

Crop-growing Skyscrapers



1By the year 2050, nearly 80% of the Earth's population will live in urban centres.**(2)** Applying the most conservative estimates to current demographic trends, the human population will increase by about three billion people by then.**(3)** An estimated 109 hectares of new land (about 20% larger than Brazil) will be needed to grow enough food to feed them, if traditional farming methods continue as they are practiced today.**(4)** At present, throughout the world, over 80% of the land that is suitable for raising crops is in use.**(5)** Historically, some 15% of that has been laid waste by poor management practices.**(6)** What can be done to ensure enough food for the world's population to live on?

The concept of indoor farming is not new, since hothouse production of tomatoes and other produce has been in vogue for some time.**(7)** What is new is the urgent need to scale up this technology to accommodate another three billion people.**(8)** Many believe an entirely new approach to indoor farming is required, employing cutting-edge technologies.**(9)** One such proposal is for the "Vertical Farm".**(10)** The concept is of multi-storey buildings in which food crops are grown in environmentally controlled conditions.**(11)** Situated in the heart of urban centres, they would drastically reduce the amount of transportation required to bring food to consumers.**(12)** Vertical farms would need to be efficient, cheap to construct and safe to operate.**(13)** If successfully implemented, proponents claim, vertical farms offer the promise of urban renewal, sustainable production of a safe and varied food supply (through year-round production of all crops), and the eventual repair of ecosystems that have been sacrificed for horizontal farming.**(14)**

It took humans 10,000 years to learn how to grow most of the crops we now take for granted.**(15)** Along the way, we despoiled most of the land we worked, often turning verdant, natural ecozones into semi-arid deserts.**(16)** Within that same time frame, we evolved into an urban species, in which 60% of the human population now lives vertically in cities.**(17)** This means that, for the majority, we humans have shelter from the elements, yet we subject our food-bearing plants to the rigours of the great outdoors and can do no more than hope for a good weather year.**(18)** However, more often than not now, due to a rapidly changing climate, that is not what happens.**(19)** Massive floods, long droughts, hurricanes and severe monsoons take their toll each year, destroying millions of tons of valuable crops.**(20)**

The supporters of vertical farming claim many potential advantages for the system.**(21)** For instance, crops would be produced all year round, as they would be kept in artificially controlled, optimum growing conditions.**(22)** There would be no weather-related crop failures due to droughts, floods or pests.**(23)** All the food could be grown organically, eliminating the need for herbicides, pesticides and fertilizers.**(24)** The system would greatly reduce the incidence of many infectious diseases that are acquired at the agricultural interface.**(25)** Although the system would consume energy, it would return energy to the grid via methane generation from composting non-edible parts of plants.**(26)** It would also dramatically reduce fossil fuel use, by cutting out the need for tractors, ploughs and shipping.**(27)**

A major drawback of vertical farming, however, is that the plants would require artificial light.**(28)** Without it, those plants nearest the windows would be exposed to more sunlight and grow more quickly, reducing the efficiency of the system.**(29)** Single-storey greenhouses have the benefit of natural overhead light: even so, many still need artificial lighting.**(30)** A multi-storey facility with no natural overhead light would require far more.**(31)** Generating enough light could be prohibitively expensive, unless cheap, renewable energy is available, and this appears to be rather a future aspiration than a likelihood for the near future.**(32)**

One variation on vertical farming that has been developed is to grow plants in stacked trays that move on rails.**(33)** Moving the trays allows the plants to get enough sunlight.**(34)** This system is already in operation, and works well within a single-storey greenhouse with light

reaching it from above: it is not certain, however, that it can be made to work without that overhead natural light.(35)

Vertical farming is an attempt to address the undoubted problems that we face in producing enough food for a growing population.(36) At the moment, though, more needs to be done to reduce the detrimental impact it would have on the environment, particularly as regards the use of energy.(37) While it is possible that much of our food will be grown in skyscrapers in future, most experts currently believe it is far more likely that we will simply use the space available on urban rooftops.(38)

Questions 1-7

Complete the sentences below.

Choose **NO MORE THAN TWO WORDS** from the passage for each answer.

Write your answers in boxes **1-7** on your answer sheet.

Indoor farming

1. Some food plants, including are already grown indoors.
2. Vertical farms would be located in, meaning that there would be less need to take them long distances to customers.
3. Vertical farms could use methane from plants and animals to produce
4. The consumption of would be cut because agricultural vehicles would be unnecessary.
5. The fact that vertical farms would need light is a disadvantage.
6. One form of vertical farming involves planting in which are not fixed.
7. The most probable development is that food will be grown on in towns and cities.

Questions 8-13

Do the following statements agree with the information given in Reading Passage 182?

In boxes **8-13** on your answer sheet, write

- TRUE** if the statement agrees with the information
FALSE if the statement contradicts the information
NOT GIVEN if there is no information on this

8. Methods for predicting the Earth's population have recently changed.
9. Human beings are responsible for some of the destruction to food-producing land.
10. The crops produced in vertical farms will depend on the season.
11. Some damage to food crops is caused by climate change.
12. Fertilisers will be needed for certain crops in vertical farms.
13. Vertical farming will make plants less likely to be affected by infectious diseases.

The Falkirk Wheel



A unique engineering achievement

The Falkirk Wheel in Scotland is the world's first and only rotating boat lift.⁽²⁾ Opened in 2002, it is central to the ambitious £84.3m Millennium Link project to restore navigability across Scotland by reconnecting the historic waterways of the Forth & Clyde and Union Canals.⁽⁴⁾

The major challenge of the project lays in the fact that the Forth & Clyde Canal is situated 35 metres below the level of the Union Canal.⁽⁵⁾ Historically, the two canals had been joined near the town of Falkirk by a sequence of 11 locks - enclosed sections of canal in which the water level could be raised or lowered - that stepped down across a distance of 1.65 km.⁽⁷⁾ This had been dismantled in 1933, thereby breaking the link.⁽⁸⁾ When the project was launched in 1994, the British Waterways authority were keen to create a dramatic twenty-first-century landmark which would not only be a fitting commemoration of the Millennium, but also a lasting symbol of the economic regeneration of the region.⁽⁹⁾

Numerous ideas were submitted for the project, including concepts ranging from rolling eggs to tilting tanks, from giant seesaws to overhead monorails.⁽¹⁰⁾ The eventual winner was a plan for the huge rotating steel boat lift which was to become The Falkirk Wheel.⁽¹¹⁾ The unique shape of the structure is claimed to have been inspired by various sources, both manmade and natural, most notably a Celtic double headed axe, but also the vast turning propeller of a ship, the ribcage of a whale or the spine of a fish.⁽¹²⁾

The various parts of The Falkirk Wheel were all constructed and assembled, like one giant toy building set, at Butterley Engineering's Steelworks in Derbyshire, some 400 km from

Falkirk.⁽¹³⁾ A team there carefully assembled the 1,200 tonnes of steel, painstakingly fitting the pieces together to an accuracy of just 10 mm to ensure a perfect final fit.⁽¹⁴⁾ In the summer of 2001, the structure was then dismantled and transported on 35 lorries to Falkirk, before all being bolted back together again on the ground, and finally lifted into position in five large sections by crane.⁽¹⁵⁾ The Wheel would need to withstand immense and constantly changing stresses as it rotated, so to make the structure more robust, the steel sections were bolted rather than welded together.⁽¹⁶⁾ Over 45,000 bolt holes were matched with their bolts, and each bolt was hand-tightened.⁽¹⁷⁾

The Wheel consists of two sets of opposing axe-shaped arms, attached about 25 metres apart to a fixed central spine.⁽¹⁸⁾ Two diametrically opposed water-filled 'gondolas', each with a capacity of 360,000 litres, are fitted between the ends of the arms.⁽¹⁹⁾ These gondolas always weigh the same, whether or not they are carrying boats.⁽²⁰⁾ This is because, according to Archimedes' principle of displacement, floating objects displace their own weight in water.⁽²¹⁾ So when a boat enters a gondola, the amount of water leaving the gondola weighs exactly the same as the boat.⁽²²⁾ This keeps the Wheel balanced and so, despite its enormous mass, it rotates through 180° in five and a half minutes while using very little power.⁽²³⁾ It takes just 1.5 kilowatt-hours (5.4 MJ) of energy to rotate the Wheel -roughly the same as boiling eight small domestic kettles of water.⁽²⁶⁾

Boats needing to be lifted up enter the canal basin at the level of the Forth & Clyde Canal and then enter the lower gondola of the Wheel.⁽²⁷⁾ Two hydraulic steel gates are raised, so as to seal the gondola off from the water in the canal basin.⁽²⁸⁾ The water between the gates is then pumped out.⁽²⁹⁾ A hydraulic clamp, which prevents the arms of the Wheel moving while the gondola is docked, is removed, allowing the Wheel to turn.⁽³⁰⁾ In the central machine room, an array of ten hydraulic motors then begins to rotate the central axle.⁽³¹⁾ The axle connects to the outer arms of the Wheel, which begin to rotate at a speed of 1/8 of a revolution per minute.⁽³²⁾ As the wheel rotates, the gondolas are kept in the upright position by a simple gearing system.⁽³³⁾ Two eight-metre-wide cogs orbit a fixed inner cog of the same width, connected by two smaller cogs travelling in the opposite direction to the outer cogs - so ensuring that the gondolas always remain level.⁽³⁴⁾ When the gondola reaches the

top, the boat passes straight onto the aqueduct situated 24 metres above the canal basin.(35)

The remaining 11 metres of lift needed to reach the Union Canal is achieved by means of a pair of locks.(36) The Wheel could not be constructed to elevate boats over the full 35-metre difference between the two canals, owing to the presence of the historically important Antonine Wall, which was built by the Romans in the second century AD.(37) Boats travel under this wall via a tunnel, then through the locks, and finally on to the Union Canal.(38)

Do the following statements agree with the information given in the Reading Passage?

In boxes **14-19** on your answer sheet, write

TRUE if the statement agrees with the information

FALSE if the statement contradicts the information

NOT GIVEN if there is no information on this

14. The Falkirk Wheel has linked the Forth & Clyde Canal with the Union Canal for the first time in their history.

15. There was some opposition to the design of the Falkirk Wheel at first.

16. The Falkirk Wheel was initially put together at the location where its components were manufactured.

17. The Falkirk Wheel is the only boat lift in the world which has steel sections bolted together by hand.

18. The weight of the gondolas varies according to the size of boat being carried.

19. The construction of the Falkirk Wheel site took into account the presence of a nearby ancient monument.

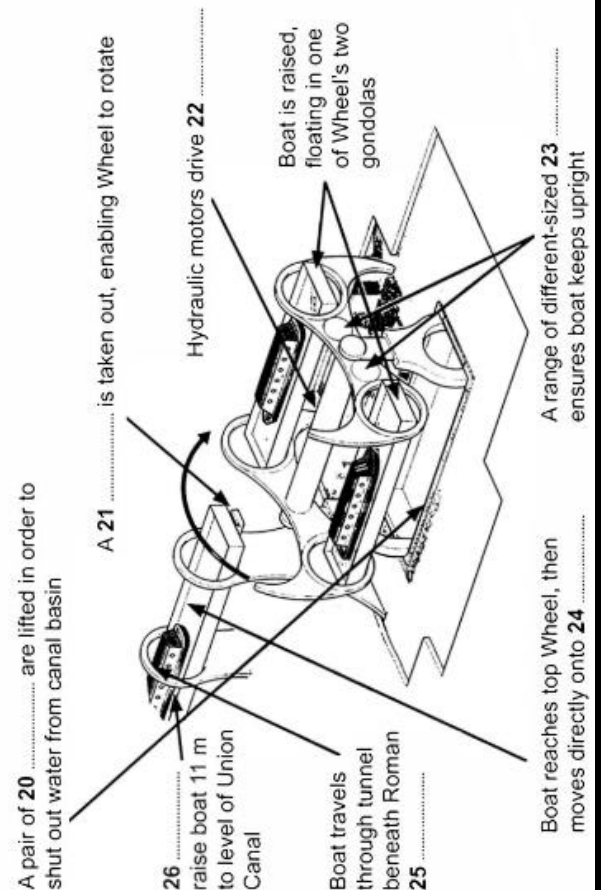
Questions 20-26

Label the diagram below.

Choose **ONE WORD** from the passage for each answer.

Write your answers in boxes **20-26** on your answer sheet.

How a boat is lifted on the Falkirk Wheel



Reducing The Effects Of Climate Change

A Such is our dependence on fossil fuels, and such is the volume of carbon dioxide already released into the atmosphere, that many experts agree that significant global warming is now inevitable. They believe that the best we can do is keep it at a reasonable level, and at present, the only serious option for doing this is cutting back on our carbon emissions. But while a few countries are making major strides in this regard, the majority are having great difficulty even stemming the rate of increase, let alone reversing it. Consequently, an increasing number of scientists are beginning to explore the alternative of geo-engineering — a term which generally refers to the intentional large-scale manipulation of the environment. According to its proponents, geo-engineering is the equivalent of a backup generator: if Plan A - reducing our dependency on fossil fuels - fails, we require a Plan B, employing grand schemes to slow down or reverse the process of global warming.

B Geo-engineering; has been shown to work, at least on a small localized scale. For decades, Mayday parades in Moscow have taken place under clear blue skies, aircraft having deposited dry ice, silver iodide and cement powder to disperse clouds. Many of the schemes now suggested look to do the opposite, and reduce the amount of sunlight reaching the planet. The most eye-catching idea of all is suggested by Professor Roger Angel of the University of Arizona. His scheme would employ up to 16 trillion minute spacecraft, each weighing about one gram, to form a transparent, sunlight-refracting sunshade in an orbit 1.5 million km above the Earth. This could, argues Angel, reduce the amount of light reaching the Earth by two per cent.

C The majority of geo-engineering projects so far carried out — which include planting forests in deserts and depositing iron in the ocean to stimulate the growth of algae - have focused on achieving a general cooling of the Earth. But some look specifically at reversing the melting at the poles, particularly the Arctic. The reasoning is that if you replenish the ice sheets and frozen waters of the high latitudes, more light will be reflected back into space, so reducing the warming of the oceans and atmosphere.

D The concept of releasing aerosol sprays into the stratosphere above the Arctic has been proposed by several scientists. This would involve using Sulphur or hydrogen supplied aerosols so that Sulphur dioxide would form clouds, which would, in turn, lead to a global dimming. The idea is modelled on historic volcanic explosions, such as that of Mount Pinatubo in the Philippines in 1991, which led to a short-term cooling of global temperatures by 0.5 °C. Scientists have also scrutinized whether it's possible to preserve the ice sheets of Greenland with reinforced high-tension cables, preventing icebergs from moving into the sea. Meanwhile, in the Russian Arctic, geo-engineering plans include the planting of millions of birch trees. Whereas the -regions native evergreen pines shade the snow and absorb radiation, birches would shed their leaves in winter, thus enabling radiation to be reflected by the snow. Re-routing Russian rivers to increase cold water flow to ice-forming areas could also be used to slow down warming, say some climate scientists.

E But will such schemes ever be implemented? Generally speaking, those who are most cautious about geo-engineering are the scientists involved in the research. Angel says that his plan is 'no substitute for developing renewable energy: the only permanent solution'. And Dr Phil Rasch of the US-based Pacific Northwest National Laboratory is equally guarded about the role of geo-engineering: 'I think all of us agree that if we were to end geo-engineering on a given day, then the planet would return to its pre-engineered condition very rapidly, and probably within ten to twenty years. That's certainly something to worry about.'

F The US National Center for Atmospheric Research has already suggested that the proposal to inject Sulphur into the atmosphere might affect rainfall patterns across the tropics and the Southern Ocean. 'Geo-engineering plans to inject stratospheric aerosols or to seed clouds would act to cool the planet, and act to increase the extent of sea ice,' says Rasch. 'But all the models suggest some impact on the distribution of precipitation.'

G A further risk with geo-engineering projects is that you can "overshoot" says Dr Dan Hunt, from the University of Bristol's School of Geophysical Sciences, who has studied the likely impacts of the sunshade and aerosol schemes on the climate. 'You may bring global temperatures back to pre-industrial levels, but the risk is that the poles will still be warmer than they should be and the tropics will be cooler than before industrialization. 'To avoid such a scenario,' Hunt says, "Angel's project would have to operate at half strength; all of which reinforces his view that the best option is to avoid the

need for geo-engineering altogether."

H The main reason why geo-engineering is supported by many in the scientific community is that most researchers have little faith in the ability of politicians to agree - and then bring in — the necessary carbon cuts. Even leading conservation organizations see the value of investigating the potential of geo-engineering. According to Dr Martin Sommerkorn, climate change advisor for the World Wildlife Fund's International Arctic Programme, 'Human-induced climate change has brought humanity to a position where we shouldn't exclude thinking thoroughly about this topic and its possibilities.'

Questions 27-29

Reading Passage 184 has eight paragraphs A-H
Which paragraph contains the following information?

- 27.** mention of a geo-engineering project based on an earlier natural phenomenon
- 28.** an example of a successful use of geo-engineering
- 29.** a common definition of geo-engineering

Questions 30-36

Choose **ONE WORD** from the passage for each answer. Write your answers in boxes 30-36 on your answer sheet.

GEO-ENGINEERING PROJECTS

Procedure	Aim
put a large number of tiny spacecraft into orbit far above Earth	to create a 30 that would reduce the amount of light reaching Earth
place 31 in the sea	to encourage 32 to form
release aerosol sprays into the stratosphere	to create 33 that would reduce the amount of light reaching Earth
fix strong 34 to Greenland ice sheets	to prevent icebergs moving into the sea
plant trees in Russian Arctic that would lose their leaves in winter	to allow the 35 to reflect radiation
change the direction of 36	to bring more cold water into ice-forming areas

Questions 37-40

Look at the following statements (Questions 37-40) and the list of scientists below.

Match each statement with the correct scientist, A-D.

List of Scientists

- A.** Roger Angel
- B.** Phil Rasch
- C.** Dan Lunt
- D.** Martin Sommerkorn

- 37.** The effects of geo-engineering may not be long-lasting.
- 38.** Geo-engineering is a topic worth exploring.
- 39.** It may be necessary to limit the effectiveness of geo-engineering projects.
- 40.** Research into non-fossil-based fuels cannot be replaced by geo-engineering.

Raising The Mary Rose

How a sixteenth-century warship was recovered from the seabed

On 19 July 1545, English and French fleets were engaged in a sea battle off the coast of southern England in the area of water called the Solent, between Portsmouth and the Isle of Wight. Among the English vessels was a warship by the name of Mary Rose. Built in Portsmouth some 35 years earlier, she had had a long and successful fighting career, and was a favourite of King Henry VIII. Accounts of what happened to the ship vary: while witnesses agree that she was not hit by the French, some maintain that she was outdated, overladen and sailing too low in the water, others that she was mishandled by undisciplined crew. What is undisputed, however, is that the Mary Rose sank into the Solent that day, taking at least 500 men with her. After the battle, attempts were made to recover the ship, but these failed.

The Mary Rose came to rest on the seabed, lying on her starboard (right) side at an angle of approximately 60 degrees. The hull (the body of the ship) acted as a trap for the sand and mud carried by Solent currents. As a result, the starboard side filled rapidly, leaving the exposed port (left) side to be eroded by marine organisms and mechanical degradation. Because of the way the ship sank, nearly all of the starboard half survived intact. During the seventeenth and eighteenth centuries, the entire site became covered with a layer of hard grey clay, which minimised further erosion.

Then, on 16 June 1836, some fishermen in the Solent found that their equipment was caught on an underwater obstruction, which turned out to be the Mary Rose. Diver John Deane happened to be exploring another sunken ship nearby, and the fishermen approached him, asking him to free their gear. Deane dived down, and found the equipment caught on a timber protruding slightly from the seabed. Exploring further, he uncovered several other timbers and a bronze gun. Deane continued diving on the site intermittently until 1840. Recovering several more guns, two bows, various timbers, part of a pump and various other small finds.

The Mary Rose then faded into obscurity for another hundred years. But in 1965, military historian and amateur diver Alexander McKee, in conjunction with the British Sub-Aqua Club, initiated a project called 'Solent Ships'. While on paper this was a plan to examine a number of known wrecks in the Solent, what McKee really hoped for was to find the Mary Rose. Ordinary search techniques proved unsatisfactory, so McKee entered into collaboration with Harold E. Edgerton, professor of electrical engineering at the Massachusetts Institute of Technology. In 1967, Edgerton's side-scan sonar systems revealed a large, unusually shaped object, which McKee believed was the Mary Rose.

Further excavations revealed stray pieces of timber and an iron gun. But the climax to the operation came when, on 5 May 1971, part of the ship's frame was uncovered. McKee and his team now knew for certain that they had found the wreck, but were as yet unaware that it also housed a treasure trove of beautifully preserved artifacts. Interest in the project grew, and in 1979, The Mary Rose Trust was formed, with Prince Charles as its President and Dr Margaret Rule its Archaeological Director. The decision whether or not to salvage the wreck was not an easy one, although an excavation in 1978 had shown that it might be possible to raise the hull. While the original aim was to raise the hull if at all feasible, the operation was not given the go-ahead until January 1982, when all the necessary information was available.

An important factor in trying to salvage the Mary Rose was that the remaining hull was an open shell. This led to an important decision being taken: namely to carry out the lifting operation in three very distinct stages. The hull was attached to a lifting frame via a network of bolts and lifting wires. The problem of the hull being sucked back downwards into the mud was overcome by using 12 hydraulic jacks. These raised it a few centimetres over a period of several days, as the lifting frame rose slowly up its four legs. It was only when the hull was hanging freely from the lifting frame, clear of the seabed and the suction effect of the surrounding mud, that the salvage operation progressed to the second stage. In this stage, the lifting frame was fixed to a hook attached to a crane, and the hull was lifted completely clear of the seabed and transferred underwater into the lifting cradle. This required precise positioning to locate the legs into the 'stabbing guides' of the lifting cradle. The lifting cradle was designed to fit the hull using archaeological survey drawings, and was fitted with air bags to provide additional cushioning for the hull's delicate timber framework. The third and final stage was to lift the entire structure into the air, by which time the hull was also supported from below. Finally, on 11

57
58

October 1982, millions of people around the world held their breath as the timber skeleton of the Mary Rose was lifted clear of the water, ready to be returned home to Portsmouth.

Questions 1-4

Do the following statements agree with the information given in Reading Passage 1?

In boxes 1-4 on your answer sheet, write

TRUE if the statement agrees with the information

FALSE if the statement contradicts the information

NOT GIVEN if there is no information on this

- 1 There is some doubt about what caused the Mary Rose to sink.
- 2 The Mary Rose was the only ship to sink in the battle of 19 July 1545.
- 3 Most of one side of the Mary Rose lay undamaged under the sea.
- 4 Alexander McKee knew that the wreck would contain many valuable historical objects.

Questions 5-8

Match each statement with the correct date, A-G.

- 5 A search for the Mary Rose was launched.
- 6 One person's exploration of the Mary Rose site stopped.
- 7 It was agreed that the hull of the Mary Rose should be raised.
- 8 The site of the Mary Rose was found by chance.

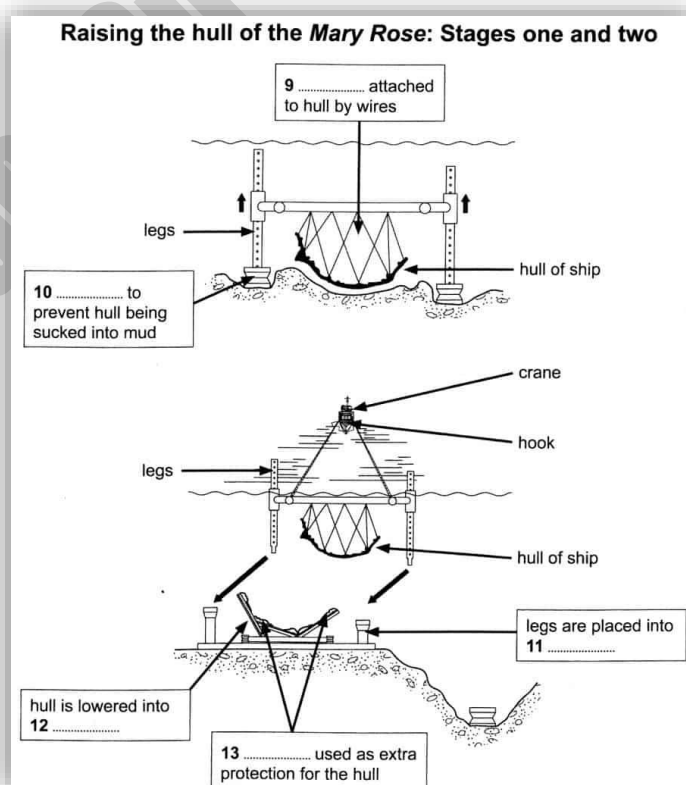
List of Dates

- A 1836
- B 1840
- C 1965
- D 1967
- E 1971
- F 1979
- G 1982

Questions 9-13

Label the diagram below.

Choose NO MORE THAN **TWO WORDS** from the passage for each answer.



What Destroyed The Civilization Of Easter Island?



1A

Easter Island, or Rapa Nui as it is known locally, is home to several hundred ancient human statues - the moai.(2) After this remote Pacific island was settled by the Polynesians, it remained isolated for centuries.(3) All the energy and resources that went into the moai - some of which are ten metres tall and weigh over 7,000 kilos - came from the island itself.(4) Yet when Dutch explorers landed in 1722, they met a Stone Age culture.(5) The moai were carved with stone tools, then transported for many kilometres, without the use of animals or wheels, to massive stone platforms.(6) The identity of the moai builders was in doubt until well into the twentieth century.(7) Thor Heyerdahl, the Norwegian ethnographer and adventurer, thought the statues had been created by pre-Inca peoples from Peru.(8) Bestselling Swiss author Erich von Daniken believed they were built by stranded extraterrestrials.(9) Modern science - linguistic, archaeological and genetic evidence - has definitively proved the moai builders were Polynesians, but not how they moved their creations.(10) Local folklore maintains that the statues walked, while researchers have tended to assume the ancestors dragged the statues somehow, using ropes and logs.(11)

B

When the Europeans arrived, Rapa Nui was grassland, with only a few scrawny trees.(12) In the 1970s and 1980s, though, researchers found pollen preserved in lake sediments, which

proved the island had been covered in lush palm forests for thousands of years.(13) Only after the Polynesians arrived did those forests disappear.(14) US scientist Jared Diamond believes that the Rapanui people - descendants of Polynesian settlers - wrecked their own environment.(15) They had unfortunately settled on an extremely fragile island - dry, cool, and too remote to be properly fertilised by windblown volcanic ash.(16) When the islanders cleared the forests for firewood and farming, the forests didn't grow back.(17) As trees became scarce and they could no longer construct wooden canoes for fishing, they ate birds.(18) Soil erosion decreased their crop yields.(19) Before Europeans arrived, the Rapanui had descended into civil war and cannibalism, he maintains.(20) The collapse of their isolated civilisation, Diamond writes, is a 'worst-case scenario for what may lie ahead of us in our own future'.(21)

C

The moai, he thinks, accelerated the self-destruction.(22) Diamond interprets them as power displays by rival chieftains who, trapped on a remote little island, lacked other ways of asserting their dominance.(23) They competed by building ever bigger figures.(24) Diamond thinks they laid the moai on wooden sledges, hauled over log rails, but that required both a lot of wood and a lot of people.(25) To feed the people, even more land had to be cleared.(26) When the wood was gone and civil war began, the islanders began toppling the moai.(27) By the nineteenth century none were standing.(28)

D

Archaeologists Terry Hunt of the University of Hawaii and Carl Lipo of California State University agree that Easter Island lost its lush forests and that it was an 'ecological catastrophe' - but they believe the islanders themselves weren't to blame.(29) And the moai certainly weren't.(30) Archaeological excavations indicate that the Rapanui went to heroic efforts to protect the resources of their wind-lashed, infertile fields.(31) They built thousands of circular stone windbreaks and gardened inside them, and used broken volcanic rocks to keep the soil moist.(32) In short, Hunt and Lipo argue, the prehistoric Rapanui were pioneers of sustainable farming.(33)

E

Hunt and Lipo contend that moai-building was an activity that helped keep the peace between islanders.(34) They also believe that moving the moai required few people and no wood,

because they were walked upright.(35) On that issue, Hunt and Lipo say, archaeological evidence backs up Rapanui folklore.(36) Recent experiments indicate that as few as 18 people could, with three strong ropes and a bit of practice, easily manoeuvre a 1,000 kg moai replica a few hundred metres.(37) The figures' fat bellies tilted them forward, and a D-shaped base allowed handlers to roll and rock them side to side.(38)

F

Moreover, Hunt and Lipo are convinced that the settlers were not wholly responsible for the loss of the island's trees.(39) Archaeological finds of nuts from the extinct Easter Island palm show tiny grooves, made by the teeth of Polynesian rats.(40) The rats arrived along with the settlers, and in just a few years, Hunt and Lipo calculate, they would have overrun the island.(41) They would have prevented the reseedling of the slow-growing palm trees and thereby doomed Rapa Nui's forest, even without the settlers' campaign of deforestation.(42) No doubt the rats ate birds' eggs too.(43) Hunt and Lipo also see no evidence that Rapanui civilization collapsed when the palm forest did.(44) They think its population grew rapidly and then remained more or less stable until the arrival of the Europeans, who introduced deadly diseases to which islanders had no immunity.(45) Then in the nineteenth century slave traders decimated the population, which shrivelled to 111 people by 1877.(46)

G

Hunt and Lipo's vision, therefore, is one of an island populated by peaceful and ingenious moai builders and careful stewards of the land, rather than by reckless destroyers ruining their own environment and society.(47) 'Rather than a case of abject failure, Rapa Nui is an unlikely story of success', they claim.(48) Whichever is the case, there are surely some valuable lessons which the world at large can learn from the story of Rapa Nui.(49)

Questions 14-20

Reading Passage 2 has seven paragraphs, A-G.

Choose the correct heading for each paragraph from the list of headings below.

Write the correct number, i-ix, in boxes 14-20 on your answer sheet.

List of Headings

- i Evidence of innovative environment management practices
- ii An undisputed answer to a question about the moai

- iii The future of the moai statues
- iv A theory which supports a local belief
- v The future of Easter Island
- vi Two opposing views about the Rapanui people
- vii Destruction outside the inhabitants' control
- viii How the statues made a situation worse
- ix Diminishing food resources

- 14 Paragraph A
- 15 Paragraph B
- 16 Paragraph C
- 17 Paragraph D
- 18 Paragraph E
- 19 Paragraph F
- 20 Paragraph G

Questions 21-24

Choose **ONE WORD ONLY** from the passage for each answer.

Write your answers in boxes **21-24** on your answer sheet.

Jared Diamond's View

Diamond believes that the Polynesian settlers on Rapa Nui destroyed its forests, cutting down its trees for fuel and clearing land for **21** Twentieth-century discoveries of pollen prove that Rapa Nui had once been covered in palm forests, which had turned into grassland by the time the Europeans arrived on the island. When the islanders were no longer able to build the **22** they needed to go fishing, they began using the island's **23** as a food source, according to Diamond. Diamond also claims that the moai were built to show the power of the island's chieftains, and that the methods of transporting the statues needed not only a great number of people, but also a great deal of **24**

Questions 25 and 26

Choose **TWO** letters, **A-E**.

Write the correct letters in boxes 25 and 26 on your answer sheet.

On what points do Hunt and Lipo disagree with Diamond?

- A. the period when the moai were created
- B. how the moai were transported
- C. the impact of the moai on Rapanui society
- D. how the moai were carved
- E. the origins of the people who made the moai

Neuroaesthetics



1An emerging discipline called neuroaesthetics is seeking to bring scientific objectivity to the study of art, and has already given us a better understanding of many masterpieces.(2) The blurred imagery of Impressionist paintings seems to stimulate the brain's amygdala, for instance.(3) Since the amygdala plays a crucial role in our feelings, that finding might explain why many people find these pieces so moving.(4)

Could the same approach also shed light on abstract twentieth-century pieces, from Mondrian's geometrical blocks of colour, to Pollock's seemingly haphazard arrangements of splashed paint on canvas? Sceptics believe that people claim to like such works simply because they are famous.(5) We certainly do have an inclination to follow the crowd.(6) When asked to make simple perceptual decisions such as matching a shape to its rotated image, for example, people often choose a definitively wrong answer if they see others doing the same.(7) It is easy to imagine that this mentality would have even more impact on a fuzzy concept like art appreciation, where there is no right or wrong answer.(8)

Angelina Hawley-Dolan, of Boston College, Massachusetts, responded to this debate by asking volunteers to view pairs of paintings - either the creations of famous abstract artists or the doodles of infants, chimps and elephants.(9) They then had to judge which they preferred.(10) A third of the paintings were given no captions, while many were labelled incorrectly -volunteers might think they were viewing a chimp's messy brushstrokes when they were actually seeing an acclaimed masterpiece.(11) In each set of trials, volunteers generally preferred the work of renowned artists, even when they believed it was by an animal or a child.(12) It seems that the viewer can sense the artist's vision in paintings, even if they can't explain why.(13)

Robert Pepperell, an artist based at Cardiff University, creates ambiguous works that are neither entirely abstract nor clearly representational.(14) In one study, Pepperell and his collaborators asked volunteers to decide how 'powerful' they considered an artwork to be, and whether they saw anything familiar in the piece.(15) The longer they took to

answer these questions, the more highly they rated the piece under scrutiny, and the greater their neural activity.(16) It would seem that the brain sees these images as puzzles, and the harder it is to decipher the meaning, the more rewarding is the moment of recognition.(17)

And what about artists such as Mondrian, whose paintings consist exclusively of horizontal and vertical lines encasing blocks of colour? Mondrian's works are deceptively simple, but eye-tracking studies confirm that they are meticulously composed, and that simply rotating a piece radically changes the way we view it.(18) With the originals, volunteers'eyes tended to stay longer on certain places in the image, but with the altered versions, they would flit across a piece more rapidly.(19) As a result, the volunteers considered the altered versions less pleasurable when they later rated the work.(20)

In a similar study, Oshin Vartanian of Toronto University asked volunteers to compare original paintings with ones which he had altered by moving objects around within the frame.(21) He found that almost everyone preferred the original, whether it was a Van Gogh still life or an abstract by Miro.(22) Vartanian also found that changing the composition of the paintings reduced activation in those brain areas linked with meaning and interpretation.(23)

In another experiment, Alex Forsythe of the University of Liverpool analysed the visual intricacy of different pieces of art, and her results suggest that many artists use a key level of detail to please the brain.(24) Too little and the work is boring, but too much results in a kind of 'perceptual overload', according to Forsythe.(25) What's more, appealing pieces both abstract and representational, show signs of 'fractals' - repeated motifs recurring in different scales, fractals are common throughout nature, for example in the shapes of mountain peaks or the branches of trees.(26) It is possible that our visual system, which evolved in the great outdoors, finds it easier to process such patterns.(27)

It is also intriguing that the brain appears to process movement when we see a handwritten letter, as if we are replaying the writer's moment of creation.(28) This has led some to wonder whether Pollock's works feel so dynamic because the brain reconstructs the energetic actions the artist used as he painted.(29) This may be down to our brain's 'mirror neurons', which are known to mimic others' actions.(30) The hypothesis will need to be thoroughly tested, however.(31) It might even be the case that we could use neuroaesthetic studies to understand the longevity of some pieces of artwork.(32) While the fashions of the time might shape what is currently popular, works that are best adapted to our visual system may be the most likely to linger once the trends of previous generations have been forgotten.(33)

It's still early days for the field of neuroaesthetics - and these studies are probably only a taste of what is to come.(34) It would, however, be foolish to reduce

art appreciation to a set of scientific laws.(35) We shouldn't underestimate the importance of the style of a particular artist, their place in history and the artistic environment of their time.(36) Abstract art offers both a challenge and the freedom to play with different interpretations.(37) In some ways, it's not so different to science, where we are constantly looking for systems and decoding meaning so that we can view and appreciate the world in a new way.(38)

Questions 27-30

27. In the second paragraph, the writer refers to a shape- matching test in order to illustrate

- A the subjective nature of art appreciation.
- B the reliance of modern art on abstract forms.
- C our tendency to be influenced by the opinions of others.
- D a common problem encountered when processing visual data.

28. Angelina Hawley-Dolan's findings indicate that people

- A mostly favour works of art which they know well.
- B hold fixed ideas about what makes a good work of art.
- C are often misled by their initial expectations of a work of art.
- D have the ability to perceive the intention behind works of art.

29. Results of studies involving Robert Pepperell's pieces suggest that people

- A can appreciate a painting without fully understanding it.
- B find it satisfying to work out what a painting represents.
- C vary widely in the time they spend looking at paintings.
- D generally prefer representational art to abstract art.

30. What do the experiments described in the fifth paragraph suggest about the paintings of Mondrian?

- A They are more carefully put together than they appear.
- B They can be interpreted in a number of different ways.
- C They challenge our assumptions about shape and colour.
- D They are easier to appreciate than many other abstract works.

Questions 31-33

Complete the summary using the list of words, **A-H**, below.

Write the correct letters, **A-H**, in boxes **31-33** on your answer sheet.

Art and the Brain

The discipline of neuroaesthetics aims to bring scientific objectivity to the study of art. Neurological studies of the brain, for example, demonstrate the impact which Impressionist paintings have on our **31** Alex Forsythe of the University of Liverpool believes many artists give their works the precise degree of **32** which most appeals to the viewer's brain. She also observes that pleasing works of art often contain certain repeated **33** which occur frequently in the natural world.

A	interpretation	B	complexity	C	emotions
D	movements	E	skill	F	layout
G	concern	H	images		

Questions 34-39

- YES** if the statement agrees with the views of the writer
NO if the statement contradicts the views of the writer
NOT GIVEN if there is no information on this

- 34.** Forsythe's findings contradicted previous beliefs on the function of 'fractals' in art.
35. Certain ideas regarding the link between 'mirror neurons' and art appreciation require further verification.
36. People's taste in paintings depends entirely on the current artistic trends of the period.
37. Scientists should seek to define the precise rules which govern people's reactions to works of art.
38. Art appreciation should always involve taking into consideration the cultural context in which an artist worked.
39. It is easier to find meaning in the field of science than in that of art.

Question 40

40. What would be the most appropriate subtitle for the article?

- A. Some scientific insights into how the brain responds to abstract art
- B. Recent studies focusing on the neural activity of abstract artists
- C. A comparison of the neurological bases of abstract and representational art
- D. How brain research has altered public opinion about abstract art

The Story Of Silk



(1) The history of the world's most luxurious fabric, from ancient China to the present day

Silk is a fine, smooth material produced from the cocoons - soft protective shells - that are made by mulberry silkworms (insect larvae).**(2)** Legend has it that it was Lei Tzu, wife of the Yellow Emperor, ruler of China in about 3000 BC, who discovered silkworms.**(3)** One account of the story goes that as she was taking a walk in her husband's gardens, she discovered that silkworms were responsible for the destruction of several mulberry trees.**(4)** She collected a number of cocoons and sat down to have a rest.**(5)** It just so happened that while she was sipping some tea, one of the cocoons that she had collected landed in the hot tea and started to unravel into a fine thread.**(6)** Lei Tzu found that she could wind this thread around her fingers.**(7)** Subsequently, she persuaded her husband to allow her to rear silkworms on a grove of mulberry trees.**(8)** She also devised a special reel to draw the fibres from the cocoon into a single thread so that they would be strong enough to be woven into fabric.**(9)** While it is unknown just how much of this is true, it is certainly known that silk cultivation has existed in China for several millennia.**(10)**

Originally, silkworm farming was solely restricted to women, and it was they who were responsible for the growing, harvesting and weaving.**(11)** Silk quickly grew into a symbol of status, and originally, only royalty were entitled to have clothes made of silk.**(12)** The rules were gradually relaxed over the years until finally during the Qing Dynasty (1644–1911 AD), even peasants, the lowest caste, were also entitled to wear silk.**(13)** Sometime during the Han Dynasty (206 BC-220 AD), silk was so

prized that it was also used as a unit of currency.**(14)** Government officials were paid their salary in silk, and farmers paid their taxes in grain and silk.**(15)** Silk was also used as diplomatic gifts by the emperor.**(16)** Fishing lines, bowstrings, musical instruments and paper were all made using silk.**(17)** The earliest indication of silk paper being used was discovered in the tomb of a noble who is estimated to have died around 168 AD.**(18)**

Demand for this exotic fabric eventually created the lucrative trade route now known as the Silk Road, taking silk westward and bringing gold, silver and wool to the East.**(19)** It was named the Silk Road after its most precious commodity, which was considered to be worth more than gold.**(20)** The Silk Road stretched over 6,000 kilometres from Eastern China to the Mediterranean Sea, following the Great Wall of China, climbing the Pamir mountain range, crossing modern-day Afghanistan and going on to the Middle East, with a major trading market in Damascus.**(21)** From there, the merchandise was shipped across the Mediterranean Sea.**(22)** Few merchants travelled the entire route; goods were handled mostly by a series of middlemen.**(23)**

With the mulberry silkworm being native to China, the country was the world's sole producer of silk for many hundreds of years.**(24)** The secret of silk-making eventually reached the rest of the world via the Byzantine Empire, which ruled over the Mediterranean region of southern Europe, North Africa and the Middle East during the period 330–1453 AD.**(25)** According to another legend, monks working for the Byzantine emperor Justinian smuggled silkworm eggs to Constantinople (Istanbul in modern-day Turkey) in 550 AD, concealed inside hollow bamboo walking canes.**(26)** The Byzantines were as secretive as the Chinese, however, and for many centuries the weaving and trading of silk fabric was a strict imperial monopoly.**(27)** Then in the seventh century, the Arabs conquered Persia, capturing their magnificent silks in the process.**(28)**

Silk production thus spread through Africa, Sicily and Spain as the Arabs swept, through these lands.**(29)** Andalusia in southern Spain was Europe's main silk-producing centre in the tenth century.**(30)** By the thirteenth century, however, Italy had become Europe's leader in silk production and export.**(31)** Venetian merchants traded extensively in silk and encouraged silk growers to settle in Italy.**(32)** Even now, silk processed in the province of

Como in northern Italy enjoys an esteemed reputation. **(33)**

The nineteenth century and industrialisation saw the downfall of the European silk industry. **(34)** Cheaper Japanese silk, trade in which was greatly facilitated by the opening of the Suez Canal, was one of the many factors driving the trend. **(35)** Then in the twentieth century, new manmade fibres, such as nylon, started to be used in what had traditionally been silk products, such as stockings and parachutes. **(36)** The two world wars, which interrupted the supply of raw material from Japan, also stifled the European silk industry. **(37)** After the Second World War, Japan's silk production was restored, with improved production and quality of raw silk. **(38)** Japan was to remain the world's biggest producer of raw silk, and practically the only major exporter of raw silk, until the 1970s. **(39)** However, in more recent decades, China has gradually recaptured its position as the world's biggest producer and exporter of raw silk and silk yarn. **(40)** Today, around 125,000 metric tons of silk are produced in the world, and almost two thirds of that production takes place in China.

Questions 1-9

Complete the notes below.

Choose **ONE WORD ONLY** from the passage for each answer.

Write your answers in boxes 1-9 on your answer sheet.

Early silk production in China

- Around 3000 BC, according to legend:
 - silkworm cocoon fell into emperor's wife's **1**
 - emperor's wife invented a **2** to pull out silk fibres
- Only **3** were allowed to produce silk
- Only **4** were allowed to wear silk
- Silk used as a form of **5**
 - e.g. farmers' taxes consisted partly of silk
- Silk used for many purposes
 - e.g. evidence found of **6** made from silk around 168 AD

Silk reaches rest of world

- Merchants use Silk Road to take silk westward and bring back **7** and precious metals
- 550 AD: **8** hide silkworm eggs in canes and take them to Constantinople
- Silk production spreads across Middle East and Europe
- 20th century: **9** and other manmade fibres cause decline in silk

Questions 10-13

Do the following statements agree with the information in Reading Passage 194? In boxes 10-13 on your answer sheet, write

TRUE if the statement agrees with the information

FALSE if the statement contradicts the information

NOT GIVEN if there is no information on this

10. Gold was the most valuable material transported along the Silk Road.

11. Most tradesmen only went along certain sections of the Silk Road.

12. The Byzantines spread the practice of silk production across the West.

13. Silk yarn makes up the majority of silk currently exported from China.

Great Migrations

Animal migration, however it is defined, is far more than just the movement of animals. It can loosely be described as travel that takes place at regular intervals - often in an annual cycle - that may involve many members of a species, and is rewarded only after a long journey. It suggests inherited instinct. The biologist Hugh Dingle has identified five characteristics that apply, in varying degrees and combinations, to all migrations. They are prolonged movements that carry animals outside familiar habitats; they tend to be linear, not zigzaggy; they involve special behaviours concerning preparation (such as overfeeding) and arrival; they demand special allocations of energy. And one more: migrating animals maintain an intense attentiveness to the greater mission, which keeps them undistracted by temptations and undeterred by challenges that would turn other animals aside.

An arctic tern, on its 20,000 km flight from the extreme south of South America to the Arctic circle, will take no notice of a nice smelly herring offered from a bird-watcher's boat along the way. While local gulls will dive voraciously for such handouts, the tern flies on. Why? The arctic tern resists distraction because it is driven at that moment by an instinctive sense of something we humans find admirable: larger purpose. In other words, it is determined to reach its destination. The bird senses that it can eat, rest and mate later. Right now it is totally focused on the journey; its undivided intent is arrival.

Reaching some gravelly coastline in the Arctic, upon which other arctic terns have converged, will serve its larger purpose as shaped by evolution: finding a place, a time, and a set of circumstances in which it can successfully hatch and rear offspring.

But migration is a complex issue, and biologists define it differently, depending in part on what sorts of animals they study. Joe! Berger, of the University of Montana, who works on the American pronghorn and other large terrestrial mammals, prefers what he calls a simple, practical definition suited to his beasts: 'movements from a seasonal home area away to another home area and back again'. Generally, the reason for such seasonal back-and-forth movement is to seek resources that aren't available within a single area year-round.

But daily vertical movements by zooplankton in the ocean - upward by night to seek food, downward by day to escape predators - can also be considered migration. So can the movement of aphids when, having depleted the young leaves on one food plant, their offspring then fly onward to a different host plant, with no one aphid ever returning to where it started.

Dingle is an evolutionary biologist who studies insects. His definition is more intricate than Berger's, citing those five features that distinguish migration from other forms of movement. They allow for the fact that, for example, aphids will become sensitive to blue light (from the sky) when it's time for takeoff on their big journey, and sensitive to yellow light (reflected from tender young leaves) when it's appropriate to land. Birds will fatten themselves with heavy feeding in advance of a long migrational flight. The value of his definition, Dingle argues, is that it focuses attention on what the phenomenon of wildebeest migration shares with the phenomenon of the aphids, and therefore helps guide researchers towards understanding how evolution has produced them all.

Human behaviour, however, is having a detrimental impact on animal migration. The pronghorn, which resembles an antelope, though they are unrelated, is the fastest land mammal of the New World. One population, which spends the summer in the mountainous Grand Teton National Park of the western USA, follows a narrow route from its summer range in the mountains, across a river, and down onto the plains. Here they wait out the frozen months, feeding mainly on sagebrush blown clear of snow. These pronghorn are notable for the invariance of their migration route and the severity of its construction at three bottlenecks. If they can't pass through each of the three during their spring migration, they can't reach their bounty of summer grazing; if they can't pass through again in autumn, escaping south onto those windblown plains, they are likely to die trying to overwinter in the deep snow. Pronghorn, dependent on distance vision and speed to keep safe from predators, traverse high, open shoulders of land, where they can see and run. At one of the bottlenecks, forested hills rise to form a V, leaving a corridor of open ground only about 150 metres wide, filled with private homes. Increasing development is leading toward a crisis for the pronghorn, threatening to choke off their passageway.

Conservation scientists, along with some biologists and land managers within the USA's National Park Service and other agencies, are now working to preserve migrational behaviours, not just species and

59 habitats. A National Forest has recognised the path of the pronghorn, much of which passes across its
60 land, as a protected migration corridor. But neither the Forest Service nor the Park Service can control
61 what happens on private land at a bottleneck. And with certain other migrating species, the challenge is
62 complicated further - by vastly greater distances traversed, more jurisdictions, more borders, more
63 dangers along the way. We will require wisdom and resoluteness to ensure that migrating species can
64 continue their journeying a while longer.

Questions 14-18

Do the following statements agree with the information given in Reading Passage 2?

TRUE if the statement agrees with the information

FALSE if the statement contradicts the information

NOT GIVEN if there is no information on this

- 14. Local gulls and migrating arctic terns behave in the same way when offered food.
- 15. Experts' definitions of migration tend to vary according to their area of study.
- 16. Very few experts agree that the movement of aphids can be considered migration.
- 17. Aphids' journeys are affected by changes in the light that they perceive.
- 18. Dingle's aim is to distinguish between the migratory behaviours of different species.

Questions 19-22

Complete each sentence with the correct ending, A-G, below.
Write the correct letter, A-G, in boxes 19-22 on your answer sheet

- 19. According to Dingle, migratory routes are likely to
- 20. To prepare for migration, animals are likely to
- 21. During migration, animals are unlikely to
- 22. Arctic terns illustrate migrating animals' ability to

- A. be discouraged by difficulties.
- B. travel on open land where they can look out for predators.
- C. eat more than they need for immediate purposes.
- D. be repeated daily.
- E. ignore distractions.
- F. be governed by the availability of water.
- G. follow a straight line.

Questions 23-26

Complete the summary below.

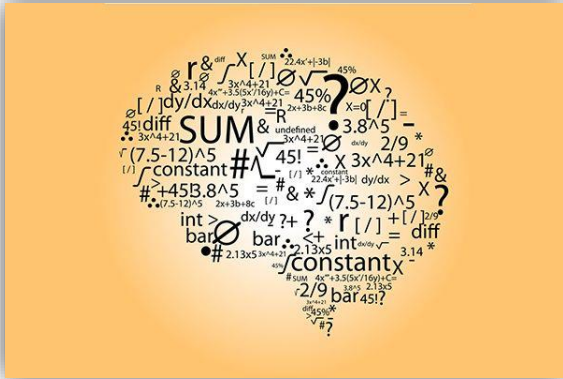
Choose **ONE WORD ONLY** from the passage for each answer.

Write your answers in boxes 23-26 on your answer sheet.

The migration of pronghorns

Pronghorns rely on their eyesight and 23 to avoid predators. One particular population's summer habitat is a national park, and their winter home is on the 24 where they go to avoid the danger presented by the snow at that time of year. However, their route between these two areas contains three 25 One problem is the construction of new homes in a narrow 26 of land on the pronghorns' route.

Adventures in Mathematical Reasoning



A 1 Occasionally, in some difficult musical compositions, there are beautiful, but easy parts - parts so simple a beginner could play them. (2) So it is with mathematics as well. (3) There are some discoveries in advanced mathematics that do not depend on specialized knowledge, not even on algebra, geometry, or trigonometry. (4) Instead, they may involve, at most, a little arithmetic, such as 'the sum of two odd numbers is even', and common sense. (5) Each of the eight chapters in this book illustrates this phenomenon. (6) Anyone can understand every step in the reasoning. (7) The thinking in each chapter uses at most only elementary arithmetic, and sometimes not even that. (8) Thus all readers will have the chance to participate in a mathematical experience, to appreciate the beauty of mathematics, and to become familiar with its logical, yet intuitive, style of thinking. (9)

B One of my purposes in writing this book is to give readers who haven't had the opportunity to see and enjoy real mathematics the chance to appreciate the mathematical way of thinking. (10) I want to reveal not only some of the fascinating discoveries, but, more importantly, the reasoning behind them. (11) In that respect, this book differs from most books on mathematics written for the general public. (12) Some present the lives of colorful mathematicians. (13) Others describe important applications of mathematics. (14) Yet others go into mathematical procedures, but assume that the reader is adept in using algebra. (15)

C

I hope this book will help bridge that notorious gap that separates the two cultures: the humanities and the sciences, or should I say the right brain (intuitive) and the left brain (analytical, numerical). (16) As the chapters will illustrate, mathematics is not restricted to the analytical and numerical; intuition plays a significant role. (17) The alleged gap can be narrowed or completely overcome by anyone, in part because each of us is far from using the full capacity of either side of the brain. (18) To illustrate our human potential, I cite a structural engineer who is an artist, an electrical engineer who is an opera singer, an opera singer who published mathematical research, and a mathematician who publishes short stories. (19)

D

Other scientists have written books to explain their fields to non-scientists, but have necessarily had to omit the mathematics, although it provides the foundation of their theories. (20) The reader must remain a tantalized spectator rather than an involved participant, since the appropriate language for describing the details in much of science is mathematics, whether the subject is expanding universe, subatomic particles, or chromosomes. (21) Though the broad. (22) outline of a scientific theory can be sketched intuitively, when a part of the physical universe is finally understood, its description often looks like a page in a mathematics text. (23)

E

Still, the non-mathematical reader can go far in understanding mathematical reasoning. (24) This book presents the details that illustrate the mathematical style of thinking, which involves sustained, step-by-step analysis, experiments, and insights. (25) You will turn these pages much more slowly than when reading a novel or a newspaper. (26) It may help to have a pencil and paper ready to check claims and carry out experiments. (27)

F

As I wrote, I kept in mind two types of readers: those who enjoyed mathematics until they were turned off by an unpleasant episode, usually around fifth grade, and mathematics aficionados, who will find much that is new throughout the book. (28) This book also serves readers who simply want to sharpen their analytical skills. (29) Many careers, such as law and medicine, require extended, precise analysis. (30) Each chapter offers practice in following a sustained and closely argued line of thought. (31) That mathematics can develop this skill is shown by these two testimonials:

G

A physician wrote, The discipline of analytical thought processes [in mathematics] prepared me extremely well for medical school.(32) In medicine one is faced with a problem which must be thoroughly analyzed before a solution can be found.(33) The process is similar to doing mathematics.(34)'

A lawyer made the same point, "Although I had no background in law - not even one political science course — I did well at one of the best law schools.(35) I attribute much of my success there to having learned, through the study of mathematics, and, in particular, theorems, how to analyze complicated principles.(36) Lawyers who have studied mathematics can master the legal principles in a way that most others cannot.(37)'

Questions 27-34

Reading Passage 196 has seven sections, **A-G**. Which section contains the following information?

Write the correct letter, **A— G**, in boxes **27 — 34** on your answer sheet.

NB. You may use any letter more than once.

- 27.** a reference to books that assume a lack of mathematical knowledge
- 28.** the way in which this is not a typical book about mathematics
- 29.** personal examples of being helped by mathematics
- 30.** examples of people who each had abilities that seemed incompatible
- 31.** mention of different focuses of books about mathematics
- 32.** a contrast between reading this book and reading other kinds of publication
- 33.** a claim that the whole of the book is accessible to everybody
- 34.** a reference to different categories of intended readers of this book

Questions 35-40

Complete the sentences below. Choose **ONE WORD ONLY** from the passage for each answer.

Write your answers in boxes **35- 40** on your answer sheet.

- 35.** Some areas of both music and mathematics are suitable for someone who is a

36. It is sometimes possible to understand advanced mathematics using no more than a limited knowledge of

37. The writer intends to show that mathematics requires thinking, as well as analytical skills.

38. Some books written by have had to leave out the mathematics that is central to their theories.

39. The writer advises non-mathematical readers to perform while reading

40. A lawyer found that studying helped even more than other areas of mathematics in the study of law.

Hardev Sir's IELTS Reading - OCM R6

READING PASSAGE 1

You should spend about 20 minutes on Questions 1-13, which are based on Reading Passage 1 on the following page.

Questions 1-6

Reading Passage 1 has six paragraphs. A-F.

Choose the correct heading for each paragraph from the list of headings below. Write the correct number, i-ix, in boxes 1-6 on your answer sheet.

List of Headings

- i A business-model approach to education
- ii The reforms that improved education in Finland
- iii Educational challenges of the future
- iv Ways in which equality is maintained in the Finnish education system
- v The benefits of the introduction of testing
- vi An approach that helped a young learner
- vii Statistical proof of education success
- viii Support for families working and living in Finland
- ix The impact of the education system on Finland's economy

- 1 Paragraph A _____
- 2 Paragraph B _____
- 3 Paragraph C _____
- 4 Paragraph D _____
- 5 Paragraph E _____
- 6 Paragraph F _____

Why Are Finland's Schools Successful?

The country's achievements in education have other nations doing their homework

A At Kirkkojarvi Comprehensive School in Espoo, a suburb west of Helsinki, Kari Louhivuori, the school's principal, decided to try something extreme by Finnish standards. One of his sixth-grade students, a recent immigrant, was falling behind, resisting his teacher's best efforts. So he decided to hold the boy back a year. Standards in the country have vastly improved in reading, math and science literacy over the past decade, in large part because its teachers are trusted to do whatever it takes to turn young lives around. 'I took Besad on that year as my private student,' explains Louhivuori. When he was not studying science, geography and math, Besart was seated next to Louhivuori's desk, taking books from a tall stack, slowly reading one, then another, then devouring them by the dozens. By the end of the year, he had conquered his adopted country's vowel-rich language and arrived at the realization that he could, in fact, *learn*.

B This tale of a single rescued child hints at some of the reasons for Finland's amazing record of education success. The transformation of its

D There are no compulsory standardized tests in Finland, apart from one exam at the end of students' senior year in high school. There is no competition between students, schools or regions. Finland's schools are publicly funded. The people in the government agencies running them, from national officials to local authorities, are educators rather than business people or politicians. Every school has the same national goals and draws from the same pool of university-trained educators. The result is that a Finnish child has a good chance of getting the same quality education no matter whether he or she lives in a rural village or a university town.

E It's almost unheard of for a child to show up hungry to school. Finland provides three years of maternity leave and subsidized day care to parents, and preschool for all five-year-olds, where the emphasis is on socializing. In addition, the state subsidizes parents, paying them around 150 euros per month for every child until he or she turns 17. Schools provide food, counseling and taxi service if needed. Health care is even free for students taking degree courses.

education system began some 40 years ago but teachers had little idea it had been so successful until 2000. In this year, the first results from the Programme for International Student Assessment (PISA), a standardized test given to 15-year-olds in more than 40 global venues, revealed Finnish youth to be the best at reading in the world. Three years later, they led in math. By 2006, Finland was first out of the 57 nations that participate in science. In the latest PISA scores, the nation came second in science, third in reading and sixth in math among nearly half a million students worldwide.

C In the United States, government officials have attempted to improve standards by introducing marketplace competition into public schools. In recent years, a group of Wall Street financiers and philanthropists such as Bill Gates have put money behind private-sector ideas, such as charter schools, which have doubled in number in the past decade. President Obama, too, apparently thought competition was the answer. One policy invited states to compete for federal dollars using tests and other methods to measure teachers, a philosophy that would not be welcome in Finland. 'I think, in fact, teachers would tear off their shirts,' said Timo Heikkinen, a Helsinki principal with 24 years of teaching experience. 'If you only measure the statistics, you miss the human aspect.'

F Finland's schools were not always a wonder. For the first half of the twentieth century, only the privileged got a quality education. But In 1963, the Finnish Parliament made the bold decision to choose public education as the best means of driving the economy forward and out of recession. Public schools were organized into one system of comprehensive schools for ages 7 through 16. Teachers from all over the nation contributed to a national curriculum that provided guidelines, not prescriptions, for them to refer to. Besides Finnish and Swedish (the country's second official language), children started learning a third language (English is a favorite) usually beginning at age nine. The equal distribution of equipment was next, meaning that all teachers had their fair share of teaching resources to aid learning. As the comprehensive schools improved, so did the upper secondary schools (grades 10 through 12). The second critical decision came in 1979, when it was required that every teacher gain a fifth-year Master's degree in theory and practice, paid for by the state. From then on, teachers were effectively granted equal status with doctors and lawyers. Applicants began flooding teaching programs, not because the salaries were so high but because autonomous decision making and respect made the job desirable. And as Louhivuori explains, 'We have our own motivation to succeed because we love the work.'

Questions 7-13 Complete the notes below.

Choose **NO MORE THAN TWO WORDS AND/OR A NUMBER** from the passage for each answer. Write your answers in boxes 7-13 on your answer sheet.

The school system in Finland

PISA tests

- In the most recent tests. Finland's top subject was **7** _____

History

1963:

- A new school system was needed to improve Finland's **8** _____
- Schools followed **9** -----that were created partly by teachers.
- Young pupils had to study an additional **10** _____
- All teachers were given the same **11** _____ to use.

1979:

- Teachers had to get a **12** -----but they did not have to pay for this.
- Applicants were attracted to the **13** _____ that teaching received.

Australia's Lost Giants

What happened to Australia's megafauna, the giant animals that once existed across this enormous continent?

A In 1969, a fossil hunter named Rod Wells came to Naracoorte in South Australia to explore what was then known as Victoria Cave. Wells clawed through narrow passages, and eventually into a huge chamber. Its floor of red soil was littered with strange objects. It took Wells a moment to realize what he was looking at; the bones of thousands of creatures that must have fallen through holes in the ground above and become trapped. Some of the oldest belonged to mammals far larger than any found today in Australia. They were the ancient Australian megafauna - huge animals of the Pleistocene epoch. In boneyards across the continent, scientists have found the fossils of a giant snake, a huge flightless bird, and a seven foot kangaroo, to name but a few. Given how much ink has been spilled on the extinction of the dinosaurs, it's a wonder that even more hasn't been devoted to megafauna. Prehistoric humans never threw spears at *Tyrannosaurus rex* but really did hunt mammoths and mastodons.

B The disappearance of megafauna in America - mammoths, saber-toothed cats, giant sloths, among others - happened relatively soon after the arrival of human beings, about 13,000 years ago. In the 1960s, paleoecologist Paul Martin developed what became known as the *blitzkrieg hypothesis*. Modern humans, Martin said, created havoc as they spread through the Americas, wielding spears to annihilate animals that had never faced a technological predator. But this period of extinction wasn't comprehensive. North America kept its deer, black bears and a small type of bison, and South America its jaguars and llamas.

C What happened to Australia's large animals is baffling. For years scientists blamed the extinctions on climate change. Indeed, Australia has been drying out for over a million years, and the megafauna were faced with a continent where vegetation began to disappear. Australian paleontologist Tim Flannery suggests that people, who arrived on the continent around 50,000 years ago, used fire to hunt, which led to deforestation. Here's what's certain, Flannery says. Something dramatic happened to Australia's dominant land creatures - somewhere around 46,000 years ago, strikingly soon after the invasion of a tool-wielding, highly intelligent predator.

In Flannery's 1994 book called *The Future Eaters*, he sets out his thesis that human beings are a new kind of animal on the planet, and are in general, one prone to ruining ecosystems. Flannery's book proved highly controversial. Some viewed it as critical of the Aborigines, who pride themselves on living in harmony with nature. The more basic problem with Flannery's thesis is that there is no direct evidence that they killed any Australian megafauna. It would be helpful if someone uncovered a *Diprotodon* skeleton with a spear point embedded in a rib - or perhaps *Thylacoleo* bones next to the charcoal of a human campfire. Such kill sites have been found in the Americas but not in Australia.

D The debate about megafauna pivots to a great degree on the techniques for dating old bones and the sediments in which they are buried. If scientists can show that the megafauna died out fairly quickly and that this extinction event happened within a few hundred, or even a couple thousand years, of the arrival of people, that's a strong case - even if a purely circumstantial one - that the one thing was the direct result of the other. As it happens, there is one place where there may be such evidence: Cuddie Springs in New South Wales. Today the person-most vocal about the site is archeologist Judith Field. In 1991, she discovered megafauna bones directly adjacent to stone tools - a headline-making find. She says there are two layers showing the association, one about 30,000 years old, the other 35,000 years old. If that dating is accurate, it would mean humans and megafauna coexisted in Australia for something like 20,000 years. "What Cuddie Springs demonstrates is that you have an extended overlap of humans and megafauna," Field says. Nonsense, say her critics. They say the fossils have been moved from their original resting places and redeposited in younger sediments.

E Another famous boneyard in the same region is a place called Wellington Caves, where *Diprotodou*, the largest known marsupial¹, was first discovered. Scientist Mike Augée says that: "This is a sacred site in Australian paleontology." Here's why: In 1830 a local official named George Rankin lowered himself into the cave on a rope tied to a protrusion in the cave wall. The protrusion turned out to be a bone. A surveyor named Thomas Mitchell arrived later that year, explored the caves

in the area, and shipped fossils off to Richard Owen, the British paleontologist who later gained fame for revealing the existence of dinosaurs. Owen recognized that the Wellington cave bones belonged to an extinct marsupial. Later, between 1909 and 1915 sediments in Mammoth Cave that contained fossils were hauled out and examined in a chaotic manner that no scientist today would approve. Still, one bone in particular has drawn extensive attention: a femur with a cut in it, possibly left there by a sharp tool.

Unfortunately, the Earth preserves its history haphazardly. Bones disintegrate, the land erodes, the climate changes, forests come and go, rivers change their course - and history, if not destroyed, is steadily concealed. By necessity, narratives are constructed from limited data. Australia's first people expressed themselves in rock art. Paleontologist Peter Murray has studied a rock painting in far northern Australia that shows what looks very much like a megafauna marsupial known as *Protheridium*. In Western Australia another site shows what appears to be a hunter with either a marsupial lion or a Tasmanian tiger - a major distinction, since the marsupial lion went extinct and the much smaller Tasmanian tiger survived into the more recent historical era. But as Murray says, "Every step of the way involves interpretation. The data doesn't just speak for itself."

Glossary

marsupial: an animal which carries its young in a pouch e.g. kangaroos and koalas

Questions 14-18

Which paragraphs contain the following information?

NB You may use any letter more than once.

- 14 descriptions of naturally occurring events that make the past hard to trace
- 15 an account of the discovery of a particular animal which had died out
- 16 the reason why a variety of animals all died in the same small area
- 17 the suggestion that a procedure to uncover fossilized secrets was inappropriate
- 18 examples of the kinds of animals that did not die out as a result of hunting

Questions 19 and 20 Choose TWO letters, A-E.

Write the correct letters in boxes 19 and 20 on your answer sheet.

Which TWO of these possible reasons for Australian mega fauna extinction are mentioned in the text?

- A human activity
- B disease
- C loss of habitat
- D a drop in temperature
- E the introduction of new animal species

Questions 21 and 22 Choose TWO letters, A-E.

The list below shows possible forms of proof for humans having contact with Australian mega fauna.

Which TWO possible forms of proof does the writer say have been found in Australia?

- A bone injury caused by a man-made object
- B bones near to early types of weapon
- C man-made holes designed for trapping animals
- D preserved images of megafauna species
- E animal remains at camp fires

Questions 23-26

YES | NO | NOT GIVEN

if the statement agrees with the claims of the writer if the statement contradicts the claims of the writer if it is impossible to say what the writer thinks about this

- 23 Extinct megafauna should receive more attention than the extinction of the dinosaurs.
- 24 There are problems with Paul Martin's 'blitzkrieg' hypothesis for the Americas.
- 25 The Aborigines should have found a more effective way to protest about Flannery's book.
- 26 There is sufficient evidence to support Tim Flannery's ideas about megafauna extinction.

The Swiffer

For a fascinating tale about creativity, look at a cleaning product called the *Swiffer* and how it came about, urges writer Jonah Lehrer. In the story of the *Swiffer*, he argues, we have the key elements in producing breakthrough ideas: frustration, moments of insight and sheer hard work. The story starts with a multinational company which had invented products for keeping homes spotless, and couldn't come up with better ways to clean floors, so it hired designers to watch how people cleaned. Frustrated after hundreds of hours of observation, they one day noticed a woman do with a paper towel what people do all the time: wipe something up and throw it away. An idea popped into lead designer Harry West's head: the solution to their problem was a floor mop with a disposable cleaning surface. Mountains of prototypes and years of teamwork later, they unveiled the *Swiffer*, which quickly became a commercial success.

Lehrer, the author of *Imagine*, a new book that seeks to explain how creativity works, says this study of the imagination started from a desire to understand what happens in the brain at the moment of sudden insight. 'But the book definitely spiraled out of control,' Lehrer says. 'When you talk to creative people, they'll tell you about the 'eureka'* moment, but when you press them they also talk about the hard work that comes afterwards, so I realised I needed to write about that, too. And then I realised I couldn't just look at creativity from the perspective of the brain, because it's also about the culture and context, about the group and the team and the way we collaborate.'

When it comes to the mysterious process by which inspiration comes into your head as if from nowhere, Lehrer says modern neuroscience has produced a 'first draft' explanation of what is happening in the brain. He writes of how burnt-out American singer Bob Dylan decided to walk away from his musical career in 1965 and escape to a cabin in the woods, only to be overcome by a desire to write. Apparently '*Like a Rolling Stone*' suddenly flowed from his pen. 'It's like a ghost is writing a song,' Dylan has reportedly said. 'It gives you the song and it goes away.' But it's no ghost, according to Lehrer.

Instead, the right hemisphere of the brain is assembling connections between past influences and making something entirely new. Neuroscientists have roughly charted this process by mapping the brains of people doing word puzzles solved by making sense of remotely connecting information. For instance, subjects are given three words - such as 'age', 'mile' and 'sand' - and asked to come up with a single word that can precede or follow each of them to form a compound word. (It happens to be 'stone'.) Using brain-imaging equipment, researchers discovered that when people get the answer in an apparent flash of insight, a small fold of tissue called the anterior superior temporal gyrus suddenly lights up just beforehand. This stays silent when the word puzzle is solved through careful analysis. Lehrer says that this area of the brain lights up only after we've hit the wall on a problem. Then the brain starts hunting through the 'filing cabinets of the right hemisphere' to make the connections that produce the right answer.

Studies have demonstrated it's possible to predict a moment of insight up to eight seconds before it arrives. The predictive signal is a steady rhythm of alpha waves emanating from the brain's right hemisphere, which are closely associated with relaxing activities. 'When our minds are at ease - when those alpha waves are rippling through the brain - we're more likely to direct the spotlight of attention towards that stream of remote associations emanating from the right hemisphere,' Lehrer writes. 'In contrast, when we are diligently focused, our attention tends to be towards the details of the problems we are trying to solve.' In other words, then we are less likely to make those vital associations. So, heading out for a walk or lying down are important phases of the creative process, and smart companies know this. Some now have a policy of encouraging staff to take time out during the day and spend time on things that at first glance are unproductive (like playing a PC game), but day-dreaming has been shown to be positively correlated with problem-solving. However, to be more imaginative, says Lehrer, it's also crucial to collaborate with people from a wide range of backgrounds because if colleagues are too socially intimate, creativity is stifled.

Creativity, it seems, thrives on serendipity. American entrepreneur Steve Jobs believed so. Lehrer describes how at Pixar Animation, Jobs designed the entire workplace to maximize the chance of strangers bumping into each other, striking up conversations and learning from one another. He also points to a study of 766 business graduates who had gone on to own their own companies. Those with the greatest diversity of acquaintances enjoyed far more success. Lehrer says he has taken all this on board, and despite his inherent shyness, when he's sitting next to strangers on a plane or at a conference, forces himself to initiate conversations. As for predictions that the rise of the Internet would make the need for shared working space obsolete, Lehrer says research shows the opposite has occurred; when people meet face-to-face, the level of creativity increases. This is why the kind of place we live in is so important to innovation. According to theoretical physicist Geoffrey West, when corporate institutions get bigger, they often become less receptive to change. Cities, however, allow our ingenuity to grow by pulling huge numbers of different people

together, who then exchange ideas. Working from the comfort of our homes may be convenient, therefore, but it seems we need the company of others to achieve our finest 'eureka' moments.

Glossary

Eureka: In ancient Greek, the meaning was 'I have found!'.

Now it can be used when people suddenly find the solution to a difficult problem and want to celebrate.

27 What are we told about the product called a 'Swiffer'?

- A Its designers had little experience working with household objects.
- B Once the idea for it was conceived, it did not take long to develop.
- C It achieved profits beyond the manufacturer's expectations.
- D Its design was inspired by a common housework habit.

28 When Jonah Lehrer began writing his book,

- A he had not intended to focus on creativity.
- B he ended up revising his plans for the content.
- C he was working in a highly creative environment.
- D he was driven by his own experience of the 'eureka' moment.

29 Lehrer refers to the singer Bob Dylan in order to

- A illustrate how ideas seem spontaneous.
- B exemplify ways in which we might limit our inventiveness.
- C contrast different approaches to stimulating the imagination.
- D propose particular approaches to regaining lost creativity.

30 What did neuroscientists discover from the word puzzle experiment?

- A Memories are easier to retrieve when they are more meaningful.
- B An analytical approach to problem-solving is not necessarily effective.
- C One part of the brain only becomes active when a connection is made suddenly.
- D Creative people tend to take a more instinctive approach to solving language problems.

Complete each sentence with the correct ending, A-G, below.

- 31 Scientists know a moment of insight is coming
- 32 Mental connections are much harder to make
- 33 Some companies require their employees to stop working
- 34 A team will function more successfully

- A when people are not too familiar with one another.
- B because there is greater activity in the right side of the brain.
- C if people are concentrating on the specifics of a problem.
- D so they can increase the possibility of finding answers.
- E when people lack the experience required for problem-solving.
- F when the brain shows strong signs of distraction.
- G when both hemispheres of the brain show activity.

Questions 35-39 Complete the notes below.

Choose **ONE WORD ONLY** from the passage for each answer.

Write your answers in boxes 35-39 on your answer sheet.

How other people influence our creativity

- Steve Jobs
- made changes to the **35** _____ to encourage interaction at Pixar.
- Lehrer
- company owners must have a wide range of **36** _____ to do well.
- it's important to start **37** _____ with new people
- the **38** _____ has not replaced the need for physical contact.
- Geoffrey West
- living in **39** _____ encourages creativity.

Question 40

Which of the following is the most suitable title for Reading Passage 3?

- A Understanding what drives our moments of inspiration
- B Challenging traditional theories of human creativity
- C Creative solutions for enhancing professional relationships
- D How the future is shaped by innovative ideas and inspired people

Spider silk cuts weight of bridges

A Scientists have succeeded in copying the silk-producing genes of the Golden Orb Weaver spider and are using them to create a synthetic material which they believe is the model for a new generation of advanced bio-materials. The new material, biosilk, which has been spun for the first time by researchers at DuPont, has an enormous range of potential uses in construction and manufacturing.

B The attraction of the silk spun by the spider is a combination of great strength and enormous elasticity, which man-made fibres have been unable to replicate. On an equal-weight basis, spider silk is far stronger than steel and it is estimated that if a single strand could be made about 10m in diameter, it would be strong enough to stop a jumbo jet in flight. A third important factor is that it is extremely light. Army scientists are already looking at the possibilities of using it for lightweight, bullet-proof vests and parachutes.

C For some time, biochemists have been trying to synthesise the drag-line silk of the Golden Orb Weaver. The drag-line silk, which forms the radial arms of the web, is stronger than the other parts of the web and some biochemists believe a synthetic version could prove to be as important a material as nylon, which has been around for 50 years, since the discoveries of Wallace Carothers and his team ushered in the age of polymers.

D To recreate the material, scientists, including Randolph Lewis at the University of Wyoming, first examined the silk-producing gland of the spider. 'We took out the glands that produce the silk and looked at the coding for the protein material they make, which is spun into a web. We then went looking for clones with the right DNA,' he says.

E At DuPont, researchers have used both yeast and bacteria as hosts to grow the raw material, which they have spun into fibres. Robert Dorsch, DuPont's director of biochemical development, says the globules of protein, comparable with marbles in an egg, are harvested and processed. 'We break open the bacteria, separate out the globules of protein and use them as the raw starting material. With yeast, the gene system can be designed so that the material excretes the protein outside the yeast for better access,' he says.

F 'The bacteria and the yeast produce the same protein, equivalent to that which the spider uses in the drag lines of the web. The spider mixes the protein into a water-based solution and then spins it into a solid fibre in one go. Since we are not as clever as the spider and we are not using such sophisticated organisms, we substituted manmade approaches and dissolved the protein in chemical solvents, which are then spun to push the material through small holes to form the solid fibre.'

G Researchers at DuPont say they envisage many possible uses for a new biosilk material. They say that earthquake-resistant suspension bridges hung from cables of synthetic spider silk fibres may become a reality. Stronger ropes, safer seat belts, shoe soles that do not wear out so quickly and tough new clothing are among the other applications. Biochemists such as Lewis see the potential range of uses of biosilk as almost limitless. 'It is very strong and retains elasticity; there are no man-

made materials that can mimic both these properties. It is also a biological material with all the advantages that has over petrochemicals,' he says.

H At DuPont's laboratories, Dorsch is excited by the prospect of new super-strong materials but he warns they are many years away. 'We are at an early stage but theoretical predictions are that we will wind up with a very strong, tough material, with an ability to absorb shock, which is stronger and tougher than the man-made materials that are conventionally available to us,' he says.

I The spider is not the only creature that has aroused the interest of material scientists. They have also become envious of the natural adhesive secreted by the sea mussel. It produces a protein adhesive to attach itself to rocks. It is tedious and expensive to extract the protein from the mussel, so researchers have already produced a synthetic gene for use in surrogate bacteria.

Questions 1-5

Reading Passage 1 has nine paragraphs, A-I. Which paragraph contains the following information?

- 1 a comparison of the ways two materials are used to replace silk-producing glands
- 2 predictions regarding the availability of the synthetic silk
- 3 ongoing research into other synthetic materials
- 4 the research into the part of the spider that manufactures silk
- 5 the possible application of the silk in civil engineering

Questions 6-10

Complete the flow-chart below. **Choose NO MORE THAN TWO WORDS** from the passage for each answer.

Synthetic gene grown in (6).....or (7).....

Globules of (8).....

Dissolved in (9).....

Passed through (10).....

To produce a solid fibre

Questions 11-13

Do the following statements agree with the information given in Reading Passage 1? In boxes 11-13 on your answer sheet, write

- | | |
|------------------|--|
| TRUE | if the statement agrees with the information |
| FALSE | if the statement contradicts the information |
| NOT GIVEN | if there is no information on this |

- 11 Biosilk has already replaced nylon in parachute manufacture.
- 12 The spider produces silk of varying strengths.
- 13 Lewis and Dorsch co-operated in the synthetic production of silk.

Revolutions in Mapping

Today, the mapmaker's vision is no longer confined to what the human eye can see. The perspective of mapmaking has shifted from the crow's nest of the sailing vessel, mountain top and airplane to new orbital heights. Radar, which bounces microwave radio signals off a given surface to create images of its contours and textures, can penetrate jungle foliage and has produced the first maps of the mountains of the planet Venus. And a combination of sonar and radar produces charts of the seafloor, putting much of Earth on the map for the first time. 'Suddenly it's a whole different world for us,' says Joel Morrison, chief of geography at the U.S. Bureau of the Census. 'Our future as mapmakers – even ten years from now – is uncertain.'

The world's largest collection of maps resides in the basement of the Library of Congress in Washington, D.C. The collection, consisting of up to 4.6 million map sheets and 63,000 atlases, includes magnificent bound collections of elaborate maps – the pride of the golden age of Dutch cartography. In the reading room scholars, wearing thin cotton gloves to protect the fragile sheets, examine ancient maps with magnifying glasses. Across the room people sit at their computer screens, studying the latest maps. With their prodigious memories, computers are able to store data about people, places and environments – the stuff of maps – and almost instantly information is displayed on the screen in the desired geographic context, and at the click of a button, a print-out of the map appears.

Measuring the spherical Earth ranks as the first major milestone in scientific cartography. This was first achieved by the Greek astronomer Eratosthenes, a scholar at the famous Alexandrian Library in Egypt in the third century BC. He calculated the Earth's circumference as 25,200 miles, which was remarkably accurate. The longitudinal circumference is known today to be 24,860 miles.

Building on the ideas of his predecessors, the astronomer and geographer Ptolemy, working in the second century AD, spelled out a system for organising maps according to grids of latitude and longitude. Today, parallels of latitude are often spaced at intervals of 10 to 20 degrees and meridians at 15 degrees, and this is the basis for the width of modern time zones. Another legacy of Ptolemy's is his advice to cartographers to create maps to scale. Distance on today's maps is expressed as a fraction or ratio of the real distance. But mapmakers in Ptolemy's time lacked the geographic knowledge to live up to Ptolemy's scientific principles. Even now, when surveyors achieve accuracies down to inches and satellites can plot potential missile targets within feet, maps are not true pictures of reality.

However, just as the compass improved navigation and created demand for useful charts, so the invention of the printing press in the 15th century put maps in the hands of more people, and took their production away from monks, who had tended to illustrate theology rather than geography. Ocean-going ships launched an age of discovery, enlarging both what could and needed to be mapped, and awakened an intellectual spirit and desire for knowledge of the world.

Inspired by the rediscovered Ptolemy, whose writing had been preserved by Arabs after the sacking of the Alexandrian Library in AD 931, mapmakers in the 15th

century gradually replaced theology with knowledge of faraway places, as reported by travelling merchants like Marco Polo.

Gerhardus Mercator, the foremost shipmaker of the 16th century, developed a technique of arranging meridians and parallels in such a way that navigators could draw straight lines between two points and steer a constant compass course between them. This distortion formula, introduced on his world map of 1569, created the 'Greenland problem'. Even on some standard maps to this day, Greenland looks as large as South America – one of the many problems when one tries to portray a round world on a flat sheet of paper. But the Mercator projection was so practical that it is still popular with sailors.

Scientific mapping of the land came into its own with the achievements of the Cassini family – father, son, grandson and great-grandson. In the late 17th century, the Italian-born founder, Jean-Dominique, invented a complex method of determining longitude based on observations of Jupiter's moons. Using this technique, surveyors were able to produce an accurate map of France. The family continued to map the French countryside and his great- grandson finally published their famous Cassini map in 1793 during the French Revolution. While it may have lacked the artistic appeal of earlier maps, it was the model of a social and geographic map showing roads, rivers, canals, towns, abbeys, vineyards, lakes and even windmills. With this achievement, France became the first country to be completely mapped by scientific methods.

Mapmaking has come a long way since those days. Today's surveyors rarely go into the field without being linked to navigation satellites. Their hand-held receivers are the most familiar of the new mapping technologies, and the satellite system, developed and still operated by the US Defense Department, is increasingly used by surveyors. Even ordinary hikers, sailors and explorers can tap into it for data telling them where they are. Simplified civilian versions of the receivers are available for a few hundred dollars and they are also the heart of electronic map displays available in some cars. Cartography is pressing on to cosmic frontiers, but its objective is, and always has been, to communicate a sense of 'here' in relation to 'there', however far away 'there' may be.

Questions 14-18

Choose the correct letter, A, B, C or D. Write the correct letter in boxes 14-18 on your answer sheet.

14 According to the first paragraph, mapmakers in the 21st century

- A** combine techniques to chart unknown territory
- B** still rely on being able to see what they map
- C** are now able to visit the darkest jungle
- D** need input from experts in other fields

15 The Library of Congress offers an opportunity to

- A** borrow from their collection of Dutch maps
- B** learn how to restore ancient and fragile maps
- C** enjoy the atmosphere of the reading room
- D** create individual computer maps to order

16 Ptolemy alerted his contemporaries to the importance of

- A** measuring the circumference of the world
- B** organising maps to reflect accurate ratios of distance
- C** working out the distance between parallels of latitude
- D** accuracy and precision in mapping

17 The invention of the printing press

- A** revitalised interest in scientific knowledge
- B** enabled maps to be produced more cheaply
- C** changed the approach to mapmaking
- D** ensured that the work of Ptolemy was continued

18 The writer concludes by stating that

- A** mapmaking has become too specialized
- B** cartographers work in very harsh conditions
- C** the fundamental aims of mapmaking remain unchanged
- D** the possibilities of satellite mapping are infinite

Questions 19-21

Look at the following list of achievements (Questions 19-21) and the list of mapmakers below.

Match each achievement with the correct mapmaker, A, B, C or D.

19 came very close to accurately measuring the distance round the Earth

20 produced maps showing man-made landmarks

21 laid the foundation for our modern time zones

List of Mapmakers

- A** Mercator
- B** Ptolemy
- C** Cassini family
- D** Eratosthenes

Questions 22-26

Complete the summary below. Choose **NO MORE THAN TWO WORDS** from the passage for each answer.

Ancient maps allow us to see how we have come to make sense of the world. They also reflect the attitudes and knowledge of the day. The first great step in mapmaking took place in (22).....in the 3rd century BC. Work continued in this tradition until the 2nd century AD but was then abandoned for over a thousand years, during which time maps were the responsibility of (23).....rather than scientists. Fortunately, however, the writings of (24).....had been kept, and interest in scientific mapmaking was revived as scholars sought to produce maps, inspired by the accounts of travellers. These days, (25).....are vital to the creation of maps and radar has allowed cartographers to map areas beyond our immediate world. In addition, this high-tech equipment is not only used to map faraway places, but cheaper versions have also been developed for use in (26).....

Hypnotism — is it real or just a circus trick?

A Hypnosis has been shown through a number of rigorously controlled studies to reduce pain, control blood pressure, and even make warts go away. But because very few studies have attempted to define the actual processes involved, most scientists are sceptical of its power and uses. That scepticism has driven David Spiegel, a professor of psychiatry at Stanford University School of Medicine, USA, and other researchers to take a hard look at what happens in the brain during hypnosis.

Among researchers there are two schools of thought. One claims that hypnosis fundamentally alters subjects' state of mind: they enter a trance, which produces changes in brain activity. The other believes that hypnosis is simply a matter of suggestibility and relaxation. Spiegel belongs to the first school and over the years has had a debate with two scientists on the other side, Irving Kirsch, a University of Connecticut psychologist, and Stephen Kosslyn, a Harvard professor.

B Kirsch often uses hypnosis in his practice and doesn't deny that it can be effective. 'With hypnosis you do put people in altered states,' he says. 'But you don't need a trance to do it.' To illustrate the point, Kirsch demonstrates how a subject holding a small object on a chain can make it swing in any direction by mere suggestion, the chain responding to minute movements in the tiny muscles of the fingers. 'You don't have to enter a trance for your subconscious and your body to act upon a suggestion,' Kirsch says. 'The reaction is the result of your focusing on moving the chain in a particular direction.'

Spiegel disagrees. One of his best known studies found that when subjects were hypnotised and given suggestions their brain wave patterns changed, indicating that they had entered a trance. In one of his studies, people under hypnosis were told their forearms were numb, then given light electrical shocks to the wrists. They didn't flinch or respond in any way, and their brain waves resembled those of people who experienced a much weaker shock. To Kirsch this still wasn't enough to prove the power of trance, but Stephen Kosslyn was willing to be convinced. Many external factors could have been responsible for the shift in the subjects' state of mind, but Kosslyn wondered, 'Is there really something going on in the brain?'

C To find out, Spiegel and Kosslyn decided to collaborate on a study focusing on a part of the brain that is well understood: the circuit which has been found to process the perception of colour. Spiegel and Kosslyn wanted to see if subjects could set off the circuit by visualising colour while under hypnosis. They selected eight people for the experiment conducted at Massachusetts General Hospital. The subjects were put in a scanner and shown a slide with coloured rectangles while their brain activity was mapped. Then they were shown a black and white slide and told to imagine its having colour. Both tasks were then repeated under hypnosis.

The results were striking. When the subjects truly saw the coloured rectangles, the circuit lit up on both sides of the brain; when they only had to imagine the colour, the circuit lit up only in the right hemisphere. Under hypnosis, however, both sides of the

brain became active, just as in regular sight; imagination seemed to take on the quality of a hallucination.

After the experiment, Kosslyn was forced to admit, 'I'm absolutely convinced now that hypnosis can boost what mental imagery does.' But Kirsch remained sceptical, saying, 'The experiments demonstrate that people are experiencing the effects of hypnotic suggestion but don't prove that they are entering a trance.' He also argued that subjects were told to see the card in colour when they were hypnotised but only to imagine it in colour when they weren't. 'Being told to pretend you're having an experience is different from the suggestion to have the experience.'

D Spiegel, however, is a clinician first and a scientist second. He believes the most important thing is that doctors recognise the power of hypnosis and start to use it. Working with Elvira Lang, a radiologist at a Harvard Medical Centre, he is testing the use of hypnosis in the operating room just as he and Kosslyn did in the scanner. Spiegel and Lang took 241 patients scheduled for surgery and divided them into three groups. One group received standard care, another standard care with a sympathetic care provider and the third received standard care, a sympathetic care provider and hypnosis. Every 15 minutes the patients were asked to rate their pain and anxiety levels. They were also hooked up to painkilling medication which they could administer to themselves.

On average, Spiegel and Lang found the hypnotised subjects used less medication, experienced less pain and felt far less anxiety than the other two groups. Original results published in *The Lancet* have been further supported by ongoing studies conducted by Lang.

E Spiegel's investigations into the nature of hypnosis and its effects on the brain continue. However, if hypnosis is ever to work its way into mainstream medicine and everyday use, physicians will need to know there is solid science behind what sounds like mysticism. Only then will their reluctance to using such things as mind over matter be overcome. 'I agree that the medical use of hypnotism should be based on data rather than belief,' says Spiegel, 'but in the end it doesn't really matter why it works, as long as it helps our patients.'

Questions 27-31

Reading Passage 3 has five sections, A-E. Choose the correct heading for each section from the list of headings below.

Write the correct number, i-vii, in boxes 27-31 on your answer sheet.

List of Headings

- i An experiment using people who are receiving medical treatment
- ii The experiment that convinced all the researchers
- iii Medical benefits of hypnosis make scientific proof less important
- iv Lack of data leads to opposing views of hypnotism
- v The effects of hypnosis on parts of the brain involved in vision
- vi Inducing pain through the use of hypnotism
- vii Experiments used to support conflicting views

27 Paragraph A

28 Paragraph B

29 Paragraph C

30 Paragraph D

31 Paragraph E

Questions 32-36

Choose the correct letter A, B, C or D.

32 Kirsch uses a small object on a chain to demonstrate that

- A** inducing a trance is a simple process
- B** responding to a suggestion does not require a trance
- C** muscles respond as a result of a trance
- D** it is difficult to identify a trance

33 Spiegel disagrees with Kirsch because the subjects in Spiegel's experiment

- A** believed what they were told
- B** showed changes in brain activity
- C** responded as expected to shocks
- D** had similar reactions to control subjects

34 Kosslyn's response to Spiegel's electric shock experiment was to

- A** challenge the results because of external factors
- B** work with Kirsch to disprove Spiegel's results
- C** reverse his previous position on trance
- D** accept that Spiegel's ideas might be correct

35 Spiegel and Kosslyn's experiment was designed to show that hypnosis

- A** affects the electrical responses of the brain
- B** could make colour appear as black and white
- C** has an effect on how shapes are perceived
- D** can enhance the subject's imagination

36 Kirsch thought Spiegel and Kosslyn's results

- A** were worthy of further investigation
- B** had nothing to do with hypnotic suggestion
- C** showed that the possibility of trance existed
- D** were affected by the words used in the instructions

Questions 37-40

Do the following statements agree with the information given in Reading Passage 3?

In boxes 37-40 on your answer sheet, write

TRUE if the statement agrees with the information

FALSE if the statement contradicts the information

NOT GIVEN if there is no information on this

37 Spiegel is more interested in scientific research than medical practice.

38 Patients in the third group in Spiegel and Lang's experiment were easily hypnotised.

39 In Spiegel and Lang's experiment, a smaller amount of painkiller was needed by the hypnotised patients than by the other two groups.

40 Spiegel feels that doctors should use hypnotism only when it is fully understood.