Unit 1

Computer Hardware

Text A

Computer Hardware (1)

扫码听课文

1. Introduction

Hardware is the most visible part of any information system: the equipment such as computers, scanners and printers that is used to capture data, transform it and present it to the user as output. Although we will focus mainly on the personal computer (PC) and the peripheral devices that are commonly used with it, the same principles apply to the complete range of computers:

- Supercomputers, a term used to denote the fastest computing engines available at any given time, which are used for running exceptionally demanding scientific applications.
- Mainframe computers, which provide high-capacity processing and data storage facilities to hundreds or even thousands of users operating from terminals.
- Servers, which have large data storage capacities enabling users to share files and application software, although processing will typically occur on the user's own machine.
- Workstations, which provide high-level performance for individual users in computationally intensive fields such as engineering.
- Personal computers (including laptop/notebook computers), which have a connected monitor, keyboard and CPU, and have developed into a convenient and flexible business tool capable of operating independently or as part of an organizational network.
- Mobile devices such as personal digital assistants or the latest generation of cellular telephones, which offer maximum portability plus wireless connection to the internet, although they do not offer the full functionality of a PC.

2. Input Devices

Data may enter an information system in a variety of different ways, and the input device that is the most appropriate will usually depend on the type of data being entered into the system, how frequently this is done, and who is responsible for the activity. For example, it would be more efficient to scan a page of typed text into an information system rather than retyping it, but if this happens very seldom, and if typing staff are readily available, then the cost of the scanner

might not be justified. However, all of the input devices described in this chapter have at least one thing in common: the ability to translate non-digital data types such as text, sound or graphics into digital format for processing by a computer.

2.1 The Keyboard

A lot of input still happens by means of a keyboard. Usually, the information that is entered by means of a keyboard is displayed on the monitor. The layout of most keyboards is similar to that of the original typewriter on which it was modeled.

2.2 Pointing Devices

The now ubiquitous electronic mouse is an essential input device for use with any graphical user interface. Buttons on the mouse can be used to select icons or menu items, or the cursor can be used to trace drawings on the screen.

Touchscreens are computer monitors that incorporate sensors on the screen panel itself or its sides. The user can indicate or select an area or location on the screen by pressing a finger onto the monitor. Light and touch pens work on a similar principle, except that a stylus is used, allowing for much finer control. Touch pens are more commonly used with handheld computers such as personal organizers or digital assistants. They have a pen-based interface whereby a stylus is used on the small touch-sensitive screen of the handheld computer, mainly by means of ticking off pre-defined options, although the fancier models support data entry either by means of a stylized alphabet, which resembles a type of shorthand, or some other more sophisticated handwriting recognition interface.

Digitizer tablets, also known as graphics tablets, use a pressure sensitive area with a stylus. This can be used to trace drawings.

Data glove looks like a hand glove but it contains a large number of sensors and has a data cable attached, though data cable is being replaced by means of infrared cordless data transmission. Not only does the data glove allow for full three-dimensional movement but it also senses the position of individual fingers and translate this into a grip. The glove is currently used in virtual reality simulators where the user moves around in an artificially rendered environment projected onto tiny LCD screens fitted into vision goggles. The computer generates various imaginary objects, which the user can “pick up” and manipulate by means of the glove. Advanced models even allow for tactile feedback by means of small pressure pockets built into the glove.

2.3 Optical Scanners and Readers

There are a number of different optical scanner technologies on the market.

- Optical scanners use light-emitting devices to illuminate the printing on paper. Depending on how much light is reflected, a light sensor determines the position and darkness (or color) of the markings on the paper. Special-purpose optical scanners are in use by postal services to read and interpret hand-written postal codes. General-purpose

scanners are used with personal computers to scan in images or text. A common use of optical scanners is the scanning of black-and-white or color images and pictures. When scanning text, it is necessary to load additional optical character recognition (OCR) software that converts the scanned raster-image of the text into the equivalent character symbols, so that they can be edited using word processing software.

- Barcode scanners detect sequences of vertical lines of different widths. These scanners have become very popular with retailers due to the fact that all pre-packaged products are now required to have a product bar code on their packaging. Libraries now also commonly use barcode scanners. They are more generally used for tracking large numbers of physical items, such as luggage handling by airlines.
- Optical mark readers are capable of reading dark marks on specially designed forms. The red multiple choice answer sheets in use at many educational and testing institutions are a good example.

2.4 Other Input Devices

A magnetic card reader reads the magnetized stripe on the back of plastic credit-card size cards. These cards need to be pre-recorded following certain standards. Although the cards can hold only a tiny amount of information, they are very popular for access control.

Biometric devices are used to verify personal identity based on fingerprints, iris or retinal scanning, hand geometry, facial characteristics etc. A scanning device is used to capture key measurements and compare them against a database of previously stored information. This type of authentication is becoming increasingly important in the control of physical access.

Finally, voice input devices are coming of age. Voicerecognition has recently made a strong entry into the market with the availability of low-cost systems that work surprisingly well with today's personal computers. These systems allow for voice control of most standard applications.

3. Central Processing Unit (CPU)

Once data has been entered into a computer, it is acted on by the CPU, which is the real brain of the computer.

3.1 Components of the CPU

- The CPU has two major components.
- The arithmetic logic unit (ALU) executes the actual instructions. It knows how to add or multiply numbers, compare data, or convert data into different internal formats.
- The control unit does the "housekeeping". It ensures that the instructions are processed on time, in the proper sequence, and operate on the correct data.

3.2 Speed of Processing

One can measure the speed of the CPU by checking the time it takes to process one single

instruction. However, instead of indicating the time it takes to execute a single instruction, the processing speed is usually indicated by how many instructions (or computations) a CPU can execute in a second.

In practice, the speed of a processor is dictated by four different elements: the "clock speed", which indicates how many simple instructions can be executed per second; the word length, which is the number of bits that can be processed by the CPU at any one time; the bus width, which determines the number of bits that can be moved simultaneously in or out of the CPU; and then the physical design of the chip, in terms of the layout of its individual transistors.

4. Main Memory

The function of main memory (also referred to as primary memory, main storage or internal storage) is to provide temporary storage for instructions and data during the execution of a program. Main memory is usually known as RAM, which stands for random access memory.

4.1 Random Access Memory (RAM)

RAM consists of standard circuit-inscribed silicon microchips that contain many millions of tiny transistors. Very much like the CPU chips, their technology follows to the law of Moore, which states that they double in capacity or power (for the same price) every 18 months. A RAM chip easily holds hundreds of megabytes (million characters). They are frequently pre-soldered in sets on tiny memory circuit boards called SIMMs (single in-line memory modules) or DIMMs (dual in-line memory modules) which slot directly onto the motherboard: the main circuit board that holds the CPU and other essential electronic elements. The biggest disadvantage of RAM is that its contents are lost whenever the power is switched off.

Two important types of RAM are:

- Cache memory is ultra-fast memory that operates at the speed of the CPU. Access to normal RAM is usually slower than the actual operating speed of the CPU. To avoid slowing the CPU down, computers usually incorporate some more expensive, faster cache RAM that sits in between the CPU and RAM. This cache holds the data and programs that are needed immediately by the CPU. Although today's CPUs already incorporate an amount of cache on the circuit itself, this on-chip cache is usually supplemented by an additional, larger cache on the motherboard.
- Flash RAM or flash memory consists of special RAM chips. It fits into custom ports on many notebooks, hand-held computers and digital cameras. Unlike normal RAM, flash memory is nonvolatile. It holds its contents even without external power, so it is also useful as a secondary storage device.

4.2 Read-Only Memory (ROM)

A small but essential element of any computer, ROM also consists of electronic memory microchips but, unlike RAM, it does not lose its contents when the power is switched off. Its function is also very different from that of RAM. Since it is difficult or impossible to change the

contents of ROM, it is typically used to hold program instructions that are unlikely to change during the lifetime of the computer. The main application of ROM is to store the so-called boot program. ROM chips are also found in many devices which contain programs that are unlikely to change over a significant period of time. Just like RAM, ROM comes in a number of different forms:

- PROM (programmable read-only memory) is initially empty and can be custom-programmed once only using special equipment. Loading or programming the contents of ROM is called burning the chip since it is the electronic equivalent of blowing tiny transistor fuses within the chip. Once programmed, ordinary PROMs cannot be modified afterwards.
- EPROM (erasable programmable read-only memory) is like PROM, but by using special equipment such as an ultraviolet light gun, the memory contents can be erased so that the EPROM can be re-programmed.
- EEPROM (electrically erasable programmable read-only memory) is similar to EPROM, but it can be re-programmed using special electronic pulses rather than ultraviolet light so no special equipment is required.

New Words

hardware	[ˈhɑ:dweə]	*n.*计算机硬件
equipment	[ɪˈkwɪpmənt]	*n.*设备，装备；器材
scanner	['skænə]	*n.*扫描设备；扫描器
printer	['prɪntər]	*n.*打印机
capture	[ˈkæptʃə]	*vt.&n.*捕获，捕捉
transform	[trænsˈfɔ:m]	*v.*转换，变换
output	[ˈaʊtpʊt]	*n.&*vt.输出
supercomputer	[ˈsu:pəkəmpju:tə]	*n.*超级计算机，巨型计算机
engine	[ˈendʒɪn]	*n.*发动机，引擎
application	[ˌæplɪˈkeɪʃn]	*n.*适用，应用，运用
mainframe	[ˈmeɪnfreɪm]	*n.*主机
process	[ˈprəʊses]	*n.*过程
		*vt.*加工；处理
terminal	[ˈtɜ:mɪnl]	*adj.*终端的，末端的
		*n.*终端
server	[ˈsɜ:və]	*n.*服务器
share	[ʃeə]	*v.*共享，分享
file	[faɪl]	*n.*文件
workstation	[ˈwɜ:ksteɪʃn]	*n.*工作站

performance	[pəˈfɔ:məns]	*n*.表现；执行
individual	[ˌɪndɪˈvɪdʒʊəl]	*adj*.个人的，独特的，个别的
computational	[ˌkɒmpjʊˈteɪʃənl]	*adj*.计算的
laptop	[ˈlæptɒp]	*n*.便携式计算机
connect	[kəˈnekt]	*vt*.连接，联结；使……有联系
		vi.连接；建立关系
monitor	[ˈmɒnɪtə]	*n*.显示器；监测仪
		vt.监控
keyboard	[ˈki:bɔ:d]	n.键盘
independently	[ˌɪndɪ'pendəntlɪ]	*adv*.独立地，无关地
portability	[ˌpɔ:tə'bɪlɪtɪ]	*n*.可携带，轻便
wireless	[ˈwaɪələs]	*adj*.无线的
connection	[kəˈnekʃn]	*n*.连接；联系，关系；连接点
internet	[ˈɪntənet]	*n*.互联网
functionality	[ˌfʌŋkʃəˈnælɪtɪ]	*n*.功能，功能性
input	[ˈɪnpʊt]	*n*.输入；输入的数据
		vt.把……输入计算机
device	[dɪˈvɑɪs]	*n*.装置，设备；方法；策略；手段
text	[tekst]	*n*.文本
digital	[ˈdɪdʒɪtl]	*adj*.数字的，数据的
format	[ˈfɔ:mæt]	*n*.格式
		vt.使格式化
enter	[ˈentə]	*vt.&vi*.输入，进入
model	[ˈmɒdl]	*n*.模型，典型
		vt.模仿
ubiquitous	[ju:ˈbɪkwɪtəs]	*adj*.无所不在的，普遍存在的
mouse	[mɑʊs]	*n*.鼠标
button	[ˈbʌtn]	*n*.按钮
icon	[ˈɑɪkɒn]	*n*.光标，图标
menu	[ˈmenju:]	*n*.菜单
touchscreen	['tʌtʃskri:n]	*n*.触摸屏
sensor	[ˈsensə]	*n*.传感器，灵敏元件
panel	[ˈpænl]	*n*.面板；控制板
fancier	[ˈfænsɪə]	*n*.发烧友，对某事物有特别爱好的人
recognition	[ˌrekəgˈnɪʃn]	*n*.认识，识别

sensitive	[ˈsensətɪv]	*adj*.敏感的，灵敏的
infrared	[ˌɪnfrəˈred]	*adj*.红外线的
		n.红外线
cordless	[ˈkɔ:dlɪs]	*adj*.不用电线与电源相连的，无电线的
three-dimensional	[θri:dɪˈmenʃənəl]	*adj*.三维的，立体的
sense	[sens]	*n*.感觉；识别力
		vt.感觉，感知，感到；理解，领会
simulator	[ˈsɪmjʊleɪtə]	*n*.模拟装置，模拟器
imaginary	[ɪˈmædʒɪnərɪ]	*adj*.想象中的，假想的，虚构的
manipulate	[məˈnɪpjʊleɪt]	*vt*.操作，处理
tactile	[ˈtæktaɪl]	*adj*.触觉的，触觉感知的
feedback	[ˈfi:dbæk]	*n*.反馈，反应
scan	[skæn]	*vt*.扫描
raster	['ræstə]	*n*.光栅
equivalent	[ɪˈkwɪvələnt]	*adj*.相等的，相当的，等效的
character	[ˈkærəktə]	*n*.字符
symbol	[ˈsɪmbl]	*n*.符号，记号
		vt.用符号代表
barcode	[bɑ:'kəʊd]	*n*.条形码
detect	[dɪˈtekt]	*vt*.检测
verify	[ˈverɪfaɪ]	*vt*.核实；证明；判定
identity	[aɪˈdentɪtɪ]	*n*.身份
fingerprint	[ˈfɪŋgəprɪnt]	*n*.指纹，指印
		vt.采指纹
iris	[ˈɑɪrɪs]	*n*.虹膜
retinal	['retɪnl]	*adj*.视网膜的
low-cost	['ləʊkɒst]	*adj*.价格便宜的，廉价的
component	[kəmˈpəʊnənt]	*n*.部件，零件
		adj.组成的，构成的
instruction	[ɪnˈstrʌkʃn]	*n*.指令
compare	[kəmˈpeə]	*vt.&vi*.比较，对照
convert	[kənˈvɜ:t]	*v*.转换，转变
sequence	[ˈsi:kwəns]	*n*.序列；顺序；连续
measure	[ˈmeʒə]	*n*.测量，测度；措施；程度；尺寸
		v.测量；估量

bit	[bɪt]	*n.*比特（二进位制信息单位）
layout	[ˈleɪaʊt]	*n.*层，布局，安排，设计
chip	[tʃɪp]	*n.*芯片
transistor	[trænˈzɪstə]	*n.*晶体管
function	[ˈfʌŋkʃn]	*n.*功能，作用；函数 *vi.*有或起作用
temporary	[ˈtemprərɪ]	*adj.*临时的，暂时的
program	[ˈprəʊgræm]	*n.*程序 *v.*给……编写程序
silicon	[ˈsɪlɪkən]	*n.*硅
microchip	[ˈmaɪkrəʊtʃɪp]	*n.*微晶片，微型集成电路片
megabyte	[ˈmegəbaɪt]	*n.*兆字节
slot	[slɒt]	*n.*插槽
cache	[kæʃ]	*n.*高速缓冲存储
supplement	[ˈsʌplɪmənt]	*vt.&n.*增补，补充
nonvolatile	['nɒn'vɒlətɑɪl]	*adj.*非易失性的，不易失的
impossible	[ɪmˈpɒsəbl]	*adj.*不可能的
modify	[ˈmɒdɪfaɪ]	*v.*修改
ultraviolet	[ˌʌltrəˈvɑɪələt]	*adj.*紫外线的
reprogram	[rɪ'prəʊgræm]	*v.*重新编程，改变程序
pulse	[pʌls]	*n.*脉冲

Phrases

information system	信息系统
peripheral device	外围设备，外部设备
application software	应用软件
personal digital assistant	个人数字助理
be responsible for ...	为……负责，形成……的原因
pointing device	指点设备
graphical user interface	图形用户界面
menu item	菜单项
touch-sensitive screen	触摸屏
handheld computer	手持式计算机
handwriting recognition interface	手写识别界面
pressure sensitive area	压力敏感区域
data glove	数字手套

virtual reality	虚拟现实
pick up	拿起，拾起
optical scanner	光学扫描仪
postal code	邮政编码
word processing software	字处理软件
magnetic card	磁卡
magnetized stripe	磁条
access control	访问控制，访问管理
hand geometry	手形，掌形
facial characteristic	面部特征
voice input device	语音输入设备
be entered into	被键入，被输入
clock speed	时钟速率
word length	字长
bus width	总线宽度
law of Moore	摩尔定律
circuit board	电路板
switch off	关闭，切断
digital camera	数码相机
external power	外部电源，外部供电
secondary storage device	辅助存储设备
boot program	引导程序
ultra-violet light gun	紫外光枪

Abbreviations

PC (Personal Computer)	个人计算机
CPU (Central Processing Unit)	中央处理器
LCD (Liquid Crystal Display)	液晶显示器
OCR (Optical Character Recognition)	光学字符识别
ALU (Arithmetic and Logic Unit)	算术逻辑单元
RAM (Random Access Memory)	随机存储器
SIMMS (Single In-line Memory Modules)	单列直插内存模块
DIMMS (Dual In-line Memory Modules)	双列直插内存模块
ROM (Read-Only Memory)	只读存储器
PROM (Programmable Read-Only Memory)	可编程只读存储器
EPROM (Erasable Programmable Read-Only Memory)	可擦除可编程只读存储器

EEPROM (Electrically Erasable Programmable Read-Only Memory)	电可擦除可编程只读存储器

Text A 参考译文

计算机硬件(1)

1. 引言

硬件是任何信息系统中最容易看见的部分，如计算机、扫描仪和打印机之类的设备，用于捕获数据，对数据进行转换并将其作为输出呈现给用户。尽管我们将主要关注个人计算机（PC）及其常用的外围设备，但是相同的原理也适用于所有计算机。

- 超级计算机，用来表示在任何给定时间可用的最快的计算引擎，用于运行要求极高的科学应用程序。
- 大型计算机，为成百上千的终端用户提供高性能的处理能力和大容量的数据存储功能。
- 服务器，具有大的数据存储容量，使用户可以共享文件和应用程序软件，尽管处理过程通常会在用户自己的计算机上进行。
- 工作站，可在计算密集型领域（例如工程）中为单个用户提供高性能的处理能力。
- 个人计算机（包括膝上型计算机/笔记本计算机），具有连接的显示器、键盘和 CPU，并且已发展成为一种既方便又灵活的业务工具，能够独立运行或作为组织网络的一部分运行。
- 移动设备（例如个人数字助理或最新一代的蜂窝电话）可提供最大的便携性以及与互联网的无线连接，尽管它们不能提供 PC 的全部功能。

2. 输入设备

数据可以以各种不同的方式进入信息系统，由输入到系统中的数据类型、执行的频率以及负责该活动的人员决定哪些输入设备最合适。例如，将键入的文本页面扫描到信息系统中比重新键入它的效率更高，但是，如果这种情况很少发生，并且打字人员很容易找到，那么扫描仪的成本可能就不合理了。但是，本章中描述的所有输入设备至少有一个共同点：能够将非数字数据类型（例如文本、声音或图形）转换为数字格式以供计算机处理。

2.1 键盘

键盘仍然可以进行很多输入。通常，通过键盘输入的信息会显示在显示器上。大多数键

盘的布局类似于原始打字机的布局。

2.2 指点设备

现在无处不在的电子鼠标是一个必不可少的输入设备，用于任何图形用户界面。可以使用鼠标上的按钮选择图标或菜单项，或者可以使用光标来跟踪屏幕上的图形。

触摸屏是在屏幕面板本身或其侧面装有传感器的计算机显示器。用户可以通过将手指按在显示器上来指示或选择屏幕上的区域或位置。除了使用手写笔以外，光笔和触控笔的工作原理相似，可以进行更精细的控制。触控笔更常用于手持计算机，例如个人管理器或数字助理。它们具有笔控界面，主要通过勾选预定义的选项，在掌上计算机的小型触摸屏上使用手写笔，尽管更高级的模型支持使用风格化字母（这类似于一种速记）或用其他更复杂的手写识别界面来输入数据。

数字化仪平板电脑也称为图形输入板，使用带有手写笔的压敏区域。可用于跟踪图形。

数据手套看起来像手套，但它包含大量传感器并连接了数据线，尽管数据线已被红外无线数据传输所取代。数据手套不仅可以进行完整的三维运动，而且还可以感应单个手指的位置，然后将其转化为抓握感。该手套目前用于虚拟现实模拟器中。在该模拟器中，用户在人工渲染的环境中四处移动，这些环境被投影到安装在视觉护目镜中的微型 LCD 屏幕上。计算机生成各种虚拟对象，用户可以通过手套“拾取”并进行操作。高级型号的手套甚至可以通过内置于手套中的小压力袋实现触觉反馈。

2.3 光学扫描仪和阅读器

市场上有许多不同的光学扫描仪技术。

- 光学扫描仪使用发光设备照亮纸张上的打印内容。根据反射的光量，光传感器确定纸张上标记的位置和暗度（或颜色）。邮政部门正在使用专用光学扫描仪来读取和识别手写的邮政编码。通用扫描仪与个人计算机结合可以扫描图像或文本。光学扫描仪的常见用途是扫描黑白或彩色图像和图片。扫描文本时，有必要加载附带的光学字符识别（OCR）软件，该软件将扫描的文本光栅图像转换为等效的字符符号，以便可以使用文字处理软件进行编辑。
- 条形码扫描仪可检测不同宽度的垂直线序列。由于现在要求所有预包装产品的包装上都带有产品条形码，因此这些扫描仪已在零售商中变得非常受欢迎。现在，图书馆通常也使用条形码扫描仪。它们更常用于跟踪大量的物品，例如航空公司的行李处理。
- 光学标记阅读器能够读取特殊设计形式的深色标记。许多教育和考试机构使用的红色的多项选择答案纸就是一个很好的例子。

2.4 其他输入设备

磁卡读取器读取信用卡大小的塑料卡背面的磁条。这些卡需要按照某些标准预先记录。尽管这些卡只能容纳极少量的信息，但它们在访问控制中非常受欢迎。

生物识别设备用于根据指纹、虹膜或视网膜扫描、手部几何形状、面部特征等来验证个人身份。扫描设备用于捕获关键测量值并将它们与先前存储的信息的数据库进行比较。这种类型的身份验证在物理访问控制中变得越来越重要。

最后，语音输入设备已经成熟。语音识别技术最近凭借大量低成本的系统进入了市场，这些系统可与当今的个人计算机完美配合。这些系统允许对大多数标准应用程序进行语音控制。

3. 中央处理器（CPU）

数据输入到计算机后，将由 CPU 对其进行处理，CPU 是计算机的真正大脑。

3.1 CPU 组件

CPU 有两个主要组件。

- 算术逻辑单元（ALU）执行实际指令。它知道如何加或乘数字，比较数据或将数据转换为不同的内部格式。
- 控制单元执行“内部处理”。它确保按时、按正确的顺序处理指令，并对正确的数据进行操作。

3.2 处理速度

可以通过检查处理一条指令所需的时间来测量 CPU 的速度。但是，除了显示执行一条指令所花费的时间外，处理速度通常由一秒内 CPU 可以执行多少条指令（或计算）来表示。

实际上，处理器的速度由 4 个不同的要素决定：“时钟速度”，它表示每秒可以执行多少条简单指令；字长，即在任何时候 CPU 可以处理的位数；总线宽度，确定可以同时移入或移出 CPU 的位数；然后是芯片的物理设计，即各个晶体管的布局。

4. 主存

主存储器（也称为主要存储器、主存或内部存储器）的功能是在程序执行期间为指令和数据提供临时存储。主存储器通常称为 RAM，它代表随机存取存储器。

4.1 随机存取存储器（RAM）

RAM 由包含数百万个微型晶体管的标准刻写电路硅芯片组成。与 CPU 芯片非常相似，它们的技术遵循摩尔定律，该定律指出，每 18 个月它们的容量或性能就会增加一倍（以相同的价格）。一个 RAM 芯片很容易容纳数百兆字节（百万个字符）。它们通常预先焊接在称为 SIMMs（单列直插式内存模块）或 DIMMs（双列直插式内存模块）的微型存储电路板上，这些电路板直接插入主板，主板是用于固定 CPU 和其他组件的主电路板。RAM 的最大缺点是，一旦关闭电源，其内容就会丢失。

RAM 的两种重要类型是：

- 高速缓存是一种以 CPU 的速度运行的超快内存。访问普通 RAM 的速度通常比 CPU 的实际运行速度慢。为了避免降低 CPU 的速度，计算机通常会在 CPU 和 RAM 之间集成一些更昂贵、速度更快的缓存 RAM。该高速缓存保存 CPU 立即需要的数据和程序。尽管当今的 CPU 已经在电路本身上集成了一定数量的高速缓存，但通常还要在主板上增加一个更大的高速缓存以提供片载高速缓存。
- Flash RAM 或闪存由特殊的 RAM 芯片组成。它适合许多笔记本计算机、手持计算机和数码相机的自定义端口。与普通 RAM 不同，闪存是非易失性的。即使没有外部电源，它也可以保存其内容，因此它也可用作辅助存储设备。

4.2 只读存储器（ROM）

ROM 是任何计算机中一个很小但必不可少的单元，它也由电子存储微芯片组成，但是与 RAM 不同，ROM 在关闭电源时不会丢失其内容。它的功能也与 RAM 完全不同。由于很难或不可能更改 ROM 的内容，因此它通常用于保存在计算机寿命期内不太可能更改的程序指令。ROM 的主要应用是存储所谓的引导程序。ROM 芯片也出现在许多设备中，这些设备包含的程序在相当长的时间内不太可能更改。就像 RAM 一样，ROM 有多种形式：

- PROM（可编程只读存储器）最初为空，只能使用特殊设备进行一次自定义编程。加载或编程 ROM 的内容称为烧录芯片,因为这等效于在芯片内烧制微小的晶体管熔丝。一旦编程，普通的 PROM 就无法修改。
- EPROM（可擦可编程只读存储器）类似于 PROM，但是通过使用特殊设备（例如紫外光枪）可以擦除存储内容，以便可以对 EPROM 进行重新编程。
- EEPROM（电可擦可编程只读存储器）与 EPROM 相似，但是可以使用特殊的电子脉冲而不是紫外线对它进行重新编程，因此不需要特殊的设备。

Text B

Computer Hardware (2)

扫码听课文

5. Secondary Storage Devices

Since the main memory of a computer has a limited capacity, it is necessary to retain data in secondary storage between different processing cycles. This is the medium used to store the program instructions as well as the data required for future processing. Most secondary storage devices in use today are based on magnetic or optical technologies.

5.1 Disk Drives

The disk drive is the most popular secondary storage device, and is found in both mainframe and microcomputer environments. The central mechanism of the disk drive is a flat disk, coated with a magnetizable substance. As this disk rotates, information can be read from or written to it by means of a head. The head is fixed on an arm and can move across the radius of the disk. Each position of the arm corresponds to a "track" on the disk, which can be visualized as one concentric circle of magnetic data. The data on a track is read sequentially as the disk spins underneath the head. There are quite a few different types of disk drives.

In Winchester hard drives, the disk, access arm and read/write heads are combined in one single sealed module. This unit is not normally removable. Since the drives are not handled physically, they are less likely to be contaminated by dust and therefore much more reliable. Mass production and technology advances have brought dramatic improvements in the storage capacity.

Large organizations such as banks, telcos and life insurance companies require huge amounts of storage space, often in the order of many terabytes (one terabyte is one million megabytes or a trillion characters). This was typically provided by a roomful of large, high-capacity hard drive units. Currently, they are being replaced increasingly by redundant arrays of independent disks (RAIDs). A RAID consists of an independently powered cabinet that contains a number (10 to 100) of microcomputer Winchester-type drives but functions as one single secondary storage unit. The advantage of the RAID is its high-speed access and relatively low cost. In addition, a RAID provides extra data security by means of its fault-tolerant design whereby critical data is mirrored (stored twice on different drives) thus providing physical data redundancy. Should a mirrored drive fail, the other drive steps in automatically as a backup.

5.2 Optical Disk Storage

Optical disks, on the other hand, are rapidly becoming the storage medium of choice for the mass distribution of data/programs and the backup of data. Similar to disk storage, information is stored and read from a circular disk. However, instead of a magnetic read head, a tiny laser beam is used to detect microscopic pits burnt onto a plastic disk coated with reflective material. The pits determine whether most of the laser light is reflected back or scattered, thus making for a binary "on" or "off". In contrast to hard disks, data is not stored in concentric cylinders but in one long continuous spiral track.

5.3 SSD

An SSD (solid state drive) is a type of mass storage device similar to a hard disk drive (HDD). It supports reading and writing data and maintains stored data in a permanent state even without power.

Unlike hard drives, SSDs do not have any moving parts (which is why they are called solid state drives). Instead of storing data on magnetic platters, SSDs store data using flash memory. Since SSDs have no moving parts, SSDs can access data faster than HDDs.

SSDs have several other advantages over hard drives as well. For example, the read performance of a hard drive declines when data gets fragmented, or split up into multiple locations on the disk. The read performance of an SSD does not diminish no matter where the data is stored on the drive. Therefore defragmenting an SSD is not necessary. Since SSDs do not store data magnetically, they are not susceptible to data loss even if there are strong magnetic fields in close proximity to the drive. Additionally, since SSDs have no moving parts, there is far less chance of a mechanical breakdown. SSDs are also lighter, quieter, and use less power than hard drives.

However, SSDs also have some disadvantages. Since the SSD technology is much newer than traditional hard drive technology, the price of SSDs is substantially higher. Most SSD drives sold today have much smaller capacities than comparable hard drives. As the SSD technology improves and the prices continue to fall, it is likely that solid state drives will replace hard disk drives for most purposes.

6. Output Devices

The final stage of information processing involves the use of output devices to transform computer-readable data back into an information format that can be processed by humans. As with input devices, when deciding on an output device you need to consider what sort of information is to be displayed, and who is intended to receive it.

One distinction that can be drawn between output devices is that of hardcopy versus softcopy devices. Hardcopy devices (printers) produce a tangible and permanent output whereas softcopy devices (display screens) present a temporary, fleeting image.

6.1 Display Screens

The desk-based computer screen is the most popular output device. The standard monitor works on the same principle as the normal TV tube: a “ray” gun fires electrically charged particles onto a specially coated tube (hence the name cathode-ray tube or CRT). When the particles hit the coating, the “coating” is being “excited” and emits light. A strong magnetic field guides the particle stream to form the text or graphics on your familiar monitor.

A technology that has received much impetus from the fast-growing laptop and notebook market is the liquid crystal display (LCD). LCDs have matured quickly, increasing in resolution, contrast, and colour quality. Their main advantages are lower energy requirements and their thin, flat size. Although alternative technologies are already being explored in research laboratories, they currently dominate the “flat display” market.

Organic light-emitting diodes (OLED) can generate brighter and faster images than LED technology, and require thinner screens.

Another screen-related technology is the video projection unit. It was originally developed for the projection of video films. Today’s units fit easily into a small suitcase and project a computer presentation in very much the same way a slide projector shows a slide presentation.

6.2 Printer

Printers are a type of computer peripheral device that fall into two broad categories: 2D printers that print text and graphics onto paper (or other media) and 3D printers that create physical objects.

6.2.1 2D Printers

2D printers are by far the most common type of printer. This category can be subdivided based on the type of technology used to transfer images onto paper. Modern printers generally fall into one of the following categories:

- Inkjet: It sprays ink at a sheet of paper. Inkjet printers produce high-quality text and graphics.
- Laser: It uses the same technology as copy machines. Laser printers produce very high-quality text and graphics.
- LED: It is similar to a laser printer but uses light-emitting diodes rather than a laser to produce an image on the drum.
- Thermal printer: It works by pushing heated pins against heat-sensitive paper. Thermal printers are widely used in ATMs and cash registers.

6.2.2 3D Printers

3D printers work by depositing layers of material on top of each other to create a physical object. This type of process is also sometimes called additive manufacturing. Currently, companies are investing in a lot of research and development around 3D printing, and the technology is changing rapidly. 3D printing is expected to grow in popularity as the technology improves and costs for 3D printers decline.

6.3 Plotters

Plotters are mainly used for engineering and architectural drawings. A plotter consists of one or several — in the case of color plotters — pens affixed to an arm. As the arm moves across the sheet of paper, the pen draws lines onto the paper. It is ideal for line drawings such as plans.

6.4 Audio Output Devices

Audio output is becoming increasingly popular. There are some different types of audio output.

- Sound output is required by most multimedia applications and sophisticated games. The sound card in many of today's personal computers synthesizes sound by drawing from a library of stored sounds, essentially using the same process as found in music keyboards. More advanced multimedia workstations are equipped for full stereo multi-channel surround sound and easily surpass many modern Hi-Fi systems in cabling and speaker complexity.
- Speech synthesis is the production of speech-like output using an artificial voice. Although the lack of intonation still makes the voice sound artificial, the technology is

reasonably mature and can be found anywhere.

New Words

retain	[rɪˈteɪn]	*vt.*保持
magnetic	[mægˈnetɪk]	*adj.*磁性的
optical	[ˈɒptɪkl]	*adj.*光学的
mechanism	[ˈmekənɪzəm]	*n.*机制；（机械）结构，机械装置
substance	[ˈsʌbstəns]	*n.*物质，材料
track	[træk]	*n.*磁道，轨道
concentric	[kənˈsentrɪk]	*adj.*同一中心的，同轴的
removable	[rɪˈmu:vəbl]	*adj.*可移动的，抽取式的
reliable	[rɪˈlaɪəbl]	*adj.*可靠的，可信赖的
improvement	[ɪmˈpru:vmənt]	*n.*改进，改善，改良，增进
telco	[ˈtelkəʊ]	*abbr.*电信公司
huge	[hju:dʒ]	*adj.*巨大的，庞大的，极大的
terabyte	[ˈterəbaɪt]	*n.*太字节
fault-tolerant	[fɔ:lt-ˈtɒlərənt]	*adj.*容错的
mirror	[ˈmɪrə]	*vt.*镜像，映射
redundancy	[rɪˈdʌndənsɪ]	*n.*冗余
backup	[ˈbækʌp]	*n.*备份文件
		*adj.*备份的，备用的
distribution	[ˌdɪstrɪˈbju:ʃn]	*n.*分配，分布
microscopic	[ˌmɑɪkrəˈskɒpɪk]	*adj.*微小的，细微的
reflective	[rɪˈflektɪv]	*adj.*反射的，反光的
scatter	[ˈskætə]	*vt.*（使）散开，（使）分散
		*vi.*散开，分散
cylinder	[ˈsɪlɪndə]	*n.*圆柱
spiral	[ˈspɑɪrəl]	*n.*螺旋（线）
		*v.*使成螺旋形
		*adj.*螺旋形的
permanent	[ˈpɜ:mənənt]	*adj.*永久（性）的，不变的，持久的
fragment	[ˈfrægmənt]	*n.*碎片，片段；（将文件内容）分段
		vt.（使）碎裂，破裂
susceptible	[səˈseptəbl]	*adj.*易受影响的，易受感染的
replace	[rɪˈpleɪs]	*vt.*替换，代替

display	[dɪˈspleɪ]	*n.*显示器
		*v.*显示
distinction	[dɪˈstɪŋkʃn]	*n.*区别；特质
hardcopy	['hɑ:dkɒpɪ]	*n.*硬拷贝
softcopy	['sɒftkɒpɪ]	*n.*软拷贝
printer	['prɪntə]	*n.*打印机
tangible	[ˈtændʒəbl]	*adj.*确实的，实际的；有形的
particle	[ˈpɑ:tɪkl]	*n.*粒子
contrast	[ˈkɒntrɑ:st]	*n.*对比度
energy	[ˈenədʒɪ]	*n.*能量
slide	[slɑɪd]	*n.*幻灯片
projector	[prəˈdʒektə]	*n.*放映机，幻灯机；投影仪
inkjet	['ɪŋkdʒet]	*adj.*喷墨的
spray	[spreɪ]	*v.*喷，喷射
laser	[ˈleɪzə]	*n.*激光；激光器
diode	[ˈdɑɪəʊd]	*n.*二极管
deposit	[dɪˈpɒzɪt]	*v.*放下，放置；使沉积，使沉淀
plotter	[ˈplɒtə]	*n.*绘图仪，绘图机
multimedia	[ˌmʌltɪˈmi:dɪə]	*n.*多媒体
		*adj.*多媒体的
synthesize	[ˈsɪnθəsaɪz]	*v.*合成；综合
stereo	[ˈsterɪəʊ]	*adj.*立体声的；有立体感的
		*n.*立体声，立体声系统
multi-channel	['mʌltɪ-ˈtʃænl]	*n.*多通道
surround	[səˈraʊnd]	*vt.*环绕，包围
complexity	[kəmˈpleksɪtɪ]	*n.*复杂性
artificial	[ˌɑ:tɪˈfɪʃl]	*adj.*人造的，人工的，人为的
intonation	[ˌɪntəˈneɪʃn]	*n.*语调，声调
reasonably	[ˈri:znəblɪ]	*adv.*相当地，合理地

Phrases

sealed module	密封模块
be contaminated by...	被……污染
storage capacity	存储容量
storage space	存储空间

in the order of	大约
a roomful of	一屋子的
optical disk	光盘
laser beam	激光束
computer-readable data	计算机可读的数据
magnetic field	磁场
video projection unit	视频投影单元
slide presentation	幻灯片演示
inkjet printer	喷墨打印机
copy machine	复印机
laser printer	激光打印机
light-emitting diode	发光二极管
thermal printer	热敏打印机，热转印打印机
cash register	现金出纳机，收银机

Abbreviations

RAID (Redundant Arrays of Independent Disk)	独立磁盘冗余阵列
SSD (Solid State Drive)	固态硬盘
HDD (Hard Disk Drive)	硬盘驱动器
CRT (Cathode-Ray Tube)	阴极射线管
OLED (Organic Light-Emitting Diodes)	有机发光二极管
ATM (Automatic Teller Machine)	自动柜员机
2D (2 Dimensions)	二维，两个维度，两个坐标
3D (3 Dimensions)	三维，三个维度，三个坐标
Hi-Fi (High-Fidelity)	高保真

Text B 参考译文

计算机硬件（2）

5. 辅助存储设备

由于计算机的主存储器容量有限，因此有必要在不同的处理周期之间将数据保留在辅助存储器中。辅助存储设备用于存储程序指令以及将来处理所需数据的介质。当今使用的大多

数辅助存储设备都是基于磁或光技术的。

5.1 磁盘驱动器

磁盘驱动器是最流行的辅助存储设备，在大型机和微型计算机环境中都可以找到。磁盘驱动器的中心机构是一块平盘，上面涂有可磁化物质。当该磁盘旋转时，可以通过磁头读取或写入信息。磁头固定在磁头臂上，可以在磁盘半径范围内移动。磁头臂的每个位置对应于磁盘上的一个“磁道”，可以将其视为一个磁数据同心圆。当磁盘在磁头下方旋转时，将顺序读取轨道上的数据。有很多不同类型的磁盘驱动器。

在温彻斯特硬盘驱动器中，磁盘、磁头臂和读/写磁头组合在一个密封模块中。这个部分通常是不能取出的。由于不能对驱动器进行物理操作，因此它们不太可能被灰尘污染，所以可靠性更高。大规模生产和技术进步带来了存储容量的巨大提高。

如银行、电信公司和人寿保险公司之类的大型组织需要大量的存储空间，容量通常大约在数太字节（1 太字节为一百万兆字节或一万亿个字符）。过去这通常是由一大堆大容量的硬盘驱动器提供的。当前，它们越来越多地被独立磁盘的冗余阵列（RAID）取代。RAID 由独立供电的机柜组成，该机柜包含多个（10～100 个）微计算机温彻斯特型驱动器，但充当单个辅助存储单元。RAID 的优点是其访问速度高且成本较低。此外，RAID 通过其容错设计提供了更高的数据安全性，对关键数据进行了镜像（两次存储在不同的驱动器上），从而提供了物理数据冗余。如果镜像驱动器发生故障，其他驱动器将自动作为备份启动。

5.2 光盘存储

另外，光盘正迅速成为数据/程序的大规模分发和数据备份的首选存储介质。与磁盘存储类似，信息是从圆形磁盘存储和读取的。但是不是用磁读取头，而是使用微小的激光束来检测烧在涂有反射材料的塑料盘上的微小凹坑。凹坑确定大多数激光是反射回来还是散射出去，从而形成二进制的“开”或“关”。与硬盘相反，数据不是存储在同心圆柱体中，而是存储在一个长的连续螺旋轨道中。

5.3 固态硬盘

SSD 是类似于硬盘驱动器（HDD）的一种大容量存储设备。它支持读取和写入数据，并且即使没有电源也可以将存储的数据永久保存。

与硬盘驱动器不同，SSD 没有任何活动部件（这就是它们被称为固态驱动器的原因）。SSD 不用磁盘存储数据，而是使用闪存存储数据。由于 SSD 没有活动部件，因此，SSD 可以比 HDD 更快地访问数据。

与硬盘驱动器相比，SSD 还具有其他一些优势。例如，当数据碎片化或拆分到磁盘上的多个位置时，硬盘驱动器的读取性能会下降。无论数据存储在驱动器上的什么位置，SSD 的读取性能都不会降低。因此，无须对 SSD 进行碎片整理。由于 SSD 不用磁性存储数据，即使驱动器附近有强磁场，也不会丢失数据。此外，由于 SSD 没有活动部件，因此发生机械故

障的机会要少得多。与硬盘驱动器相比，SSD 更加轻便、安静且省电。

然而 SSD 也有一些缺点。由于 SSD 技术比传统的硬盘技术要新得多，因此 SSD 的价格要高得多。如今出售的大多数 SSD 驱动器的容量都比同类硬盘小得多。随着 SSD 技术的改进和价格的不断下降，固态驱动器很可能会在大多数情况下取代硬盘驱动器。

6. 输出设备

信息处理的最后阶段涉及使用输出设备将计算机可读数据转换回可以由人类处理的信息格式。与输入设备一样，在确定输出设备时，需要考虑要显示什么类型的信息以及由谁来接收信息。

输出设备之间的区别是硬拷贝与软拷贝。硬拷贝设备（打印机）产生有形的、永久性的输出，而软拷贝设备（显示屏）显示暂时的、短暂的图像。

6.1 显示屏

基于桌面的计算机屏幕是最受欢迎的输出设备。标准显示器的工作原理与普通电视管相同：“射线”枪将带电粒子发射到经过特殊涂层的管上（因此称为阴极射线管或 CRT）。当粒子撞击涂层时，“涂层”被“激发”并发光。强磁场引导粒子流在你熟悉的显示器上形成文本或图形。

笔记本计算机的市场的迅速扩展极大地推动了液晶显示器（LCD）技术的发展。LCD 已迅速成熟，分辨率、对比度和颜色质量得到了提高。它的主要优点是有较低的电量需求以及薄而扁平的尺寸。尽管研究实验室已经在探索替代技术，但它目前在“平板显示器”市场上占主导地位。

与 LED 技术相比，有机发光二极管（OLED）可以产生更明亮、更快的图像，并且需要更薄的屏幕。

与屏幕相关的另一项技术是视频投影单元。它最初是为视频电影的放映而开发的。如今的装置可以很容易装入一个小手提箱，并以类似于幻灯机显示幻灯演示的方式投影计算机演示。

6.2 打印机

打印机是计算机外围设备的一种，分为两大类：将文本和图形打印到纸张（或其他介质）上的 2D 打印机和创建物品的 3D 打印机。

6.2.1 2D 打印机

到目前为止，2D 打印机是最常见的打印机类型。可以根据将图像转印到纸张上的技术类型来细分此类别。现代打印机通常属于以下类别之一。

- 喷墨：在一张纸上喷射墨水。喷墨打印机可产生高质量的文本和图形。
- 激光：使用与复印机相同的技术。激光打印机可产生非常高质量的文本和图形。

- LED：与激光打印机相似，但它使用发光二极管而不是激光在感光鼓上产生图像。
- 热敏打印机：通过将加热的针推到热敏纸上来工作。热敏打印机广泛用于 ATM 和收银机。

6.2.2 3D 打印机

3D 打印机的工作原理是用材料层层沉积以创建一个物理对象。这类过程有时也称为增材制造。当前，一些公司正在围绕 3D 打印进行大量研究和开发投资，并且该技术正在迅速变化。随着技术的进步和 3D 打印机成本的下降，预计 3D 打印将越来越受欢迎。

6.3 绘图仪

绘图仪主要用于绘制工程图和建筑图。绘图仪由一根或几根（对于彩色绘图仪而言）固定在手臂上的笔组成。当手臂在纸上移动时，笔会在纸上画线。它非常适用于线条图，例如平面图。

6.4 音频输出设备

音频输出变得越来越流行。有一些不同类型的音频输出。

- 大多数多媒体应用程序和复杂游戏都需要声音输出。当今许多个人计算机中的声卡都是通过从存储的声音库中提取声音来合成声音的，基本上使用与音乐键盘相同的过程。更高级的多媒体工作站配备完整的立体声多声道环绕声，并在布线和扬声器复杂性方面轻松超过许多现代的高保真音响系统。
- 语音合成是使用人工语音产生类似语音的输出。尽管缺少语调使语音听起来很虚假，但该技术相当成熟，到处可见。

Exercises

[Ex. 1] Answer the following questions according to Text A.

1. What are supercomputers?
2. What do personal computers have? What have they developed into?
3. What will the input device that is the most appropriate usually depend on?
4. What are touchscreens? What can the user do by pressing a finger onto the monitor?
5. What does the data glove do? Where is the data glove currently used?
6. What are the different optical scanner technologies on the market?
7. What are the two major components the CPU has?
8. What is main memory also referred to as? What is the function of main memory?
9. What does RAM stand for? What are the two important types of RAM?

10. What does ROM stand for? What is the main application of ROM?

[Ex.2] Answer the following questions according to Text B.

1. What is the disk drive? What is the central mechanism of the disk drive?
2. What does a RAID consist of? What is the advantage of the RAID?
3. What is an SSD?
4. What is the most popular output device?
5. What are the main advantages of LCDs?
6. What are printers? What are the two broad categories they fall into?
7. What categories do modern printers generally fall into?
8. How do 2D printers work?
9. What are plotters mainly used for?
10. What are the different types of audio output mentioned in the passage?

[Ex. 3] Translate the following terms or phrases from English into Chinese and vice versa.

1. boot program	1.
2. graphical user interface	2.
3. peripheral device	3.
4. virtual reality	4.
5. word length	5.
6. *n.*高速缓冲存储	6.
7. *n.*芯片	7.
8. *n.*功能，功能性	8.
9. *adj.*非易失性的，不易失的	9.
10. *n.*打印机	10.

[Ex. 4] Translate the following sentences into Chinese.

Main Components of a Computer

CPU is considered the most important component in a computer and for good reason. It handles most operations, by processing instructions and giving signals out to other components. The CPU is the main bridge between all the computer's major parts.

RAM is a computer component where data used by the operating system and software applications is stored so that the CPU can process them quickly. Everything stored on RAM is lost if the computer is shut off. Depending on the applications you use, there is typically a maximum limit of RAM you will need for the computer to function properly.

HDD — Also known as hard disk drive, it is the component where photos, apps, documents and such are kept. Although they are still being used, we have much faster types of stor-

age devices such as solid state drives (SSD) that are also more reliable.

Motherboard — There is no acronym for this component but without it, there can't be a computer. The motherboard acts as the home for all other components, allows them to communicate with each other and gives them power in order to function. There are components that don't require a physical connection to the motherboard in order to work, such as Bluetooth or Wi-Fi but, if there is no connection or signal what so ever, the computer won't know it's there.

Video and sound cards — Two components which help the user interact with the computer. Although one can use a computer with a missing sound card, it's not really possible to use it without a video card. The sound card is used mainly to play sound through a speaker. However, a video card is used to send images on the screen. Without it, it would be like looking at an empty monitor.

Network adapter — Even though it is not actually required to operate the computer, the network adapter improves the user's experience as it provides access to the internet. Modern computers with operating systems such as Windows will not offer the user all of its features without an Internet connection.

[Ex. 5] Fill in the blanks with the words given below.

components	peripherals	peripheral	memory	computer
output	external	motherboard	devices	hardware

What Are Computer Peripherals?

Computer peripherals are the devices you use to expand your system's functionality and are not essential for the computer to work. Many peripherals are ___1___ devices that give you a way to input information. For example, you might use a mouse or trackpad to navigate the screen, a keyboard to type text or a microphone to record audio. Other peripherals are ___2___ devices that let you see, print or listen to something, such as monitors, printers and speakers. While debatable since they are key ___3___ for a functional computer, internal devices like hard drives and memory may be considered peripherals.

1. Keyboard, Mouse and Touch Pad Devices

Keyboards, mice, touch pads and other human interface devices are very common ___4___ of computer systems. A HID is a peripheral that lets the computer use input data or interact with the computer. HIDs are always considered peripheral ___5___ because it is possible for a computer to operate and do countless jobs without the need for human interaction. You can disconnect an HID from a ___6___ and replace it with a new one without affecting the core functionality of the system.

2. Data Storage Devices

Data storage devices are ___7___ devices capable of holding information and include system

RAM, internal hard drives, external hard drives, solid state drives, flash drives, ___8___ cards and cassettes. Any type of storage device that connects outside of the computer, or isn't necessary for the computer to run, is considered a ___9___. For example, you can connect and disconnect external hard drives, flash drives and memory cards without disabling the the computer. However, system RAM and internal hard drives straddle the peripheral line. While the ___10___ and CPU have small amounts of built-in memory, alone, they are not enough to utilize most of the computer's capabilities.

Online Resources

二维码	内　　容
	计算机专业常用语法（1）：定语从句
	在线阅读（1）：Motherboard （主板）
	在线阅读（2）：Parallel Computing （并行计算）