

Answers to Student's Book

Exam-style questions and sample answers have been written by the authors. References to assessment and/or assessment preparation are the publisher's interpretation of the syllabus requirements and may not fully reflect the approach of Cambridge Assessment International Education. Cambridge International recommends that teachers consider using a range of teaching and learning resources in preparing learners for assessment, based on their own professional judgement of their students' needs.

Cambridge Assessment International Education bears no responsibility for the example answers to questions taken from its past question papers which are contained in this publication.

The questions, example answers, marks awarded and/or comments that appear in this digital material were written by the author(s). In examination, the way marks would be awarded to answers like these may be different.

3 Hardware

Answers to activities

3.1

- 1
 - a address bus, data bus, control bus
 - b

address bus: carries addresses throughout the computer; it is unidirectional

data bus: bidirectional bus allowing data to be sent throughout the computer

control bus: carries signals from the control unit to all other computer components; it is bidirectional
 - c
 - wider address and data buses would increase computer performance
 - wider control bus would have little, if any, effect on performance
 - higher clock speed would increase processor speed, (overclocking could have serious consequences however, such as unsynchronised operations or overheating)
- 2

fetches

current instruction register (CIR)

program counter (PC)

memory address register (MAR)

address bus

memory data register (MDR)

decoded

executed

control signals

control bus

arithmetic and logic unit (ALU)

accumulator (ACC)

3.2

- 1 a
- increasing the width of the address bus and width of the data bus
 - increasing clock speed but care needed to avoid over-clocking
 - use of larger cache memories (uses static RAM) which have faster data access time than normal RAM (which is dynamic)
 - using dual core and quad core processors; but doubling number of cores doesn't double processor performance since the CPU needs to communicate with each core which uses up time
- b
- instructions are a set of operations which are decoded in sequence
 - each operation is made up of an opcode (which informs the CPU about what operation needs to be done) and an operand (data which needs to be acted on/register)
 - limited number of opcodes exist and this is known as an instruction set
 - instruction sets are low level language instructions which instruct the microprocessor how to carry out an operation
- 2 a
- destination address input
 - other factors (e.g. avoiding toll roads) are input
 - data from satellites, which gives the location of three or four satellites ...
 - ... together with very accurate timings
 - Sat Nav computer uses satellite data to calculate the position of a car on the stored maps
 - this combination allows accurate tracking of the vehicle on stored roads
- b
- use of satellite or cellular network used to download the latest map updates/software updates
 - if the Sat Nav is a portable unit, it can be connected to a computer via USB port and new maps/software will be downloaded

3.3

- 1 a || wwwbwbb/wwwbbwb/wwwbbwb || bwwwwbw/bwbbbww/bbbwwbw ||
- b || wwbbwwb/wwbwbb/wbbwwb/wbbbwbb ||
bwbwww/bwbwww/bwbbbww/bwbwww ||
- c || wwwbbwb/wbbwwwb/wbbbbb/wbbbbb/wwwbwb ||
bbbwwb/bbwbww/bbbbw/bbwbbw/bwbwww ||
- 2 a
- hold more information
 - fewer errors due to built-in error-checking in QR codes
 - easier to read – QR codes can be read by a smartphone/tablet camera and app
 - QR codes can be encrypted
- b $40 \times 40 = 1600 \text{ pixels} = 1600 \text{ bits} = 200 \text{ bytes}$
- c
- they are used as a form of alignment when reading the QR code
 - the remaining corner square is used to ensure the correct size and correct angle of QR camera shot
- d
- more than one QR format exists

- QR codes can contain malicious codes (called attagging); QR code software is free; therefore, it is easy to embed malicious software or fake websites

3.4

1 a Laser printer:

- uses dry powdered ink (toner)
- makes use of the properties of static electricity to produce text and images on paper
- prints whole page in one go
- ink is fused onto paper using heated rollers

Inkjet printer:

- uses liquid ink in four or five cartridges
- printing is done line by line as paper advances forward after each printed line
- ink droplets are ejected onto paper using thermal bubble or piezoelectric technology

b Parts i and ii

Laser printer:

- high-quality flyers and posters (in large quantities)
- any large volume printing job
- equipped with large capacity toner cartridges
- have large paper trays

Inkjet printer:

- one-off printouts, such as photos
- small batch printing jobs
- can print on various types of paper and other media (for example, can print on T-shirts)
- where small paper trays and small capacity ink cartridges are not important for small print jobs

2 Order: C, E, G, A, I, B, F, H, D

3 a In an LCD–LED screen, each pixel is made from liquid crystals that are backlit using LEDs. In pure LED screens, the pixels are made up of the LEDs themselves.

b LEDs:

- use less power
- they do not need to warm up to reach maximum brightness
- produce a 'whiter' light
- produce a brighter light
- last for much longer

- #### 4
- Filipe uses an application on his computer that can play music files.
 - The application finds the files on the backing store (HDD or SSD) and moves it into RAM.
 - The data in the file is read by the application and then sent via a device driver to loudspeakers which are connected to the computer.
 - The device driver software translates the digital data into a series of analogue electrical signal using a digital-to-analogue converter (DAC).
 - The electrical signals make the loudspeaker cones move, through the use of a solenoid.
 - If the file is a stereo recording then two different signals are sent to each loudspeaker.

- The movement of the loudspeaker cone moves molecules of air, which Filipe's ears detect, and means he can hear music.

3.5

1 a Control:

- sensors used to collect data to send to a microprocessor
- sensor data is compared to stored/pre-set data
- the output affects the next set of inputs
- microprocessor sends signals to actuators to operate valves, motors and switches

Monitoring:

- sensors used to collect data to send to a microprocessor
- sensor data is compared to stored/pre-set data
- no actual changes to the process are made
- results of data comparison are shown on a screen/printed out or an alarm is activated

- b**
- temperature and humidity sensors are used
 - both sensors constantly send data to a microprocessor
 - the data is converted to digital, if necessary, using an ADC
 - the temperature levels are set by the user ...
 - ... humidity levels are set at the factory
 - if the temperature sensor reading $>$ set temperature, the microprocessor will send a signal to an actuator ...
 - ... to switch on the air conditioning unit
 - if the temperature sensor reading $\leq$ the set temperature, the microprocessor will send a signal to an actuator ...
 - ... to switch off the air conditioning unit
 - if the humidity sensor reading $>$ factory set value, the microprocessor will send a signal to an actuator ...
 - ... to switch on the air conditioning unit
 - if the humidity sensor reading $\leq$ the factory setting AND temperature sensor reading $<$ the set temperature ...
 - ... the microprocessor will send a signal to an actuator to switch off the air conditioning unit
 - the process is continuous

- 2**
- pH sensors send data back to microprocessor
 - data changed to digital if necessary (using ADC)
 - if $\text{pH} < \text{stored value}$ then microprocessor sends signals to actuators ...
 - ... to open valve to add alkaline solution to soil
 - if $\text{pH} > \text{stored value}$ then microprocessor sends signals to actuators ...
 - ... to open valve to add acidic solution to soil
 - if $\text{pH} = \text{stored value}$ then microprocessor sends signals to actuators ...

- ... to close all valves
- the process is continuous
- 3**
 - readings taken from pressure and temperature sensors
 - readings changed to digital if necessary (using ADC)
 - readings are sent to microprocessor
 - if temperature > stored value, microprocessor sends signal to actuators ...
 - ... to open water valves
 - if temperature ≤ stored value, microprocessor sends signals to actuators ...
 - ... to close water valves
 - if pressure ≥ stored value, microprocessor sends signals to actuators ...
 - ... to close CO² gas valves
 - if pressure < stored value, microprocessor sends signals to actuators ...
 - ... open CO² gas valves
 - monitoring/control is continuous
- 4**
 - pressure sensors in all four roads at junction used to detect vehicles approaching lights in all directions
 - data is sent back to a microprocessor
 - number of vehicles approaching each set of traffic lights is calculated by the microprocessor based on sensor data
 - generated data is compared to a data model stored in the microprocessor system
 - signals sent by the microprocessor to alter light sequences as required
 - monitoring of roads is a continuous process

3.6

- 1 a** RAM – settings (time, weight, defrost, ...)

ROM – microwave wavelength, pre-programmed cooking times, safety systems
- b** RAM – temperature settings

ROM – control program to monitor fridge
- c** RAM – user settings, bespoke programs

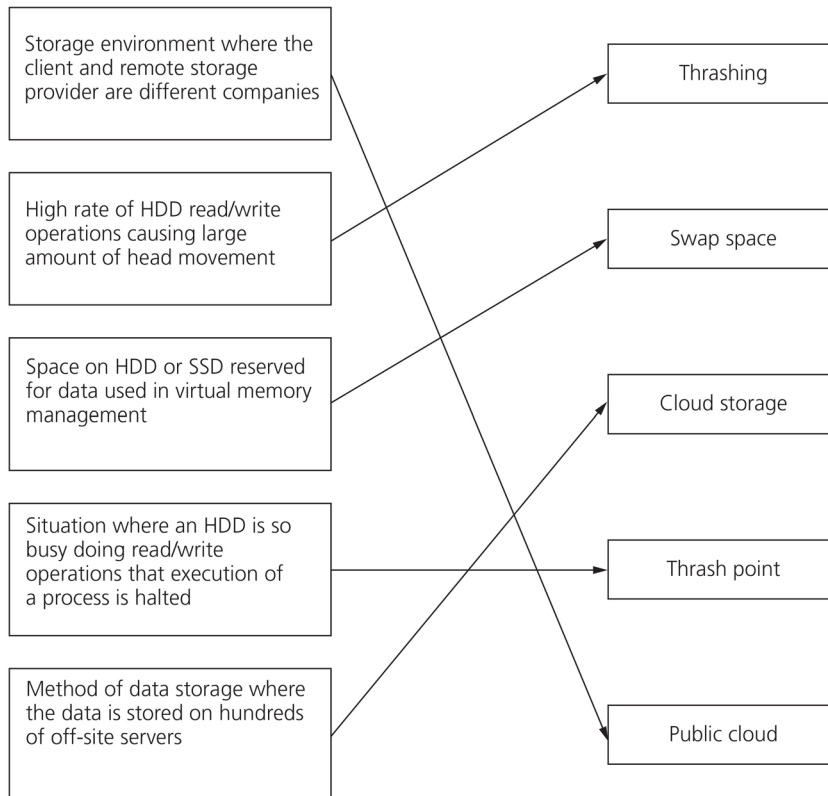
ROM – wavelength of remote signals, pre-programmed flights, ...

3.7

- 1** RAM:
 - used by both OS and applications software
 - when phone switched on, it pulls OS and app data from solid state memory to allow it to function; user's data
 Solid state:
 - used to store apps and operating system so that it is always there even when phone switched off
 - part of solid-state memory not accessible to users (for example, the OS)
 - stores user's photos, music files, and so on
- 2 a**
 - uses movement of data between RAM and HDD/SSD

- RAM is physical memory and virtual memory is RAM + swap space on HDD/SSD
- to execute a program, data is loaded into RAM from HDD/SSD
- gives the illusion that RAM is much larger than it really is
- b**
 - when P5 wants access to RAM we use virtual memory since RAM is full
 - assuming P1 is oldest data, P1 data (10 GiB) is moved out of RAM into HDD/SSD
 - P5 now points to memory space in RAM once occupied by P1
 - process continues to allow all five programs to run in RAM

3



4

a RAM:

- temporary memory device
- volatile memory
- can be written to and read from
- used to store data, files, programs, part of OS **currently** in use
- can be increased in size to improve operational speed of a computer
- a computer has far more RAM memory than ROM memory

ROM:

- permanent memory device
- non-volatile memory device
- read-only
- used to store the boot-up instructions
- an increase in the amount of ROM has no effect on computer performance

b For example:

- RAM – used by a PC to store the contents of an application when the computer is running
- ROM – used by a PC to find out what it should to do when the power is switched on

- 5 a** electrons
NAND
matrix
intersection
control gate
floating gate
electrons
control gate
- b** Compared to HDDs, SSDs:
- have faster data access times
 - are lighter
 - consume less power
 - don't get as hot
 - are thinner
 - are more reliable
- c** More expensive – questions over how long they can store data for

3.8

- 1 a**
- A network interface card (NIC) is needed to allow a device to connect to a network (such as the internet).
 - It is usually part of the device hardware and contains the Media Access Control (MAC) address generated at the manufacturing stage.
- b**
- Media Access Control is an address which refers to a number which uniquely identifies a device on the internet.
 - It takes the form: NN-NN-NN-DD-DD-DD.
- c**
- Internet Protocol identified either as IPv4 or IPv6
 - It gives a unique address to each device connected to the internet which identifies their location.
- d**
- These enable data packets to be routed between the different networks, for example, to join a LAN to a WAN onto the internet.
- e**
- A server that automatically provides and assigns an IP address.
- 2 a**
- changes each time a device connects to the internet
 - allows for greater privacy
 - can be less reliable for some applications (e.g. VoIP)
- b**
- IP address is associated with a particular device and does not change each time the device connects to the internet
 - allows faster upload and download speeds
 - less privacy as a specific device can be identified by its IP address
- c** Dynamic IP addresses are needed for the following reasons:
- they give greater privacy since they change each time a user logs on

- dynamic IP addresses can be an issue when using, for example, VoIP since this type of addressing is less reliable as it can disconnect and change the IP address causing the VoIP connection to fail

Static IP addresses are needed for the following reasons:

- since static IP addresses don't change, they allow each device to be fully traceable
- allow for faster upload and download speeds

3 MAC:

- Permanent address associated with the piece of hardware
- Unique
- 48-bit address
- Used to find the particular device within a network

IP:

- An address assigned to hardware by an ISP – even a static IP address is not physically associated with the hardware
- Not necessarily unique
- 32 (IPv4) or 128 (IPv6) bit address
- Used to route data to the correct network

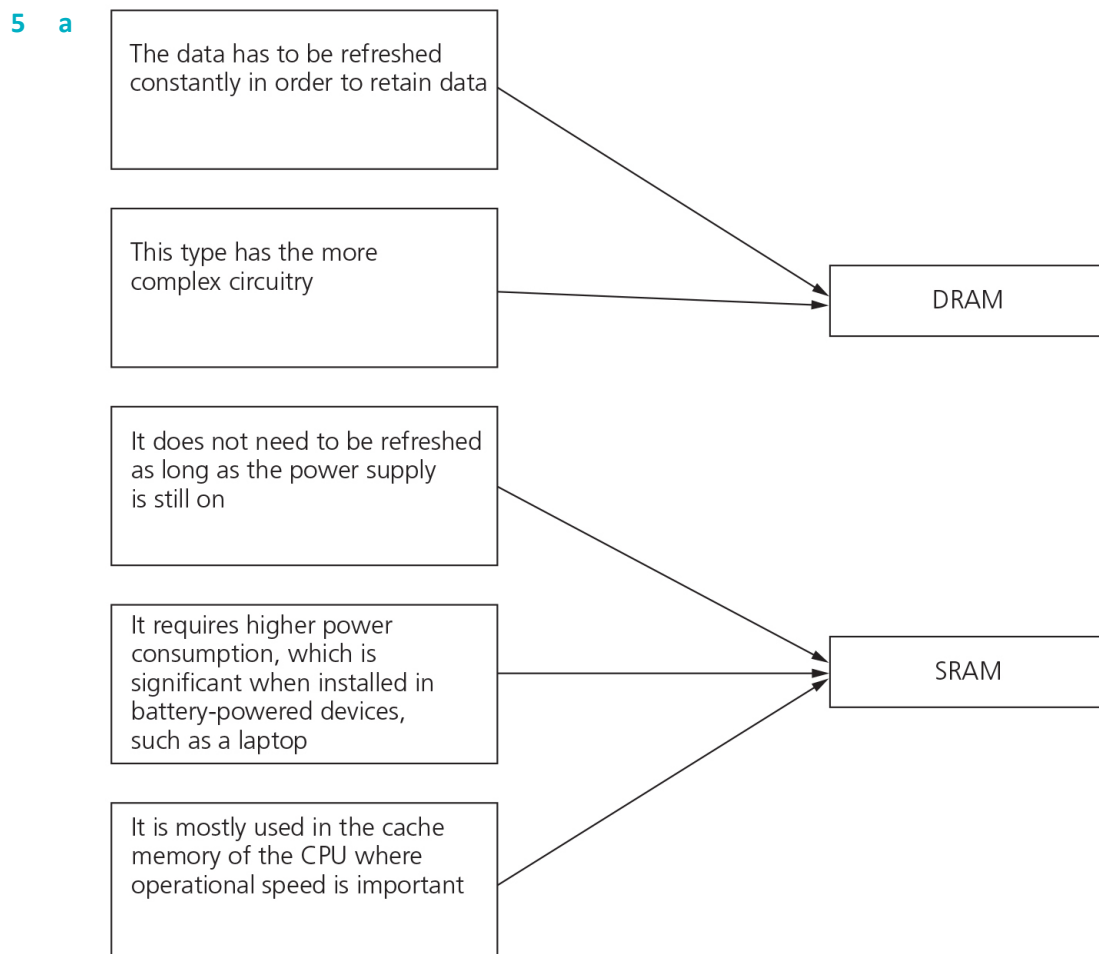
Answers to exam-style questions

Answers to questions 7–9 in this section are example answers for past paper questions. The details of the relevant past paper can be found with the corresponding exam-style question in the Student's Book.

- 1 a**
- The plastic, organic layers of an OLED are thinner, lighter and more flexible than the crystal structures used in LEDs or LCDs.
 - The light-emitting layers of an OLED are lighter; OLED layers can be made from plastic rather than the glass used in LED and LCD screens.
 - OLEDs give a brighter light than LEDs.
 - OLEDs do not require backlighting like LCD screens – OLEDs generate their own light.
 - Since OLEDs require no backlighting, they use much less power than LCD screens (most of the LCD power is used to do the backlighting); this is very important in battery-operated devices such as mobile phones.
 - Since OLEDs are essentially plastics, they can be made into large, thin sheets (this means they could be used on large advertising boards in airports, subways, and so on).
 - OLEDs have a very large field of view, about 170 degrees, which makes them ideal for use in televisions and for advertising screens.
- b**
- many colours are possible if each primary colour (RGB) uses several bits to represent its colour intensity ...
 - ... for example, 32 bits per colour gives $2^{32} \times 2^{32} \times 2^{32}$ possible colour combinations
 - however, the human eye cannot detect more than a few thousand different colour shades ...
 - ... therefore, it is impossible to experience the 1 million different colours as claimed by the manufacturer

- television contrast (etc.) needs to be set up perfectly to show all colours accurately
- 2 a i** Two from:
- cannot be changed by the user
 - more difficult to copy the software
 - immediately available as soon as device powered up
 - programs are permanently stored
- ii** RAM allows the user to store their own data, such as game status
- only the part of the software needed at each stage in the game would be in RAM at any time
- iii** USB ports allow other games stored on memory sticks, for example, to be plugged into the games console
- can plug the console into external speakers for better sound effects
 - can plug in keyboard and/or mouse to navigate menu systems
 - can plug in VR headsets for consoles with this capability
- b**
- the design may change several times ...
 - ... therefore, it is cheaper and quicker to make a prototype using a 3D printer
 - the 3D solid object lets the development team see how well it will work in real life before building the final version
- 3 a**
- both use sensors to gather data
 - in control, the output affects the input and actuators are used to change the process (for example, open valve, operate pump)
 - in monitoring, no changes to the process are made; the system simply shows the status on a screen or prints out data or sounds an alarm
- b**
- temperature and humidity sensors are used
 - both sensors constantly send data to a microprocessor
 - the data is converted to digital, if necessary, using an ADC
 - the temperature levels are set by the user ...
 - ... humidity levels are set at the factory
 - if the temperature sensor reading is $>$ set temperature, the microprocessor will send a signal to an actuator ...
 - ... to switch on the air conditioning unit
 - if the temperature sensor reading $\leq$ the set temperature, the microprocessor will send a signal to an actuator ...
 - ... to switch off the air conditioning unit
 - if the humidity sensor reading $>$ factory set value, the microprocessor will send a signal to an actuator ...
 - ... to switch on the air conditioning unit
 - if the humidity sensor reading $\leq$ factory setting AND temperature sensor reading $<$ set temperature ...
 - ... the microprocessor will send a signal to an actuator to switch off the air conditioning unit

- 4 a
- the process is continuous
 - static IP address doesn't change
 - dynamic IP address is a temporary IP address assigned to a device each time it logs onto the internet
 - dynamic IP addresses make use of a Dynamic Host Configuration Protocol (DHCP) server which assigns the IP addresses whereas static IP addresses are assigned by the ISP
 - static IP addresses assigned to servers which host websites or to FTP servers; this gives the device a consistent location and also means less bandwidth is used reducing network traffic (and takes less time to retrieve data)
 - dynamic IP addresses afford greater privacy since they change each time a device logs onto the internet, therefore it makes the device more difficult to trace
- b
- MAC address is a media access control address
 - MAC is used to uniquely identify a device
 - uses the format: NN – NN – NN – DD – DD – DD
 - where NN – NN – NN refers to the manufacturer and DD – DD – DD refers to the serial number of the device
 - there are two types referred to as UAA (set at factory) or LAA (can be changed by user)



b RAM:

- temporary memory device
- volatile memory
- can be written to and read from
- used to store data, files, part of OS currently in use
- can be increased in size to improve the performance of computer

ROM:

- permanent memory device
- non-volatile memory device
- data cannot be altered
- sometimes used to store the BIOS and other start-up procedures

c DVD:

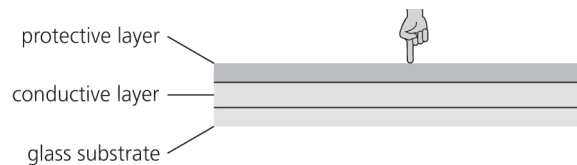
- uses red laser technology
- storage capacity is ~ 4.7 GB max
- doesn't allow great interactivity
- relatively easy to copy
- data transfer rate is ~ 10 Mbps
- always comes in dual-layer format

Blu-ray:

- uses blue laser technology
- storage capacity can be up to ~ 50 GB
- allows much greater interactivity
- has built-in data encryption
- data transfer rate is ~ 36 Mbps
- can come in single-layer, dual-layer ... up to 6-layer formats

6 a Capacitive touch screens:

- capacitive touch screens are composed of a layer of glass (protective layer), a transparent electrode (conductive) layer and a glass substrate
- since human skin is a conductor of electricity, when bare fingers (or special stylus) touch the screen, the electrostatic field of the conductive layer is changed
- the installed microcontroller is able to calculate where this change took place and hence determine the coordinates of the point of touching



- with surface capacitive screens, sensors are placed at the corners of a screen
- small voltages are also applied at the corners of the screen creating an electric field
- a finger touching the screen surface will draw current from each corner reducing the capacitance
- a microcontroller measures the decrease in capacitance and hence determines the point where the finger touched the screen
- this system only works with a bare finger or stylus
- with projective capacitive screens, the transparent conductive layer is in the form of an X-Y matrix pattern
- this creates a three dimensional (3D) electrostatic field
- when a finger touches the screen it disturbs the 3D electrostatic field allowing a microcontroller to determine the coordinates of the point of contact
- this system works with bare fingers, stylus and thin surgical or cotton gloves; it also allows multi-touch facility (for example, pinching or sliding)

Infrared touch screens:

- infrared touch screens use a glass screen with an array of sensors and infrared transmitters
- the sensors detect the infrared radiation; if any of the infrared beams are broken (for example, with a finger touching the screen), the infrared radiation reaching the sensors is reduced
- the sensor readings are sent to a microcontroller which calculates where the screen was touched

Resistive touch screens:

- these screens are made up of two layers of electrically resistive material with a voltage applied across them
 - the upper layer is made of flexible polyethylene (a type of polymer) with a resistive coating on one side
 - the bottom layer is made of glass also with a resistive coating (usually indium tin oxide) on one side
 - these two layers are separated by air or an inert gas (such as argon)
 - when the top polyethylene surface is touched, the two layers make contact
 - since both layers are coated in a resistive material, a circuit is now completed which results in a flow of electricity
 - the point of contact is detected where there was a change in voltage
 - a microcontroller converts the voltage (created when the two resistive layers touch) to digital data which it then sends to the microprocessor
- b i** Uses organic layers which emit their own light and therefore there is no need for any backlighting
- ii**
- The plastic, organic layers of an OLED are thinner, lighter and more flexible than the crystal structures used in LEDs or LCDs.
 - The light-emitting layers of an OLED are lighter; OLED layers can be made from plastic rather than the glass used in LED and LCD screens.
 - OLEDs give a brighter light than LEDs.
 - OLEDs do not require backlighting like LCD screens – OLEDs generate their own light.
 - Since OLEDs require no backlighting, they use much less power than LCD screens (most of the LCD power is used to do the backlighting); this is very important in battery-operated devices such as mobile phones.
 - Since OLEDs are essentially plastics, they can be made into large, thin sheets (this means they could be used on large advertising boards in airports, subways, and so on).
 - OLEDs have a very large field of view, about 170 degrees, which makes them ideal for use in televisions and for advertising screens.

- 7 a touchscreen/concept keyboard/microphone/trackerball/touchpad
b headphones/speakers
c (removable) hard disk drive/SSD/USB drive/Blu-ray disk
d
- QR code scanned using a camera on smartphone or tablet
 - QR code is decoded/read using the app on the smartphone/tablet
 - customer is provided with text about the animal
 - customer is directed to a website about the animal
 - QR code can be saved for future use
- 8 a input device which measures/takes readings from the surroundings/environment
b
- moisture sensor:
 - measures water content of the soil
 - alerts Anna when soil is too dry/too wet
 - maintains correct water level in the soil
 - pH sensor:
 - measures how acidic/alkaline the soil is
 - alerts Anna when there may be something polluting the soil
 - maintains correct pH level of the soil
 - light sensor:
 - measures brightness of the surroundings
 - alerts Anna when fruit has too little/too much light
 - temperature sensor:
 - measures the temperature of the surroundings
 - alerts Anna when it is too hot/too cold for optimum growing conditions
 - gas/O₂/CO₂ sensor:
 - measures amount of CO₂ in the air
 - alerts Anna if CO₂ levels are too high/too low
 - humidity sensor:
 - measures the water content of the air
 - alerts Anna if the air is too dry/too damp
 - infrared sensor/motion sensor:
 - measures infrared/microwaves
 - detects intruders/wild animals
 - pressure sensor:
 - measures the weight of fruit fallen to the ground ...
 - ... to alert Anna about how much fruit has fallen from the trees

9

