided which examples were actually abusive.

           Outline **one** limitation of collecting data in this way. [2]

(b)   The new system has been implemented in phases, starting with the instant feedback system.

       (i)   Explain **one** reason why *Riot Games* decided to use a phased changeover when introducing the new system to the game. [2]

       (ii)   *Riot Games* has been happy to share both its data and best practices for controlling abusive behaviour with the wider gaming industry.

           Explain **one** benefit of this decision. [2]

       (iii)   Explain **one** reason why *Riot Games* chose to ask the end-users to decide what should be considered as abusive behaviour. [2]

(c)   While *Riot Games* is using artificial intelligence algorithms to improve game behaviour, similar algorithms could be used to evaluate the performance of employees, such as speed of service, body language, and so on. For example, the interactions between employees and customers in a coffee shop could be recorded and analysed to evaluate employee behaviour.

       Discuss the impact on the employees of the coffee shop of their managers using artificial intelligence algorithms to evaluate their performance. [8]

5.   Japan's robot hotel

Hen-na Hotel, the first hotel staffed almost entirely by robots, has opened in Sasebo, Japan.
Figure 5 shows the reception desk which is staffed by three robots:
• a small robot that speaks 19 different languages
• a female android that mimics human expressions and speaks Japanese and English
• a dinosaur that speaks English and Japanese.

All three robots use speech recognition and natural language software.

**Figure 5: The reception desk at Hen-na Hotel, Japan**

A robotic porter carries your luggage to your room, and room service is delivered by a rolling
vending machine. There is no need for a room key – facial recognition is used instead.
Inside the room is Tulip, a small robot that answers general questions, such as what the weather
will be like (see **Figure 6**).

A human hotel manager is on duty at all times to monitor the hotel and deal with any technical
failures.

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(Question 5 continued)

Figure 6: Tulip, the hotel room robot
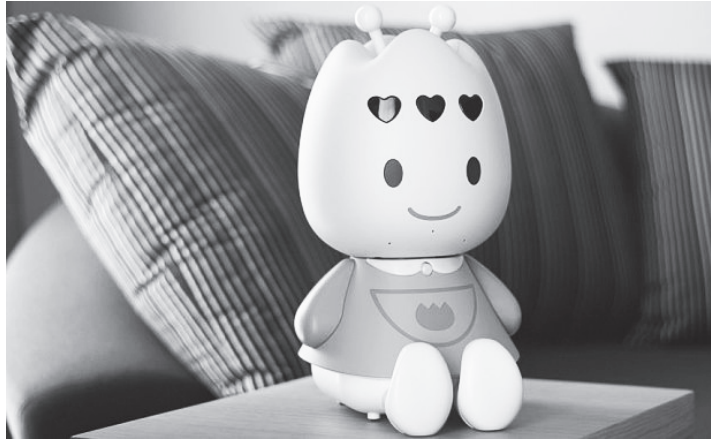
[Sources: www.nytimes.com, www.knowtechie.com and www.h-n-h.jp]

(a)　(i)　Identify the steps used by the facial recognition software to control access to the hotel rooms.　[4]

　　(ii)　Identify **two** characteristics of a "natural language".　[2]

(b)　Guests are understandably concerned about what happens when something goes wrong.　One day at the hotel Ms Kuragawa, the human manager, received the following incident report (a list of problems in the hotel) when she began her work shift:
　　• a room service robot has lost power on its way back from a delivery
　　• two guests have discovered that their luggage was taken to the wrong room
　　• the dinosaur robot that checks people in began repeating itself and had to be shut down, so there are now only two clerks to check people in
　　• the Tulip robot in room 104 has stopped working.

　　Incidents are given priority ratings of low, normal, high or very high.　Ms Kuragawa must give a priority rating to each incident.

　　Explain **three** criteria that she can use to determine the priority of these incidents.　[6]

(c)　Several other hotels are experimenting with robots that can check guests in, deliver room service and store bags.

　　Discuss the impact of using robots instead of human beings to provide services to guests in hotels.　[8]

6.   Self-driving (autonomous) trucks

For the first time, self-driving trucks (lorries) have been officially licensed to operate on public roads in the state of Nevada in the United States. These trucks will only be self-driving on interstate routes (motorways) similar to the example shown in **Figure 7** below. In other situations, such as on roads in a city, the driver will be in control.

Figure 7: A self-driving truck on an interstate route
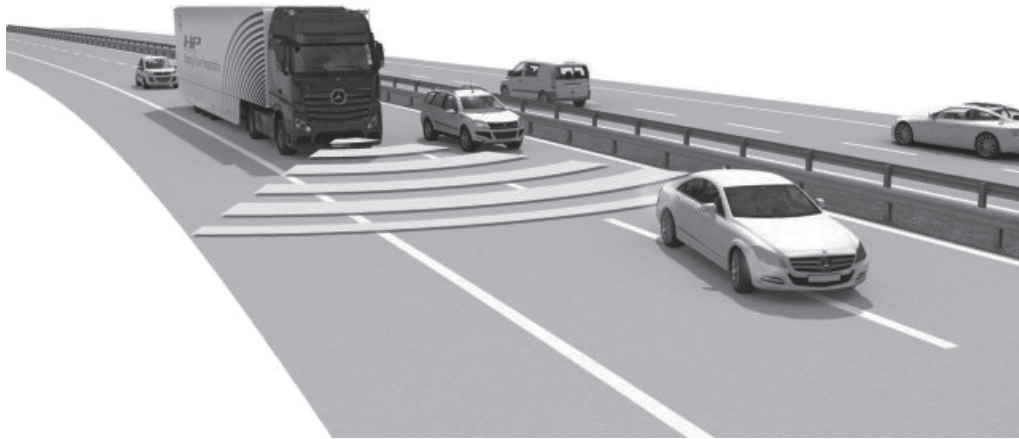
[Source: Daimler AG]

Currently, self-driving trucks use a number of algorithms that know when to change lanes, change speed and avoid collisions. However they still require a driver to take over in case of an unexpected event, such as in situations where the driver feels the truck cannot operate safely.

These trucks will not be commercially available for several years. However George Mahoney, the owner of Acme Trucking Company, wants to change all of his 75 trucks to self-driving trucks as soon as they are available. Mr Mahoney believes in long-term planning, so he has appointed a project management team to analyse the current situation, create a feasibility study and plan a possible changeover from driver-operated to self-driving vehicles.

[Sources: www.fleetowner.com, www.newscientist.com, www.theverge.com, www.bbc.com, www.marketwatch.com and www.cdf.toronto.edu]

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(Question 6 continued)

    (a)   (i)   Identify **two** sensors required by these trucks. [2]

            (ii)   Identify **two** characteristics of an algorithm. [2]

            (iii)   Identify **two** situations, in addition to roads in cities, where the self-driving trucks may not be able to operate safely without a human driver. [2]

    (b)   (i)   Explain **one** reason why the software that controls these trucks needs to use pattern recognition. [2]

            (ii)   Mr Mahoney has asked the project management team to undertake a feasibility study.

   Explain why undertaking a feasibility study will help Mr Mahoney decide whether to go ahead with the purchase. [4]

    (c)   To what extent would changing his 75 trucks to self-driving trucks benefit Mr Mahoney's company? [8]

Turn over

7.   Saving elephants from poaching

In 2016 conservationists estimated that in sub-Saharan Africa (all of Africa south of the Sahara Desert) 96 African elephants were killed every day by poachers (people that hunt animals illegally). At this rate, elephants could become extinct in our lifetime.

The most effective form of protection for these elephants is human patrols by rangers (people that are paid to protect wildlife), who catch the poachers. However these ranger patrols are labour-intensive and have to cover thousands of square kilometers. Usually the rangers only find the slaughtered animals, rather than the poachers.

Figure 8: The extent of elephant poaching in sub-Saharan Africa
(figures represent the number of elephants poached in each region)
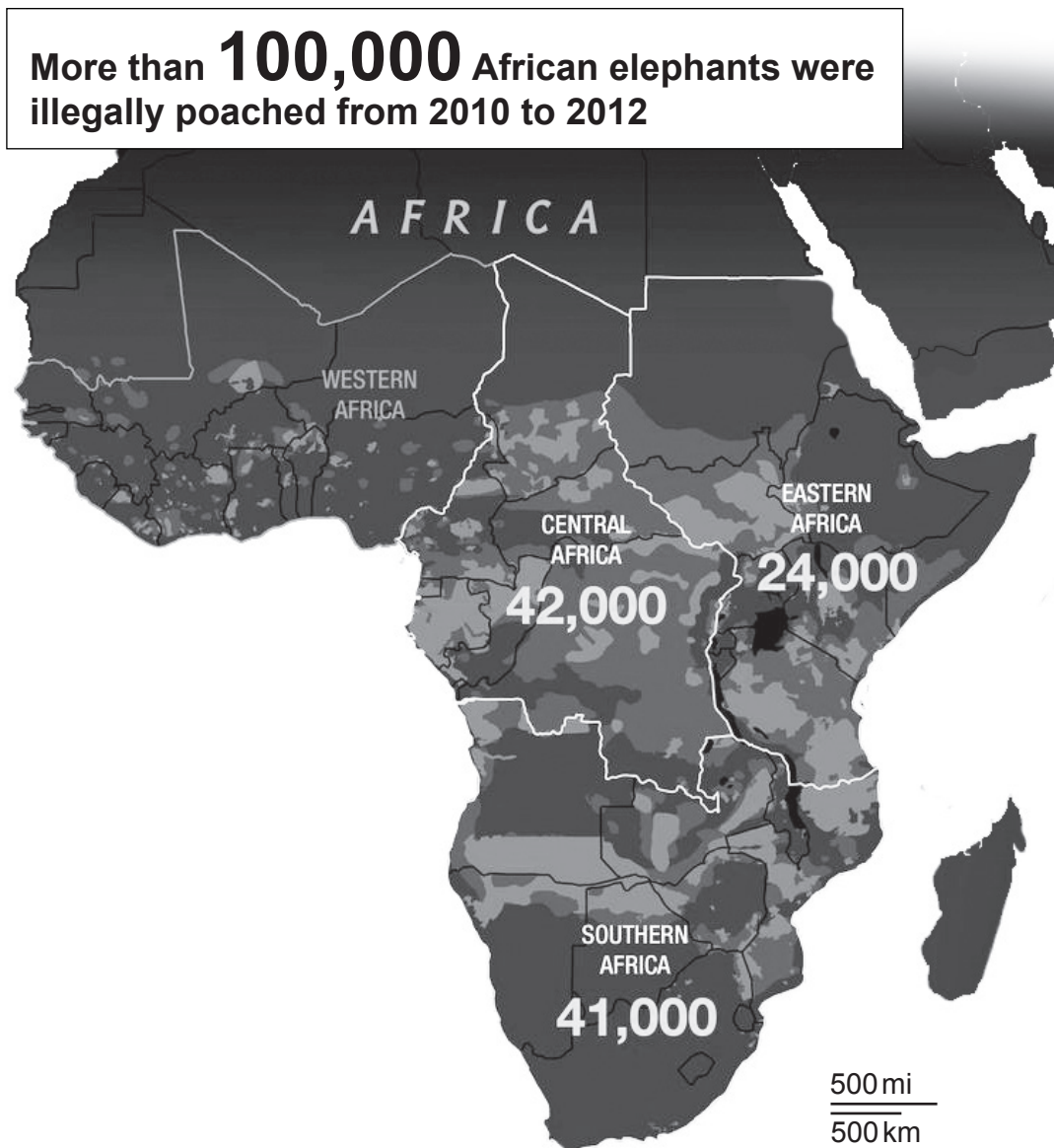
[Source: NATIONAL GEOGRAPHIC CREATIVE]

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(Question 7 continued)

To try to assist the rangers, scientists at the University of Southern California have developed an artificial intelligence (AI) software that can help predict where the poachers will be, and thus make the patrols more effective. This is called Protection Assistant for Wildlife Integrity (PAWS).

PAWS uses machine learning and pattern recognition to analyse years of data about poaching activities. This data includes things such as animal sightings and signs of poaching such as snares and animal remains. Using this data, PAWS can identify the natural paths that animals use and combine that information with evidence of poaching.

The artificial intelligence software is also able to create random patrols. These random patrols are intended to confuse poachers, so that they do not know where the rangers are likely to be at any given time.

The scientists have worked with rangers in Uganda to beta test a prototype of PAWS. In the future, scientists hope to expand the program to all the areas of sub-Saharan Africa where elephants are endangered.

[Sources: www.latimes.com, www.ibtimes.co.uk, www.zmescience.com, www.sciencenode.org and www.gotscience.or]]

(a)   Alpha testing and beta testing were used during the development of PAWS.

    (i)   Identify **two** characteristics of alpha testing. [2]

    (ii)   Identify **two** characteristics of beta testing. [2]

    (iii)   Identify **two** characteristics of artificial intelligence. [2]

(b)   The developers used the agile project development methodology rather than the waterfall project development methodology to develop PAWS.

    Explain why the developers have decided to use an agile project development methodology. [6]

(c)   In the future the use of PAWS will be extended to cover all of sub-Saharan Africa, and will be run from a control centre that communicates where it thinks the poachers might be active to the rangers who are patrolling these areas.

    To what extent can the implementation of PAWS assist in reducing the poaching of African elephants? [8]