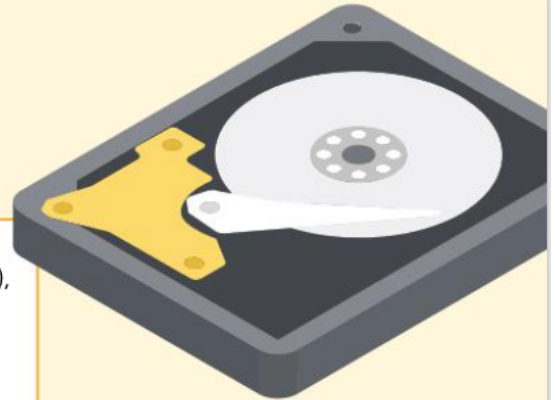


## SECONDARY STORAGE

### The need for secondary storage

**Secondary storage** includes **hard disks** (internal and external), **USB flash drives**, **CDs** and other portable storage devices. We need secondary storage for longer term storage of files and data because it is non-volatile, which means your data will not disappear when the power is turned off. External devices are portable and may have very large capacities.



### The advantages and disadvantages of different storage devices

	Optical	Magnetic (HDD)	Solid state (SSD)
<b>Capacity</b>	From 650 MB (CD) to 50 GB (Blu-ray Dual layer)	Up to 16 TB	Up to 4 TB for an SSD, or 256 GB for a USB flash drive
<b>Speed</b>	Up to 50 MB/s. Limited as there are moving parts	Up to 200 MB/s. Moving parts means relatively slow speed compared to SSD	Up to 3.5 GB/s for an SSD as there are no moving parts
<b>Portability</b>	Highly portable and lightweight	Internal drives are not portable. External drives are similar in size to a large smartphone	Flash drives and memory cards are highly portable. Internal SSDs are not intended to be portable but are very lightweight for use in laptops and tablet computers
<b>Durability</b>	Susceptible to scratches and will degrade over time and with exposure to sunlight	Good when not in use. Can be affected by magnetic fields and heat	Extremely durable
<b>Reliability</b>	Good in the medium term	Very reliable	Extremely reliable
<b>Cost</b>	50 GB for 45p	8 TB for £120	4 TB for £400

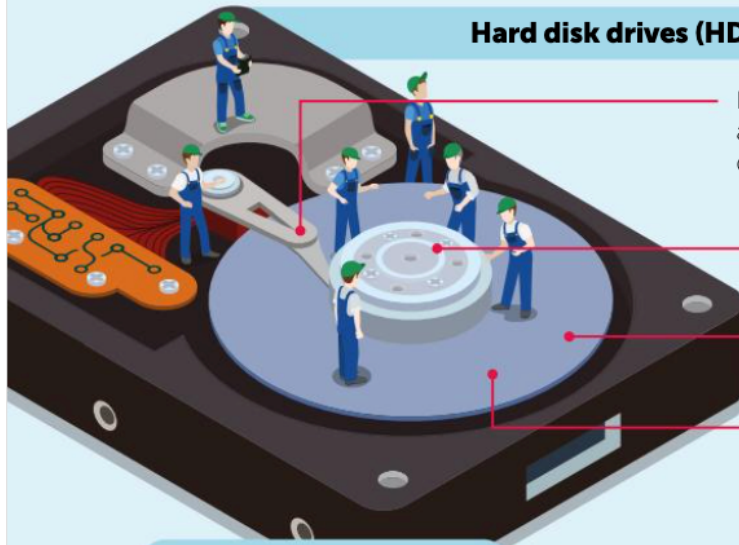
Construct an expression to show that one 2 TiB solid state disk can store the same volume of data as eight 256 GiB USB keys. [2]

$$\begin{aligned}
 8 \times 256 \text{ GiB} &= 2048 \text{ GiB}^{[1]} &= 2 \times 1024 \text{ GiB} \\
 & &= 2 \text{ TiB}^{[1]}
 \end{aligned}$$



# DEVICE OPERATION

## Hard disk drives (HDD)



Drive read/write head moves into position across concentric tracks which hold the data. This movement takes time.

Drive spindle rotates disk. Moving parts cause issues if dropped.

Magnetic platter stores data. Affected by heat and magnetic fields.

Iron particles on the disk are magnetised to be either north or south, representing 0 or 1.

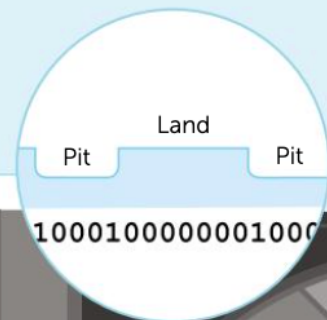
## Solid state disks (SSD)

SSDs look like a standard circuit board.

They use electrical circuits to persistently store data. These use microscopic transistors to control the flow of current. One that allows current to flow is a 1. Where current is blocked, a 0 is represented.

## Optical drives (CD / Blu-ray)

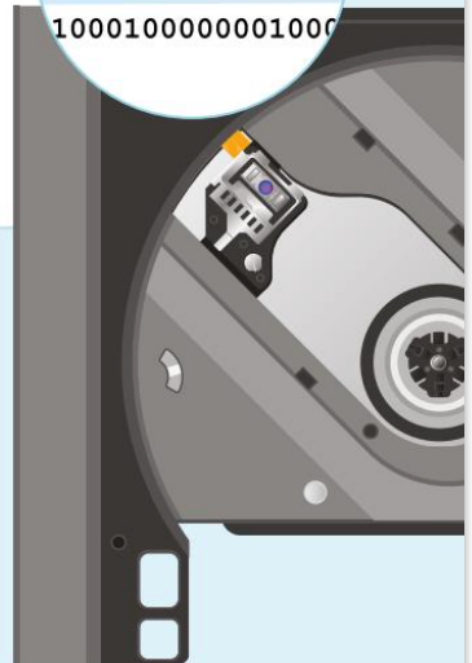
An optical drive uses a laser to reflect light off the surface of the disk. One long spiral track contains pits and lands. When the laser beam hits the curved start or end of a pit, the light is refracted and a 1 is recorded. Where light is reflected back directly from the flat bottom of a **pit**, or from an area of the track with no pit (a **land**) a 0 is recorded.



1. Explain why hard disk drives have been largely replaced by solid state drives in portable devices.

[4]

*Hard disk drives have lots of moving parts<sup>[1]</sup> which can cause problems if dropped or shaken<sup>[1]</sup>. The read/write head moves across the disk and can scratch the disk irreparably if accidentally moved too violently whilst in operation.<sup>[1]</sup> Moving the head across the disk to read or write data reduces the access speed<sup>[1]</sup> that can be achieved with solid state devices that have no moving parts. The cost and capacity of solid-state storage is improving.<sup>[1]</sup>*



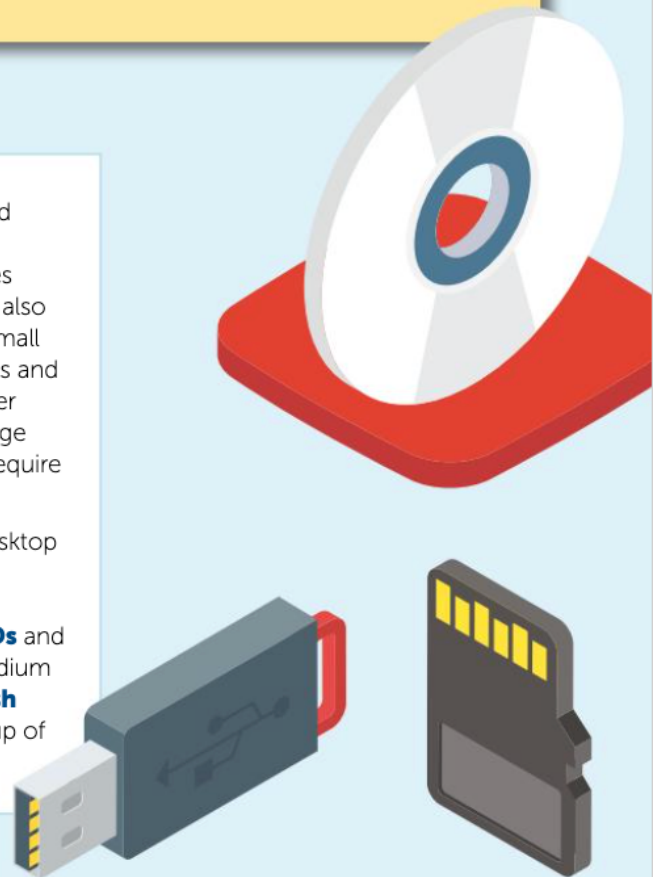
2. Explain why secondary storage is necessary in most smartphones. [2]
3. Explain why a solid state drive is commonly chosen for smartphone storage. [4]

2. Secondary storage is non-volatile.<sup>[1]</sup> Without secondary storage, you are not able to store photos, video and files for another session once the power has been switched off.<sup>[1]</sup>
3. Solid state storage is durable with no moving parts<sup>[1]</sup>, so it will be more robust if dropped<sup>[1]</sup>. It is reliable which will mean few repairs or inconvenient faults.<sup>[1]</sup> It is portable and lightweight and takes up little physical space<sup>[1]</sup>, reducing the physical size of the device<sup>[1]</sup>, ease of use<sup>[1]</sup> and weight<sup>[1]</sup> of the phone for the user. Solid state storage has very efficient power consumption<sup>[1]</sup> providing longer battery life for mobile devices<sup>[1]</sup>.

### Applications of storage media

**Solid state drives (SSDs)** require very little power and create little heat owing to the lack of moving parts. This makes them suitable for laptop and tablet devices commonly used on the go. The lack of moving parts also means they are very small and reliable – perfect for small portable devices with built-in storage such as cameras and smartphones. SSDs are also used in desktop and larger computers and are replacing hard disks in mass storage facilities as they can be 100 times faster and do not require expensive cooling equipment.

**Hard disk drives (HDDs)** are commonly found in desktop computers, but SSDs are frequently used for some applications such as the operating system and other software that needs to execute as fast as possible. **CDs** and **DVDs** are useful for archiving data in the short to medium term given a life expectancy of 10–25 years. **USB flash drives** may be more effective for more regular backup of small files as they are more durable.



4. Justify a different storage device for each of the following applications.
  - (a) A database server in a busy office. [3]
  - (b) Event photographs sent by post to a company from a photographer. [3]
  - (c) Regular transfer of files between home and a place of work. [3]
  - (a) Hard disk drives (HDD)<sup>[1]</sup> have very high capacities<sup>[1]</sup> and are relatively inexpensive compared to SSDs<sup>[1]</sup>. Fast, durable and reliable.<sup>[1]</sup> (Or, could justify SSD on grounds of speed, capacity, reliability.)
  - (b) CD or DVD.<sup>[1]</sup> Very inexpensive, costing only a few pence<sup>[1]</sup>, easy to post<sup>[1]</sup>, and will only be written to once<sup>[1]</sup>.
  - (c) USB flash drive.<sup>[1]</sup> Has sufficient capacity and speed for this purpose<sup>[1]</sup>, very portable<sup>[1]</sup>, durable<sup>[1]</sup>, reliable<sup>[1]</sup> and inexpensive<sup>[1]</sup>. (Accept valid alternatives.)