Diploma Programme
Programme du diplôme
Programa del Diploma

Information technology in a global society
Higher level
Paper 1

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]**.

International Baccalaureate
Baccalauréat International
Bachillerato Internacional

Section A

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

1. **Smart lamp posts**

    The city of Hong Kong, in China, has installed smart lamp posts (see **Figure 1**). The lamp posts include LED lighting, sensors that monitor the environment, and cameras that take images of the surrounding area. The data collected is transmitted to a data centre that is part of a cloud computing network. This is part of a strategy to use digital technologies to improve the physical quality of life.

    Figure 1: A smart lamp post

    [Source: © Hong Kong Special Administrative Region (HKSAR) Government. GovHK (www.gov.hk).]

    (a) (i)   Identify **two** sensors the smart lamp posts could use.   [2]

         (ii)   Outline **one** reason why encryption is used to transmit the data from the smart
                lamp posts to the data centre.   [2]

         (iii) Outline **one** reason the Hong Kong authorities are using cloud computing to store
                the data collected by the lamp posts.   [2]

    (b) Explain **three** technical requirements that will need to be met to enable the smart lamp
         post system to function effectively.   [6]

    (c) To what extent will the introduction of smart lamp posts lead to an improvement in the
         environmental conditions within a city?   [8]

2. No more snow days

Around the world, extreme weather can prevent schools from opening. Examples of extreme weather include snow in Canada, rain in Oman, and typhoons in Japan.

In 2020 and 2021, many schools implemented a distance learning programme so they did not need to add days to the school year to make up for lost learning. Schools were given funding to upgrade their information technology (IT) infrastructures so students and staff would be able to study and work from home.

Some schools have used this funding to introduce a virtual private network (VPN), and others have used it to increase their cloud computing capability.

Students and staff are required to agree to an acceptable use policy before they are allowed to access a school's network.

With the movement towards online learning, teachers have also been asked to teach synchronously and asynchronously.

(a) (i) Identify **two** types of software required for distance learning. [2]

(ii) Identify **two** reasons why a school would introduce an acceptable use policy. [2]

(iii) Outline **one** advantage for users if a school introduces a virtual private network (VPN). [2]

(b) Two strategies for distance learning are synchronous teaching and asynchronous teaching.

Analyse these strategies. [6]

(c) Many schools are considering moving to a one-to-one mobile device programme where each student has access to one device.

Two options for implementing a one-to-one mobile device programme are:
• schools owning devices that are issued to students
• students owning their own devices and using them in the school (also called a bring-your-own-device (BYOD) policy).

Evaluate these options. [8]

Turn over

3.   **Digital documentation**

Governments currently use paper documents, such as a passport or driving license, to authenticate a citizen's identity.

Some governments, however, are allowing citizens to create a digital ID that they can use as proof of identity. This digital ID can be securely stored in a digital wallet app* on smartphones and other digital devices (see **Figure 2**).

Figure 2: Using a digital ID

Some governments are also considering extending their digital services and moving them completely online. These services could include digital medical records, digital tax information, digital driving licenses, and digital car registration documentation.

(This question continues on the following page)

(Question 3 continued)

One proposal is to store this data in a relational database. **Figure 3** shows part of the relational database.

Figure 3: Part of the relational database

Citizen
IdentID
Given_Name
Surname
DoB
More fields

Licenses
License_ID
IdentID
Driving_Lic_ID
More fields

Driving_License
Driving_Lic_ID
Date_Issued
Date_Expires
Issue_Centre
More fields

---

* app: small specialized program run on mobile devices, the internet, a computer or other electronic device

(a) (i) State the primary key in the Citizen table in **Figure 3**.   [1]

(ii) State the relationship between the Licenses and Driving License tables in **Figure 3**. [1]

(iii) Outline **one** advantage of using a relational database instead of a flat file database to store the data collected by the government.   [2]

(iv) Describe the difference between identification and authentication.   [2]

(b) The development of digital services will require policies for the collection, storage and sharing of data.

Explain how a government and the developers of its digital systems can ensure that the privacy of citizens is not compromised when data is collected, stored **and** shared.   [6]

(c) Discuss the advantages **and** disadvantages for the citizens of a country if the government moves its services online.   [8]
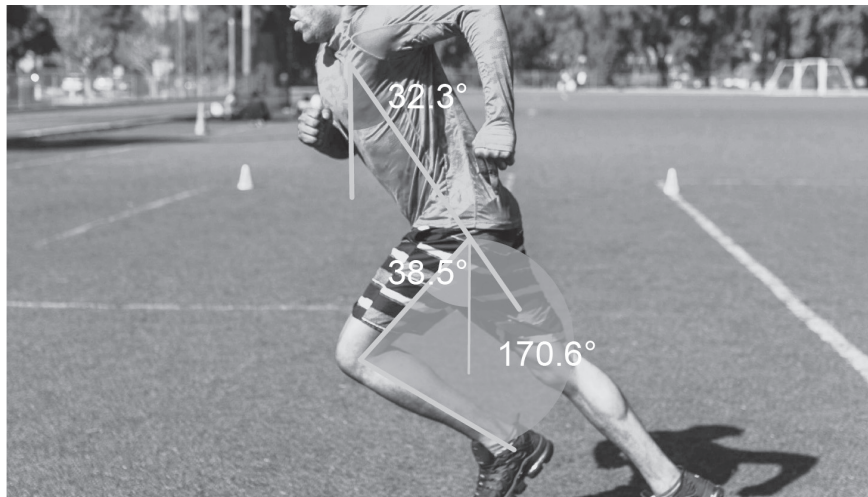
Section B

Answer **one** question. Each question is worth [20 marks].

4.   **Gait recognition biometrics**

Scientists have developed gait recognition systems that have been used to provide an athlete with information about their gait* (see **Figure 4**). Each athlete has a unique gait.

Figure 4: Gait information from an athlete

The data collected is input into a neural network for processing and pattern recognition, enabling the athlete's performance to be analysed.

This gait analysis can be used by national athletics organizations to identify strengths and weaknesses in the gait of their athletes. Using this information, coaches can develop a training plan to improve an athlete's performance while changing as little as possible in the athlete's gait.

_____

*   gait: the manner or style of moving

(a)   (i)   Identify **two** input devices used to capture data about an athlete's gait.   [2]

(ii)   Identify **two** forms of biometric identification **other than** gait.   [2]

(iii)   Identify **two** characteristics of a neural network.   [2]

(b)   (i)   Explain **two** reasons why a feasibility study would be carried out before gait analysis was considered.   [4]

(ii)   Explain **one** reason why a national athletics organization would employ a systems analyst.   [2]

(c)   Gait recognition systems that use neural networks and pattern recognition can be used to analyse an athlete's performance.

Discuss the decision by national athletics organizations to use gait analysis as a tool to improve the performance of their athletes.   [8]

5.   Patient diagnosis using expert systems

MYCIN was one of the first expert systems to use backward chaining to help determine if a patient had an infection, working back through several steps to determine the type of bacteria causing the infection and which antibiotics to use.

For example:
*   The patient has a bacterial infection.
*   The patient has a fever.
*   The patient is also experiencing severe stomach upset.
*   Therefore, the patient has typhoid (a bacterial infection caused by *Salmonella typhi*).

Expert systems will be developed in the future using the system development life cycle (SDLC). The SDLC includes a design phase and a testing phase.

(a)   (i)   Identify **two** components of an expert system.   [2]

(ii)   Identify **two** elements of the design phase in the system development life cycle (SDLC).   [2]

(iii) Identify **two** reasons why alpha testing is used in the development of a new expert system.   [2]

(b)   (i)   Distinguish between the use of backward chaining and forward chaining to determine the type of infection a patient has.   [2]

(ii)   Explain **two** reasons why prototypes are used in the development of a new expert system.   [4]

(c)   To what extent should doctors use expert systems for diagnosing patients?   [8]

6.   Assistive robots

Care homes* in Ireland plan to use a variety of assistive robots to support staff. These assistive robots use depth cameras, natural language processing and vision sensors to interact intelligently with care home residents. Two types of robot are being considered: Stevie and Ameca (see **Figure 5** and **Figure 6**).
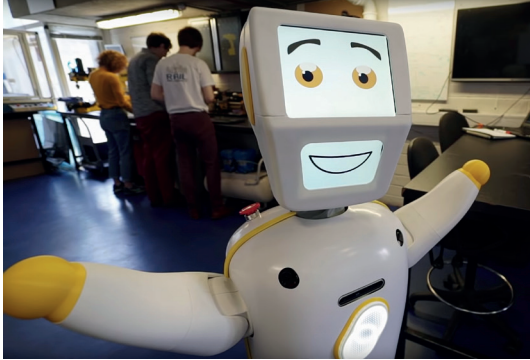
Figure 5: Stevie   **Figure 6: Ameca**

Ameca and Stevie have face and voice recognition. This means they can understand someone who is speaking to them, reply to commands, and interact with care home residents.

Ameca is an example of an android and has been developed by a company called *Engineered Arts*. The project manager, Morgan Roe, who is overseeing the development of Ameca, explained that the android has 17 motors inside its head that control its movements and expressions. Ameca's facial expressions are surprisingly lifelike. Morgan is aware that the project development team should avoid the uncanny valley.

---

*   care homes: large houses or institutions where people with particular problems or special needs are looked after

(This question continues on the following page)

(Question 6 continued)

    (a)   (i)   Identify **two** characteristics of an android. [2]

            (ii)   Identify **two** responsibilities of a project manager. [2]

            (iii)   Identify **two** characteristics of the uncanny valley. [2]

    (b)   (i)   Explain **one** reason why interviews would be used to gather information about the use of language from care home residents when developing assistive robots such as Stevie and Ameca. [2]

            (ii)   Explain **one** advantage of using supervised learning to develop the natural language processing capabilities used by Stevie to interact with care home residents. [2]

            (iii)   Explain **one** disadvantage of using supervised learning to develop the natural language processing capabilities used by Stevie to interact with care home residents. [2]

    (c)   Discuss the advantages **and** disadvantages of using an android robot like Ameca to support care home residents. [8]

References:

Figure 1   © Hong Kong Special Administrative Region (HKSAR) Government. GovHK (www.gov.hk).

Figure 2   Fedpol. https://commons.wikimedia.org/wiki/File:NIDK-front.jpg. Licensed under CC 3.0 CH https://creativecommons.org/licenses/by/3.0/ch/deed.en. Image adapted.

Figure 4   RDNE Stock project / Pexels. Source adapted.

Figure 5   Trinity College Dublin, 2019. *Robotics engineers unveil 'Stevie II' – Ireland's first socially assistive AI robot*. [video online] Available at: https://www.youtube.com/watch?v=bRlVtjhkQ8M [Accessed 28 July 2022].

Figure 6   Image with permission from Engineered Arts.