You should spend about 20 minutes on ***Questions 1–13****, which are based on Reading Passage 1 on pages 1 and 2.*

Why does skin wrinkle in water?

A Thousands of years after the invention of the bath, scientists have come up with a theory to explain why our fingers and toes wrinkle when steeped in water. Puckered or wrinkled skin gives a better grip and may have helped our ancestors uproot wet plants when foraging for food, or be steadier and more sure-footed in a slippery, wet environment, they say. Writing in *Biology Letters*, Tom Smulders, an evolutionary neurobiologist at Newcastle University suggests that it may be an evolutionary development, 'Going back in time, this wrinkling could have helped with gathering food from wet vegetation or streams. The analogous effect in the toes could have helped our ancestors get a better footing in the rain,' he says.

B The familiar wrinkles on wet fingers and toes may also have benefitted early humans in their first forays into technology. 'It might have helped handling tools in wet conditions,' Smulders added, such as fixing hunting weapons in the rain, or fishing with harpoons.

C It is popularly believed that fingertips absorb water and swell up, making the skin ripple with tiny folds. But this was proved to be incorrect by studies that showed the effect disappeared when the nerves in the fingers were damaged. Rather than swelling up, fingertips shrink when they wrinkle because the blood vessels inside them contract. The effect is controlled by the autonomic nervous system, which also governs breathing and heart rate.

D Smulders investigated the benefits of wrinkled fingers after reading a paper by Mark Changizi, director of human cognition at 2A1 Labs in Idaho. His report in the journal *Brain, Behaviour and Evolution* suggested that wrinkles on fingers resemble car treads and the network drainage systems seen on mountains.

E In the latest study, Smulders had 20 people move 45 submerged marbles and fishing weights from one container to another. The objects were plucked one at a time, with the forefinger and thumb of the right hand, passed through a hole in a screen separating the containers and into the thumb and forefinger of the left hand. Smulder timed them on the task, once when they had dry and unwrinkled hands before starting, and again after they had soaked their hands in water for half an hour.

F The task took between 90 and 150 seconds to complete, but those with wrinkled fingers moved the wet objects 15 seconds faster on average, compared with those who began with dry hands. Wrinkles made no difference to the time it took to do the task with dry objects, according to the study reported in *Biology Letters*. 'It could be working like treads on your car tyres which give you a better grip,' said Smulders.

G The findings raise the question of how, and from which species, humans inherited their wrinkling skin. 'My guess is that all primates have pruney fingers, but our only evidence at the moment beyond humans is from macaques,' said Changizi. At his lab in Idaho, Changizi has done a similar, though more rudimentary, experiment and reached the same conclusions as the Newcastle team. 'The obvious application here is biologically inspired rain treads for your shoes,' Changizi said. 'We'd ideally like to have shoe treads with the right wrinkle shapes for our foot topography. And we'd ideally like to have the treads flatten so that the entire shoe grips the ground once the water is squirted out through the channels.'

H One question that remains is why fingers are not wrinkled all the time, even when they are not in water. The answer may be that wrinkling comes at a cost: the loss of *sensitivity*.

Questions 1–6

Complete the sentences. Use **NO MORE THAN TWO WORDS** *for each answer.*

Write your answers in boxes 1–6 on your answer sheet.

1 It is possible that wrinkling evolved to enable people to maintain a secure ..... in wet conditions while running and walking.

2 Wrinkles on fingers may have helped our ancestors to handle ..... and weapons in the rain.

3 For a long time it was assumed that wrinkles were the result of the skin ..... in water.

4 Changizi showed that the pattern of the skin works in a similar way to ..... or run-off channels on the sides of hills.

5 The researchers found that there was ..... in the time it took for wrinkled fingers to move dry objects.

6 Scientists want to find out how many other ..... display the same trait of wrinkles as humans.

Questions 7–13

Complete the summary using words from the reading passage. Use **NO MORE THAN TWO WORDS** *for each answer.*
Write your answers in boxes 7–13 on your answer sheet.

Wrinkled fingers help us to grip objects better underwater and they work in much the same way as **7** …… help cars stay on the road. New research shows that wrinkles are caused by the **8** …… constricting below the skin in reaction to the water. The wrinkles help divert water away from the **9** …… . Scientists had previously discovered that **10** …… fingers did not wrinkle underwater. This suggests that the wrinkling mechanism is controlled by the **11** …… and must be some kind of **12** …… response. It is not clear why our fingers are not permanently wrinkled but scientists believe it may be due to the need to maintain the **13** …… of the fingertips.

You should spend about 20 minutes on ***Questions 14–26****, which are based on Reading Passage 2 on pages 5 and* **6**.

PHYSICAL TOUCH AFFECTS EMOTIONAL MOOD

Sitting in a comfortable chair does put you in a better mood, a new study suggests.

A Scientists have discovered that the hardness of a chair directly influences the way someone feels about another person. In an astonishing study, volunteers given wooden seats were less flexible while negotiating the price of a new car than people who sat on a padded cushion. The finding is part of an astonishing series of experiments that reveal the links between our attitudes to other people – and the texture of objects all around us. In one experiment, people given a soft blanket to hold were less likely to judge someone as rigid or strict than those handed a hard wooden block to play with. In another experiment, people who were given heavy clipboards to hold rated job applicants as more serious than people given a lightweight board – even though both groups of job applicants were identical.

B The findings suggest that the behaviour of everyone – from high court judges and teachers to job interviewers and politicians – is influenced by something as mundane as the seat they are using, or the feel of the pen in their hand. Researchers who carried out the experiments believe the link between touch and emotion goes right back to early childhood. Physical concepts such as roughness, hardness and warmth are among the first that infants develop – and the study suggests that these are crucial to how people eventually develop ideas about people and relationships such as understanding the meaning of a warm smile or a hard heart. Christopher Nocera, who led the study at Harvard University said, 'Touch remains perhaps the most underappreciated sense in behavioural research. People often assume that exploration of new things occurs primarily through the eyes. While the power of vision is irrefutable, this is not the whole story. Our work suggests that greetings involving touch, such as handshakes and cheek kisses, may in fact have critical influences on our social interactions in an unconscious fashion'.

C The researchers carried out a set of experiments on volunteers to test how objects' weight, texture and hardness unconsciously shape judgements about other people. The results, published in the journal *Science*, make fascinating reading. In one experiment, 86 volunteers were invited to a lab, seated in either wooden chairs or soft seats and asked to imagine shopping for a new car at a dealer's. After being told the sticker price of the car they were invited to write down their first offer price and a second price, assuming the dealer rejected the first offer. Those in hard chairs were less flexible in their haggling skills and were far less willing to drop their prices during the negotiations, the researchers found.

D Another study asked 49 volunteers to examine a piece of soft blanket or hard block of wood before looking at a scenario set in a workplace describing a meeting between a boss and employee. The scenario was designed to be ambiguous – and included friendly conversation between the characters as well as an exchange of sharp words. Volunteers who were given the hard block of wood to handle judged the employee to be more rigid and stricter than those who had been given a blanket to hold. In a third experiment, a similar scenario was given to volunteers after they had

completed a five piece jigsaw. Half the volunteers were given a smooth puzzle while the others were given one covered with sandpaper. Again, those who were given the rough object rated the relationship between the characters as harsher and more adversarial than those given the smooth jigsaw.

E Even the weight of a clipboard can influence someone's attitude, the study found. The researchers asked 54 volunteers to give their impression of a job applicant by reading their CVs. When the CVs were given to the volunteers on heavy clipboards, they were rated as far more serious than when the identical CVs were attached to flimsy, lightweight clipboards. Dr John Bargh of Yale University, who took part in the study said, 'It is behavioural priming through the seat of the pants. Our minds are deeply and organically linked to our bodies'. Not only is touch an important sense for exploring the world, but it also shapes our understanding of it, reflected in the use of everyday phrases such as 'take the rough with the smooth', 'have a soft spot for someone' or 'a prickly situation'.

F Past studies have shown that people judge strangers to be more generous and caring after they have held a warm cup of coffee, rather than a cold drink., 'Physical experiences not only shape the foundations of our thoughts and perceptions, but influence our behaviour towards others, sometimes just because we are sitting on a hard instead of a soft chair'.

Questions 14–21

Complete the table below.

Write **NO MORE THAN TWO WORDS** *for each answer.*

Write your answers in boxes 14–21 on your answer sheet.

Purpose of test	**Test procedure**	**Test findings**
To find out how the weight of an object influences behaviour	Volunteers evaluate CVs on either heavy or lightweight clipboards	Volunteers with heavy clipboards rated job applicants as **14** ..... about the position
To find out how the **15** ..... of an object influences behaviour	Volunteers arrange a **16** ..... before reading about a conversation between two people	Volunteers were less likely to characterise the interaction as difficult if the pieces were **17** .....
To find out how the hardness of an object influences behaviour	Volunteers hold hard or soft objects before watching a scene which takes place in a **18**	Volunteers were more likely to view the worker as strict if they held a **19** .....
	Volunteers engage in mock **20** ..... over the price of a car	Volunteers in **21** ..... showed more movement between offers

Questions 22–25

Complete the sentences using the list of words and phrases **A–H** *in the box below.*

Write the correct letter, **A–H** *in boxes* ***22–25*** *on your answer sheet.*

NB *You may use any letter more than once.*

22 The way people view the outside world is directly affected by the physical touch of their .....

23 Soft textures are thought to encourage people to demonstrate a greater degree of .....

24 Hard materials may encourage people to display feelings of .....

25 The sense of touch is reflected in the use of language, including common .....

A	aggression
B	experiences
C	expressions
D	flexibility
E	influences
F	interaction
G	perceptions
H	surroundings

Question 26

Which is the best alternative title for Reading Passage 2? Choose the correct letter, **A**, **B**, **C**, *or* **D**.

Write the correct letter in box 26 on your answer sheet.

A Use your eyes more than your hands if you want to talk tough

B Touch: the most important sense in human communication

C Sit on a comfortable chair if you want a good bargain

D A hard chair can give you a hard heart

You should spend about 20 minutes on ***Questions 27–40****, which are based on Reading Passage 3 on pages 10–11.*

Owl secrets

It always appeared to fly in the face of logic. But now, the biological secrets that allow owls to rotate their heads without cutting off their blood supply have finally been unravelled. Scientists have discovered four major adaptations in owls designed to prevent injury when the animals rotate their overly large heads by up to 270 degrees.

The study found that the birds' unique bone structures and vascular systems let them move with increased flexibility. Scientists at John Hopkins University School of Medicine in the US studied snowy, barred and great horned owls after their deaths from natural causes. They found that the vertebral artery enters the neck higher than in other birds, creating more slack. Unlike humans, owls were found to have small vessel connections between the carotid and vertebral arteries, allowing the blood to be exchanged between the two blood vessels. This creates an uninterrupted blood flow to the brain, even if one route is blocked during extreme neck rotation.

The adaptation gives the birds a huge range of vision without having to move their bodies and arouse detection by prey. The lack of similar adaptations in humans could explain why humans are more vulnerable to neck injury, the experts concluded. When humans attempt sudden and violent twists of their neck they risk damaging the lining of their blood vessels, which can result in a fatal blockage or stroke. Study senior investigator Doctor Philippe Gailloud, said: 'Until now, brain imaging specialists like me who deal with human injuries caused by trauma to arteries in the head and neck have always been puzzled as to why rapid, twisting neck movements did not leave thousands of owls lying dead on the forest floor from stroke. 'The carotid and vertebral arteries in the neck of most animals – including owls and humans – are very fragile and highly susceptible to even minor tears of the vessel lining.'

To solve the puzzle, the researchers studied the bone and blood vessel structures in the heads and necks of the birds. An injectable contrast dye was used to highlight the birds' blood vessels, which were then dissected, drawn and scanned to allow detailed analysis.

The most striking finding came after researchers injected dye into the owls' arteries, mimicking blood flow, and manually turned the animals' heads. They found that when they turned the heads, the blood vessels below the jaw bone expanded as more dye entered, creating pools of blood capable of maintaining the energy supply to the brain and eyes. They showed that the big carotid arteries, instead of being on the side of the neck as in humans, are carried close to the centre of rotation just in front of the spine. As a consequence, these arteries experience much less twisting and turning. The potential for damage is therefore greatly reduced. This contrasted starkly with human anatomical ability, where arteries generally tend to get smaller and smaller, and do

not balloon out as they branch out. This creates the risk of clotting after sudden neck movements such as whiplash.

Researchers say these contractile blood reservoirs act as a trade-off, allowing birds to pool blood to meet the energy needs of their large brains and eyes, while they rotate their heads. The supporting vascular network, with its many interconnections and adaptations, helps minimise any interruption in blood flow. The study results demonstrate what physical properties are needed to allow such extreme head movements, and explain why injuries sustained from treatments that involve manipulating bones with the hands such as chiropractic therapy can have such serious consequences for humans. Dr Gailloud added: 'Our new study results show precisely what morphological adaptations are needed to handle such head gyrations and why humans are so vulnerable to bone injury from chiropractic therapy. Extreme manipulations of the human head are really dangerous because we lack so many of the vessel-protecting features seen in owls.'

Medical illustrator Fabian de Kok-Mercado said: 'In humans, the vertebral artery really hugs the hollow cavities in the neck. But this is not the case in owls, whose structures are specially adapted to allow for greater arterial flexibility and movement.' It is a powerful adaptive trait, but it is not unique. Plenty of birds have a similar ability to look behind them. Red tailed hawks for example are almost as flexible as their nocturnal cousins. 'There are lots of advantages to being able to look over your shoulder and see something coming – if you're trying to avoid predators or detect prey', he added.

The team's findings were published in the journal *Science*.

Questions 27–34

Complete the summary using the list of words and phrases **A–M** *below.*

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

NB *You may use any letter more than once.*

How can owls rotate their heads by **27** ..... 270 degrees? The many small bones that make up the neck and spine enable them to achieve **28** ..... movement. A research team has discovered that in **29** ..... , their vascular network has adapted to make the rotation possible. Owls' carotid arteries are **30** ..... the spine, at the centre of rotation. This means the arteries endure **31** ..... strain when the head is turned. In addition, the vessels **32** ..... their heads can expand, creating reservoirs of blood to supply the brain when the head is turned. And the cavities in the neck vertebrae, through which the vessels pass, are extremely **33** ..... , giving the vessels space to move around when twisted. All this is necessary because their eyes can't move: owls can only look **34** ..... ahead.

A flexible
B as much as
C at the base of
D in front of
E intense
F limited
G far less
H multiple
I in excess of
J to the side of
K various ways
L large
M straight

Questions 35–40

Complete each sentence with the correct ending, **A–H** *below.*

Write the correct letter, **A–H** *in boxes 35–40 on your answer sheet.*

35 The bone structure and circulatory system of owls has evolved in order to

36 Humans' arteries tend to

37 Scientists injected dye into the blood vessels of dead owls in order to

38 When humans attempt sudden twists of their neck they are more likely to

39 The back-up arteries of owls are designed to

40 Owls have a huge range of vision which enables them to

A collect any excess blood created in the process of turning.
B cope with their very large heads.
C damage the lining of their blood vessels.
D decrease in size.
E make them lighter.
F mimic natural blood flow.
G offer a fresh supply of nutrients when blood vessels get closed off.
H avoid detection by predators or to find prey.