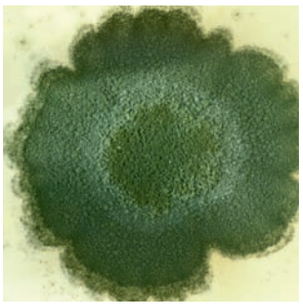
1 Innovations

1 Eureka!



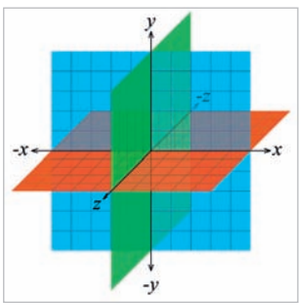
Start here

1 Work in pairs. Talk about accidental discoveries or inventions in science or technology which you have heard about.

Example: *1 Alexander Fleming was growing some bacteria in his lab when some* penicillium *fungus fell on the bacteria and killed them. That is how he accidentally discovered antibiotics.*

Task

2 Work in pairs. Match the notes 1–6 with the accidental discoveries.



X-ray ☐ inkjet printer ☐
vulcanised rubber ☐ co-ordinate geometry ☐
safety glass ☐ antibiotics 1

1 Alexander Fleming – grows bacteria in lab – *penicillium* fungus falls on bacteria – fungus kills them
2 Charles Goodyear – works with raw rubber powder containing sulphur – brushes powder off hands – powder falls onto hot stove – forms tough elastic substance
3 Rene Descartes – watches insect flying around room – realises he can specify insect's position in 3D space as – distance from two walls and ceiling
4 Wilhelm Roentgen – projects light from cathode ray generator onto wall – sees outline of bones of own hand on wall
5 Ichiro Endo, engineer – works with a hot iron and a syringe full of ink – touches neck of syringe with iron – forces ink out
6 Edouard Benedictus – puts away glass flask – flask contains liquid plastic – drops flask on floor – flask doesn't break – thin plastic film holds pieces together

3 Describe the accidental discoveries outlined in the notes in 2. Use the past continuous and the past simple tenses where appropriate.

Example: *1* – see the example in 1.

Language
page 101

Writing

4 Write about the discoveries and inventions you talked about in 1, using the past simple and continuous. Follow the example in 1.

Scanning

5 Practise your speed reading. Look for the information you need on the SPEED SEARCH pages (116–117). Try to be first to complete this text.

We don't know if Archimedes really stepped into his bath and shouted 'Eureka!' ('I've discovered it!') when the water level (1) _____ . But we do know that he discovered that a body immersed in fluid experiences a (2) _____ force equal to the weight of the liquid displaced. We also know that Archimedes invented the (3) _____ and the (4) _____.

Listening

6 02 Listen to this talk and choose the picture that illustrates what Jaap (Will's colleague) was looking at when he had his *eureka* moment.

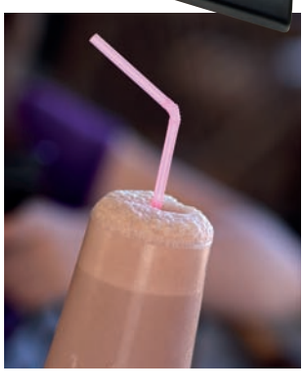
7 Listen again and answer these questions.

1 What is Will's (the speaker's) job title at his petroleum company in Brunei?
2 What problem has the speaker been trying to solve for the last few years?
3 What was happening when Jaap suddenly had his *eureka* moment?
4 What was the name of the type of drill that Jaap and his team invented as a result?
5 How does this new drill solve Will's problem?

Speaking

8 In the question and answer session after his talk, Will gives these answers. Write down the questions that were asked. Then practise the questions and answers in pairs.

1 Well, I would say that the main reason for using snake well technology is mainly economic. Snake wells allow us to get more oil out of a single field.
2 Yes, it does. The technology has a very big environmental benefit, because snake wells mean that you can build fewer oil platforms and do less drilling.
3 Yes, we are. We're using it right now, at this very moment. We have a number of snake wells in operation off the coast of Brunei.
4 Well, most of the oil in the Brunei field is between 2,000 and 4,000 metres below the seabed, I think.
5 We've been drilling snake wells off the Brunei coast since 2005.
6 Well, our company first started exploring the Brunei field a long time ago. I believe the first survey was in the 1980s.
7 Yes, we have. In addition to the snake well, we've been developing a system of sensors that transmit data from the drill bit back to computers on the surface.
8 Well, I don't know exactly what my next project is going to be! Maybe I'll drill a snake well off the coast of Nigeria.



Language
page 102

Language **Present perfect continuous**

How long	have	you	been	using	snake wells?	
Our company		has			them	since 2005.

Speaking

9 Work in pairs. Take turns to act the roles of a reporter and an oil company representative. When you are the reporter, use the present perfect continuous in your *first* question about each project, and then follow up with different types of questions.

Student A: Turn to page 115. Student B: Turn to page 113.

1 *Oil sands, Canada: how long? surface / underground mining? area project covers? kind of oil extracted? extracted oil converted into …? expected length of project?*

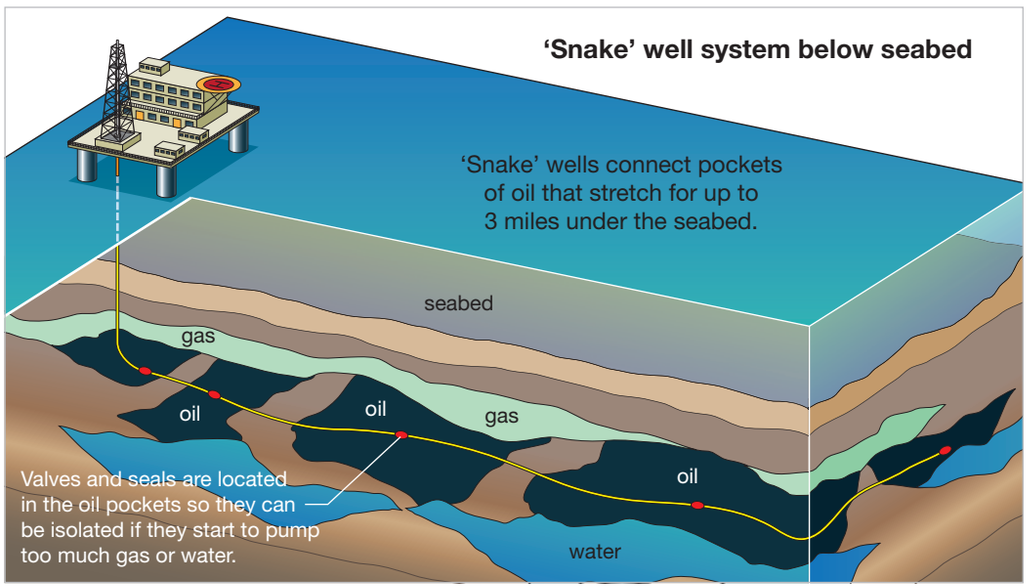
2 *Drilling for gas, Russia: how long? based where in Russia? onshore / offshore? gas converted into …? meaning of 'LNG'? future exports to …? expected production (tonnes)?*

2 Smart wells

Start here

1 Work in pairs. Discuss these questions about the illustration below. Make notes.

1 What are the advantages of this method of oil extraction compared with vertical wells?
2 How do you think computers are used in this method?



Reading

2 Read this article and check the notes you made in 1.

SMART OIL FIELDS

If an oil company discovers a large single reservoir of oil and gas, the solution is simple: drill a vertical well down to the reservoir and bring up the oil. But what can be done when an oilfield consists of hundreds or even thousands of small, **isolated** pockets of oil? It would be too expensive to drill hundreds of vertical wells to reach all the small pockets.

The innovative solution to this problem is the 'snake well'. Unlike the **conventional** vertical well, this is a horizontal well that weaves **laterally** back and forth across a number of oil-containing zones. Guided by smart technology, a single snake well can access multiple pockets of oil and achieve output **equivalent** to several individual wells, which has the **dual** advantage of reducing cost and ensuring that no oil is overlooked.

A snake well uses **steerable** drills that can be positioned with great accuracy. Special imaging software generates detailed computer models of underground geology and reservoirs. This enables drills to hit a target far underground that is less than two metres across.

Located 90 km off the coast of Brunei, the Champion West oilfield is Shell's flagship project using Smart Fields technology. For 30 years, Champion West lay dormant, its rich oil reserves **locked** 2,000 to 4,000 m beneath the seabed in a **complex** web of small reservoirs (see illustration above).

In the past, these small pockets of oil were too expensive to develop. But now Champion West has been changed into one of the world's most advanced oil and gas fields by means of Smart Fields technology and new drilling techniques.

Buried deep beneath Champion West's seabed, sensors relay digital information about temperature, pressure and other factors to control centres on land by means of a network of fibre-optic cables.

This enables continuous monitoring of production, and engineers can make speedy decisions on how best to extract the maximum amount of oil, monitor its movement within the reservoir and instantly notice production problems, such as blockages.

They can take action to solve problems, for example by the remote electronic activation of hydraulic well valves. If gas or water threatens to break into the well, for example, the valve for that section can be closed down using a remote control. **Swellable** seals are used to isolate the zones from one another, and prevent fluid from one zone from flowing into another **adjacent** zone.

3 Answer these questions about the article.

1 What are the two main economic reasons for drilling a snake well?
2 How accurate is the drill of a snake well when it is guided remotely?
3 For how long was the Champion West oilfield left unused following the discovery of oil there? Why was it left unused?
4 How is data about conditions inside the snake well transmitted to the surface?
5 How do engineers stop the oil in the well being contaminated with water or gas?

4 Match the reference words 1–6 from the article with the correct words or ideas a–j that they refer to.

1 this (line 12)	a) increased output from many oil zones
2 which (line 18)	b) conventional vertical well
3 that (line 21)	c) engineers
4 This (line 25)	d) snake well
5 This (line 47)	e) blockages
6 They (line 54)	f) transmission of data
	g) computer model generation
	h) underground reservoir
	i) steerable drills
	j) network of cables

Vocabulary

5 Match these words or phrases with their synonyms (in bold) in the article in 2.

1 capable of being expanded	6 having two parts
2 complicated	7 trapped
3 capable of being guided	8 separated from one another
4 neighbouring	9 horizontally sideways
5 normal	10 equal in value

Language

Linking (past participial phrase)

The **past participle alone** can sometimes replace **subject + passive verb**. It makes the text more concise.

- *The Champion West oilfield, **located** 90 km off the coast of Brunei, is Shell's flagship project …* (= *The Champion West oilfield, **which is located** …*)

The past participle can also be placed at the beginning of a sentence. Find these examples in the text in 2:

- ***Located** 90 km off the coast of Brunei*, the Champion West oilfield is Shell's flagship project …
- ***Guided** by smart technology*, a single snake well can access pockets of oil …
- ***Buried** deep beneath Champion West's seabed*, sensors relay digital information …

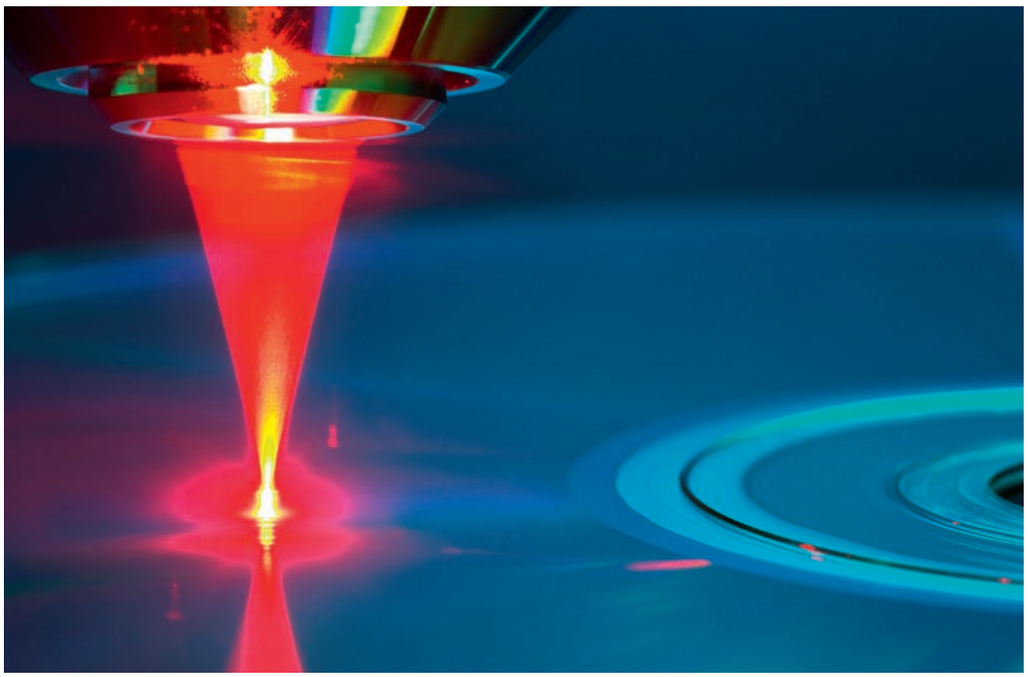
Note that the participle must have the same subject as the verb in the main clause.

6 Join the information in each note into a single sentence in a similar way. Begin each sentence with the past participle in italics.

Example: *1 Isolated in small pockets, the oil can't be extracted using vertical wells.*

1 the oil is *isolated* in small pockets + it can't be extracted using vertical wells
2 the sensors are *connected* by fibre-optic cable + they collect data from inside the snake well
3 the drills are *guided* by remote controllers + they can hit a target only 2 m wide
4 the oil is *locked* 4,000 m beneath the seabed + it couldn't be extracted for 30 years
5 the sensors are *attached* to the drill bit + they allow controllers to guide the drill
6 the software was *developed* by GeoSolutions + it generates computer models of the geology

3 Lasers

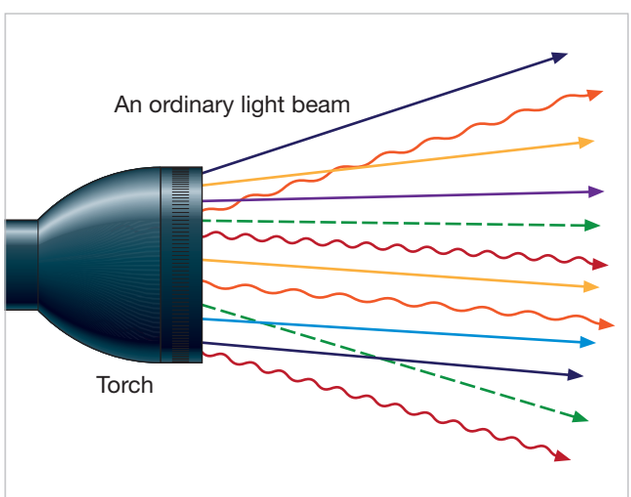


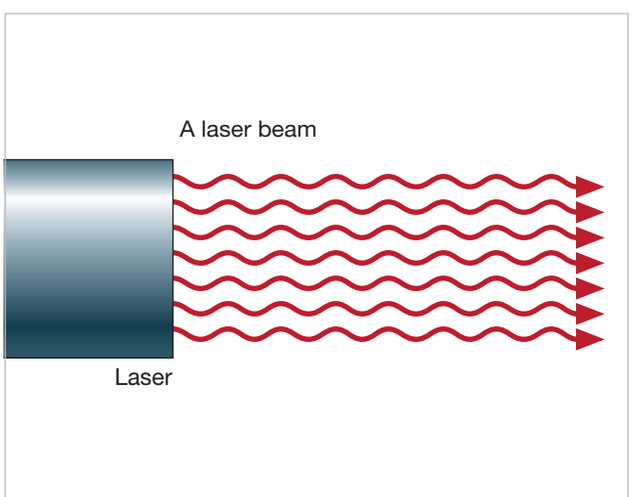
Start here

1 Work in pairs. Discuss these questions and make notes. Then share your ideas with the rest of the class.

1 What does LASER stand for?
_____ _____ by *Stimulated* _____ of _____

2 Study the diagrams below. What are the three main differences between ordinary light and laser light? Use some of the words and phrases in the box.





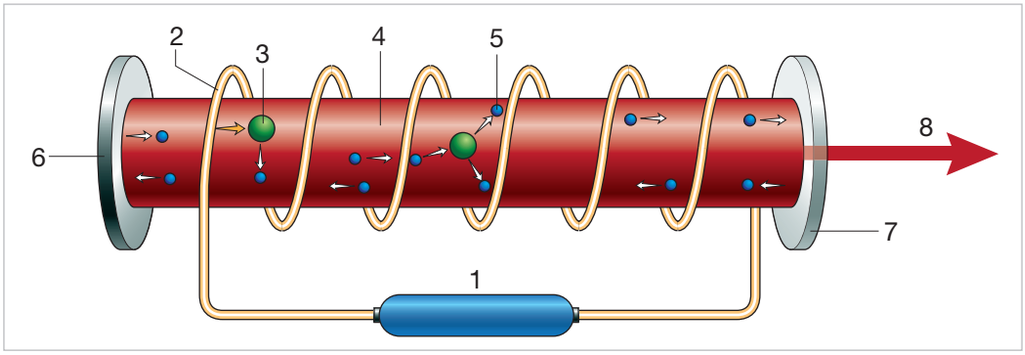
laser light amplification stimulated emission of radiation organised disorganised directional in one direction in all directions coherent concentrated photon colours of the spectrum wavelength

03

Listening

2 04 Listen to part of a talk about lasers. Match the words in the box with the labels 1–8 in the diagram on the next page.

ruby crystal atom light tube mirror power source photon laser beam partial mirror



3 Work in pairs or small groups. Before you listen to the next part of the talk, put these notes into the best order.

Note: The eight items in the notes correspond to the eight points in the diagram above.

A escaping photons form a powerful laser beam ☐
B atom absorbs photon – gets excited – calms down – emits new photon ☐
C tube flashes on / off rapidly – pumps energy (photons) into crystal ☐
D partial mirror lets 1% of photons escape ☐
E power source makes tube flash on / off 1
F new photon hits excited atom – atom emits *two* photons (instead of one) ☐
G photons are reflected by mirror along inside of crystal ☐
H new photons travel inside crystal at speed of light ☐

4 05 Listen to the next part of the talk, and check your answers to 3.

5 Listen again and tick the phrases that you hear. (Note: X is a number, and A is someone's name.)

1 A has been explaining
2 let's move on to the next section of the talk
3 if you look at point X on the diagram, you will see
4 we can now turn to the next part of the talk
5 as you can see in point X on the diagram
6 I think I've covered the main points
7 I'll now ask A to take over
8 now I'm going to hand over to A

6 Group the phrases from 5 under these headings.

Moving to the next topic	Referring to the previous topic(s)
Handing over to the next speaker	Referring to a visual

Speaking

7 Work in groups to prepare a talk on lasers. Divide into three sub-groups and prepare one section of the talk with your sub-group. Then return to the main group to finalise the talk.

Sub-group A: Laser light – a brief explanation
Sub-group B: The basic components of a laser machine
Sub-group C: How a laser machine works

8 Give your talk to another group. Use phrases from 5 to signpost the sections of the talk, to refer to the diagram and to hand over to the next sub-group. Invite and answer questions from the audience.

Writing

9 Write a description of how a laser machine works, referring to the diagram above. Use past participial phrases where possible.

Begin: *Here is a brief outline of how a laser machine works. First of all, the high-voltage power source, located below the ruby crystal, makes the tube flash on and off rapidly. These flashes inject particles of light, known as 'photons', into the ruby crystal. …*