

Academic Reading Paper 26

Cables, Rubber Hands and Species

Time allowed: 1 hour

INSTRUCTIONS TO CANDIDATES

- Do not open this booklet until you are told to do so.
- Write your name and the date at the top of the answer sheet.
- Answer **all** the questions.
- Write your answers **on the answer sheet**, not in this booklet.
- You must transfer your answers within the hour. **No extra time is given for transferring answers in the Reading test.**
- Do not remove this booklet from the examination room.

INFORMATION FOR CANDIDATES

- There are 40 questions in this paper.
- Each question carries one mark.
- There are three passages, with 13, 13 and 14 questions.

These passages were written for this library. They are **not** reproduced from any published past paper. The format, timing and task types follow the published specification for the Academic Reading test so that sitting this on paper feels like the real thing.

You should spend about 20 minutes on Questions 1–13, which are based on Reading Passage 1 below.

Two thousand volts and three weeks

Until 1866 a message from London to New York travelled by ship and took about ten days, and the reply took another ten. A government could not consult its ambassador, a merchant could not learn a price, and a family could not be told of a death until the news was three weeks old on both sides. The Atlantic telegraph was an attempt to reduce that to minutes, and it took four expeditions, two total failures, one success that lasted three weeks, and a public argument about physics that one side lost very badly.

The first attempt in 1857 ended after about three hundred and eighty miles when the brake controlling the rate at which the cable ran off the ship was applied too firmly and the cable snapped. The following year two vessels, one British and one American, met in mid-ocean, spliced the two halves together and steamed away from each other, paying out in opposite directions. On the fourth try this worked, and in August 1858 the two continents were connected. There were celebrations in New York substantial enough to set the roof of the City Hall on fire.

The first substantial message was from Queen Victoria to the President of the United States. It was ninety-eight words long and took about sixteen hours to send. That figure is the whole problem in one number, and it needs explaining rather than laughing at, because it is not a matter of the operators being slow.

A long cable under the sea is not a wire. It is a conductor separated from a conducting ocean by a thin layer of insulation, which is the arrangement of a device for storing charge, and a sharp electrical pulse pushed in at one end does not arrive at the other as a sharp pulse. It arrives spread out and blurred, with the tail of one signal overlapping the head of the next. William Thomson, who had worked out the mathematics of this before the cable was laid, drew the conclusion that follows: you cannot fix it by pushing harder, so you must detect gently and send slowly.

He had built an instrument for detecting gently. A tiny mirror is fixed to a magnet hung on a silk fibre inside a coil of wire, and a lamp throws a spot of light onto the mirror, which reflects it onto a scale some distance away. A current far too small to move a needle turns the magnet through a fraction of a degree, and because the reflected beam is long, that fraction becomes a visible movement of the spot along the scale. The instrument has almost no moving mass and therefore almost no reluctance to move. Nothing is amplified in the modern sense; the mirror simply converts a very small rotation into a large displacement by putting a long lever of light on the end of it.

The company's chief electrician, Wildman Whitehouse, took the opposite view and had the authority to act on it. He believed the answer to a weak arriving signal was a stronger departing one, and he connected induction coils producing something in the region of two thousand volts to a cable insulated with a substance that had been sitting in a hot ship's hold for weeks. The insulation failed, the cable died after

about three weeks of service, and an inquiry followed. Whitehouse was dismissed, and the argument was over, although it is worth noticing that he was not a fool and his instinct is the one most people share: if a signal is too weak, send a stronger one.

The 1865 attempt used the Great Eastern, the only ship in existence large enough to carry the whole cable in one hull, and it broke after about twelve hundred miles. In 1866 the same ship laid a complete cable, and then did something that had been considered impossible: it went back to the position where the previous year's cable had been lost, dragged the seabed at a depth of more than three kilometres, found the broken end, brought it to the surface, spliced it and completed that one as well. The season ended with two working cables where there had been none, which is the sort of ending that makes a story sound invented.

What the public bought was not cheap. Twenty words cost twenty pounds in 1866, which was close to a year's wages for a labouring man, and the line carried about eight words a minute. Neither figure mattered very much. What mattered was that a question asked in London could be answered from New York on the same day, and every institution that depended on the ten-day gap — insurance, shipping, diplomacy, the price of cotton — had to be rebuilt around its absence.

Questions 1–4

Label the diagram below.

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

Thomson's instrument for detecting gently

- **1** what the magnet hangs on inside the coil
- **2** the source of the spot of light
- **3** the small object fixed to the magnet

- 4 what the reflected beam falls on, some distance away

Questions 5–9

Complete the sentences below.

Choose **NO MORE THAN TWO WORDS AND/OR A NUMBER** from the passage for each answer.

- 5 Before 1866 a message from London to New York took about days.
- 6 The Queen's message was ninety-eight words long and took roughly hours to send.
- 7 The 1857 cable snapped after about 380 miles when the was applied too firmly.
- 8 Whitehouse connected induction coils producing around volts.
- 9 In 1866 twenty words cost twenty pounds and the line carried about eight words a
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Questions 10–13

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

Write **TRUE** if the statement agrees with the information, **FALSE** if the statement contradicts the information, or **NOT GIVEN** if there is no information on this.

- 10 Thomson had worked out the behaviour of a long cable before one was laid.
- 11 The writer regards Whitehouse's approach as absurd.
- 12 The Great Eastern was built for the purpose of laying cable.
- 13 The 1865 cable was abandoned where it broke.

You should spend about 20 minutes on Questions 14–26, which are based on Reading Passage 2 below.

The hand that is not yours

- A** The experiment takes about a minute and needs a rubber hand, two paintbrushes and a screen. The subject's own hand is hidden behind the screen and the rubber one is placed in view, roughly where a hand of theirs might plausibly be. An experimenter then strokes both, the real one and the false one, at the same time and in the same place, so that what the subject sees and what the subject feels agree with each other for the first time about an object that is not part of them. Within a minute most people report that the sensation of being touched seems to come from the rubber hand, and that it has begun in some difficult-to-describe way to feel like theirs. Nobody is deceived about the facts; the subject knows exactly what is on the table in front of them.
- B** Matthew Botvinick and Jonathan Cohen published this in 1998 in a paper of one page. What made it more than a curiosity was a measurement they added. If a subject is asked, with their eyes closed, to reach across with the other hand and point to where their hidden hand is, they point wrongly, and they point towards the rubber one. The error is a few centimetres and it can be recorded with a ruler, which turns a report about a feeling into a number. It is called proprioceptive drift, and it is the reason the finding entered the literature rather than the anecdote collection.
- C** The control that matters is simple and it is what separates this from suggestion. If the two brushes are moved out of step with each other, the illusion does not occur, and the pointing error does not appear. Everything else about the situation is identical: the same room, the same instructions, the same rubber hand in the same place. Only the timing has changed. Whatever the brain is doing here, it is doing it on the basis of whether two streams of information arrive together. A delay of a fraction of a second between the two brushes is enough to remove the effect.
- D** Henrik Ehrsson and colleagues then showed what the rest of the body makes of it. Scanning subjects during the procedure, they found activity in a region of the frontal lobe concerned with the space immediately around the body, rising as the feeling of ownership arrived. More striking was what happened when the rubber hand was threatened with a needle. The subject's skin conductance rose and areas associated with anxiety became active, in the way they would if a real hand were about to be hurt. The body was not merely reporting a peculiar sensation; it was preparing for damage to an object that the subject could see was made of rubber.
- E** It would be easy to conclude from this that the brain will accept anything that arrives at the right time, and that conclusion is wrong. Manos Tsakiris and Patrick Haggard tested the limits in 2005 and found the effect to be considerably fussier than it looks. The object must be shaped like a hand: a wooden block stroked in perfect synchrony produces nothing. It must be roughly aligned with the posture of the real arm, and it must be on the correct side of the body. The system is not accepting

a candidate on the strength of the timing alone; it is checking the candidate against something it already holds about what a body is and how it is arranged. Synchrony is necessary and it is nowhere near sufficient.

- F** That is the finding with the longest reach, because it implies a stored model rather than a running calculation. The same logic has since been applied at larger scale, using head-mounted displays to show people a view of their own back from behind while they are stroked, which produces a reported sense of being located outside the physical body. The ingredients are the same: correlated touch and sight, and a candidate that the model will accept. What changes is the scale of the object being adopted, from a hand to a whole person.
- G** Two cautions belong with all of this and are usually left out. Roughly a quarter of people do not experience the illusion at all, which is rarely mentioned when it is described as a universal property of the brain. And the standard questionnaire used to measure it contains statements that invite agreement, with control statements attracting more agreement than they should, so part of what is being measured in some studies is the willingness of a subject to say yes. The pointing error does not have that problem, which is why it remains the more useful of the two measures, although it and the subjective report do not always move together, and there is an unresolved argument about whether they are measuring one thing or two.

Questions 14–18

Reading Passage 2 has seven sections, A–G.

Which section contains the following information?

Write the correct letter, A–G.

NB You may use any letter more than once.

- 14** a note that the effect is not universal
- 15** a statement that the subject is not being deceived about the facts
- 16** the reason a finding was taken seriously rather than treated as a curiosity
- 17** an application of the same principle to the whole body
- 18** evidence that the body prepared itself for injury

Questions 19–22

Look at the following findings and the list of researchers below.

Match each finding with the correct researchers, A–C.

NB You may use any letter more than once.

List of Researchers

- A Botvinick and Cohen
- B Ehrsson and colleagues
- C Tsakiris and Haggard

- 19 They showed that the object must be the right shape for the effect to occur.
- 20 They converted a subjective report into a measurement.
- 21 They observed a physiological response to a threat.
- 22 They found that alignment with the real arm was necessary.

Questions 23–26

Complete the summary below.

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

What the illusion shows

The effect disappears if the two brushes are moved out of step, so what the brain is responding to is whether two streams of information arrive **23** But timing alone is not enough: a wooden block produces nothing, and the candidate must be aligned with the posture of the real **24** The system is therefore checking the candidate against a stored **25** of the body rather than running a calculation. The subjective questionnaire is less trustworthy than the pointing error, because some of what it records is a subject's willingness to say **26**

You should spend about 20 minutes on Questions 27–40, which are based on Reading Passage 3 below.

Nobody agrees what a species is

Ask a biologist to define a species and you will get a definition, a qualification, and then an apology. The one most people learned at school is Ernst Mayr's: a species is a group of populations whose members breed with each other and do not breed with anything else. It is a good definition, it captures what most people mean by the word, and it cannot be applied to the majority of living things on the planet.

It cannot be applied to anything that does not reproduce sexually, which includes most bacteria and a great many plants and fungi. It cannot be applied to fossils, because the test it proposes is an experiment that cannot be run on the dead. And it handles awkwardly the numerous cases in which two obviously distinct kinds of animal produce fertile offspring wherever their ranges meet, which happens far more often than the textbook version suggests. Bears do it, birds do it constantly, and a good deal of the human genome turns out to have arrived that way.

The alternative most used by working taxonomists asks a different question: what is the smallest group of organisms that shares an ancestor and can be told apart from its neighbours? This has the advantage of being applicable to fossils, to bacteria and to anything else, and it has one large consequence. It produces more species. Applying it to primates raised the recognised number from something near one hundred and eighty to more than three hundred and fifty, without anybody finding a new animal in a forest. The animals were already known and had been described for decades. The lines around them moved, and the number of names went up.

At this point two positions form and both are mistaken. The first holds that species are real things which exist independently of us and are discovered, so that disagreement is a temporary failure of research. The second holds that they are administrative conveniences, labels we impose for our own purposes, so that the argument is not about anything. Neither survives contact with the actual pattern, which is that the category works extremely well in some places and dissolves predictably in others.

It works where large sexually reproducing animals live alongside each other in one region at one time. There the boundaries are sharp, everyone agrees where they are, and the definition and the intuition coincide. It is not a coincidence that this describes the situation of the people who invented the category. It dissolves where those conditions fail: across long stretches of time, where any line drawn between ancestor and descendant is arbitrary; across geography, where neighbouring populations grade into one another; and in organisms that exchange genes across lineages, which bacteria do so freely that the shape of the tree is itself in question.

The dissolving is not a failure of biology. It is what one should expect if evolution is true, because a process that produces gradual divergence must produce intermediate cases, and a world in which every organism fell cleanly into a category would be evidence against the theory rather than for it. The awk-

ward cases are the ones doing the explaining, and a definition that removed them would be describing something other than life. A biologist who is embarrassed by an intermediate form has mistaken the tidiness of the filing system for a claim about the world.

None of which would matter outside a seminar were it not for the law. Conservation statutes almost everywhere attach protection to the rank of species, so a decision taken by specialists on taxonomic principle redistributes legal standing and money. Splitting one widespread species into three narrow ones can create three threatened populations where the paperwork previously recorded one secure one, and the animals are unchanged throughout. Lumping has the reverse effect, and can remove protection from a population overnight without anything happening to the population. The incentive this creates is obvious, it operates in both directions, and nobody involved is comfortable discussing it.

The way out is not a better definition, which has been attempted for a century and a half. It is to say which concept is being used and why, since the answer differs legitimately between a palaeontologist and a microbiologist, and to stop hanging legal consequences on a rank that does not behave uniformly. Protection could attach to populations, which are identifiable in the field, rather than to names, which are decided at conferences. That is an administrative change rather than a scientific one, and it would remove most of the pressure that currently distorts the science. The definitions would still disagree, which is proper, but nothing would depend on which of them won.

Questions 27–31

Do the following statements agree with the claims of the writer in Reading Passage 3?

Write **YES** if the statement agrees with the claims of the writer, **NO** if the statement contradicts the claims of the writer, or **NOT GIVEN** if it is impossible to say what the writer thinks about this.

- 27** The writer thinks the disagreement over species is a temporary gap in research.
- 28** The writer accepts that Mayr's definition matches what most people mean by the word.
- 29** Most taxonomists now prefer the phylogenetic concept to Mayr's.
- 30** The writer believes intermediate cases are an embarrassment to biology.
- 31** The writer holds that taxonomic decisions can change legal protection without anything happening to the animals.

Questions 32–36

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

Endings

- A the test it proposes cannot be run on the dead.
- B it produces a larger number of species.
- C large sexually reproducing animals live alongside each other in one region at one time.
- D a process producing gradual divergence must produce intermediate cases.
- E populations, which are identifiable in the field, rather than names.
- F the animals themselves have changed.
- G biologists have not yet gathered enough data.
- H bacteria reproduce sexually more often than was thought.

- 32 Mayr's definition cannot be applied to fossils because
- 33 The main consequence of the phylogenetic concept is that
- 34 The category works well where
- 35 Intermediate cases are expected because
- 36 The writer suggests that protection should attach to

Questions 37–40

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

- 37 Why does the passage mention the change in the number of primate species?
 - A To show that many new primates have been discovered.
 - B To show that a change of concept alters the count without altering the animals.
 - C To argue that primates are unusually difficult to classify.
 - D To show that the phylogenetic concept is more accurate.
- 38 Which position does the writer reject?
 - A That the boundaries are sharp among large animals in one region.
 - B That the definitions legitimately differ between disciplines.
 - C That species are administrative labels, so the argument is about nothing.
 - D That the awkward cases are informative.

- 39** What does the writer say about the conditions under which the category works?
- A** They are the conditions of the people who invented the category.
 - B** They are found in most parts of the living world.
 - C** They apply best to bacteria.
 - D** They were chosen at conferences.
- 40** Which of the following best expresses the writer's proposal?
- A** Say which concept is being used, and stop attaching legal consequences to the rank.
 - B** Agree on a single definition of a species.
 - C** Abandon the idea of species altogether.
 - D** Leave conservation decisions to taxonomists.