

Academic Reading Paper 22

Sewers, Seismograms and Hindsight

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.

Built for the wrong reason

London made its river into a sewer by improving its sanitation. Until the 1840s household waste went into a cesspool under or beside the house, to be dug out by men who sold it to farmers outside the city. Then the flush lavatory spread, cesspools filled faster than they could be emptied, and the authorities did the sensible thing and allowed the overflow into the drains that had been built to carry rainwater off the streets. Those drains ran to the Thames. Within twenty years a city of two and a half million people was discharging everything it produced into the tidal river from which several of its water companies drew their supply.

Cholera arrived on that arrangement three times. An outbreak in 1848 and 1849 killed something near fourteen thousand Londoners, and another in 1853 and 1854 killed around ten thousand more. During the second of these John Snow mapped the deaths around a public pump in Broad Street and argued that the disease travelled in water rather than in air. The official view, held by the body responsible for public health, was that it travelled in air, and Snow's argument was examined and set aside. He died in 1858 without having convinced the people who mattered, and the report that dismissed his evidence was written by men who were neither careless nor corrupt and who simply found the alternative more plausible.

That was the summer the river became impossible to ignore. The weather was exceptionally hot, the flow was low, and the smell reaching the new Houses of Parliament, which had been built with their windows over the water, drove members out of the committee rooms. Curtains soaked in chloride of lime were hung at the windows and did nothing. There was serious discussion of moving Parliament to Oxford. A bill giving the Metropolitan Board of Works the authority and the money to build a sewer system, a thing that had been proposed and refused for years, passed in about eighteen days.

The engineer was Joseph Bazalgette, and his design turned the problem sideways. Rather than trying to clean the river or to carry waste down to it more efficiently, he built a set of large sewers running west to east, parallel with the Thames and beneath the streets, which cut across every existing outfall and caught its contents before the river did. The flow ran by gravity where the ground allowed and was lifted by pumping stations where it did not, and it was released far downstream, on the ebb tide, beyond the built-up city.

The quantities are worth stating. About eighty-two miles of main intercepting sewers were built, connected to something over a thousand miles of smaller street sewers, using in the region of three hundred and eighteen million bricks. Bazalgette specified Portland cement, which was then a new material of uncertain quality, and had every batch tested, rejecting what failed. Along the north bank he also built the Embankment, which narrowed the river, carried the lowest of the intercepting sewers, a road and an underground railway, and reclaimed thirty-two acres of land in the process.

One decision made more difference than any other and it was not technical. Bazalgette calculated the diameter of pipe that the densest population London could plausibly hold would require, and then doubled it. His stated reason was that the work would only be done once, and that whatever was laid would have to serve people not yet born. The system he built on that principle carried a city several times the size he designed for, and much of it is still in use.

Then came the evidence nobody had set out to gather. In 1866 cholera returned to London and killed about five thousand six hundred people, almost all of them in one district in the east of the city. That district was the only substantial area not yet connected to the new system, and its water came from a company still drawing from a contaminated source. The rest of London, on the same river in the same summer, was largely spared. Nobody had designed that comparison, and no experiment anyone could have proposed would have been permitted to run it.

The uncomfortable part is that Bazalgette was not building against waterborne infection. He and the board that employed him accepted the prevailing theory, that disease rose as a poison from decaying matter, and the object of the works was to remove the smell. Removing the smell meant removing the sewage from the water, and the sewage was where the cholera was. A correct action was taken for an incorrect reason, and it saved more lives than the correct reason would have saved on its own, because the correct reason had been available since 1854 and had persuaded nobody with the power to dig.

Questions 1–4

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.

- 1 An improvement in household sanitation made the Thames dirtier.
- 2 Snow's evidence was ignored without being examined.
- 3 Parliament moved to Oxford during the summer of 1858.
- 4 Bazalgette's design set out to clean the river itself.

Questions 5–9

Complete the table below.

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

What was built		
Element	Quantity or detail	Point of it
Main intercepting sewers	about 5 miles	to cut across every outfall before it reached the river

Brickwork	around three hundred and 6 million bricks	—
Portland 7	every batch tested, and failures rejected	it was a new material of uncertain quality
The Embankment	reclaimed thirty-two 8 of land	carried a sewer, a road and an underground railway
Pipe diameter	the figure he calculated, then 9	

Questions 10–13

Complete the sentences below.

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

- 10 Bazalgette said the work would only be done, and had to serve people not yet born.
- 11 Where gravity was not enough, the flow was lifted by
- 12 The district worst hit in 1866 was the only large area not yet to the new system.
- 13 The stated object of the works was to remove the

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

Reading the inside of the Earth

- A** Nobody has been anywhere near the inside of the Earth. The deepest hole ever drilled reached about twelve kilometres, which is a fifth of the way through the thinnest part of the outer shell and one five-hundredth of the distance to the centre. Everything that is known about the other five hundred parts has been worked out from the arrival times of waves produced by earthquakes at stations on the far side of the planet. The whole picture rests on one piece of physics: a compressional wave, which squeezes and stretches the material it moves through, will travel through a liquid, and a shear wave, which moves it sideways, will not. Nothing else about either wave matters here, and everything that follows is a consequence of that one difference.
- B** Richard Dixon Oldham made the first use of that in 1906. Comparing records of the same earthquake from many stations, he found that beyond a certain angular distance the compressional waves arrived later than the pattern of nearer stations predicted, as though they had passed through something that slowed them down. The natural interpretation was a central region of different material, and he said so. It was the first evidence that the Earth has a core, and it came from measuring when a pen had twitched. He could not say what the core was made of or whether it was solid, and he did not claim to.
- C** Three years later Andrija Mohorovičić was working on an earthquake in the Kupa Valley, in what is now Croatia, and noticed that stations beyond about two hundred kilometres recorded two separate sets of compressional waves rather than one. The first had gone straight through the surface rock. The second had gone down, met a boundary at which the material was faster, run along beneath it and come back up, and had overtaken the direct wave despite travelling further. The depth of that boundary, between thirty and fifty kilometres beneath a continent and considerably less beneath an ocean, marks the base of the crust. It is the only one of the major boundaries that was found from a single earthquake by a man who was looking at something else.
- D** Beno Gutenberg fixed the size of the core in 1913 by measuring where the waves stop. There is a band of the Earth's surface, beginning about a hundred and three degrees from an earthquake and ending about a hundred and forty-three degrees away, in which the compressional waves arrive weakly or not at all because they have been bent sharply by the core. Shear waves do not arrive anywhere beyond the near edge of that band at all. Gutenberg put the top of the core at about two thousand nine hundred kilometres down, and the number has barely moved since, which is unusual for a quantity established that early from that little data.
- E** The absence of the shear waves is the more important half of that result. A shear wave requires the material to resist being pushed sideways, which a liquid does not, so a shear wave that enters the core does not come out. That the Earth has a liquid centre was not a guess or an inference from

magnetism; it was read off the fact that a particular kind of wiggle was missing from a particular set of paper records, in every station in the world that lay beyond a certain distance.

F In 1936 Inge Lehmann noticed something in the shadow. Working at the Danish Geodetic Institute, largely on her own, she found faint compressional arrivals inside the band where the theory said there should be none, and showed that they could be explained if there were a further boundary within the core, at which waves were deflected back into the shadow. Her paper was two pages long and was titled with a single letter and a mark. The inner core it proposed is solid, is about the size of the Moon, and was accepted within a few years. She went on publishing into her nineties, and the boundary she found still carries her name.

G It is worth being clear about the status of all this. The familiar cutaway drawing of the Earth is not a photograph and is not a scale model of anything anybody has seen. It is a curve of wave speed against depth, fitted to travel times gathered over more than a century, and the boundaries in the drawing are the places where that curve changes abruptly. The curve is still being revised. Whether the inner core rotates at a slightly different rate from the rest of the planet is an open question, and has been argued in both directions within the last ten years by people looking at the same records.

Questions 14–17

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 reminder that a familiar picture is not a picture of anything
- 15** a discovery made by somebody investigating a different question
- 16** a statement of what an early researcher declined to claim
- 17** an explanation of why a missing signal is more informative than a present one

Questions 18–21

Look at the following achievements and the list of people below.

Match each achievement with the correct person, A–D.

List of People

- A** Richard Dixon Oldham
- B** Andrija Mohorovičić
- C** Beno Gutenberg
- D** Inge Lehmann

- 18** He established how deep the top of the core lies.

- 19 He found two sets of waves where one was expected.
- 20 She explained arrivals that theory said should not exist.
- 21 He produced the first evidence of a central region of different material.

Questions 22–26

Label the diagram below.

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

What the wave arrivals imply

The diagram illustrates the Earth's internal structure with concentric circles representing layers. A red line represents a seismic wave path. The labels point to the following features:

- 22: The layer whose base lies 30 to 50 km down beneath a continent
- 23: The region whose top Gutenberg placed about 2,900 km down
- 24: The solid body at the centre, about the size of the Moon
- 25: The band of surface, 103° to 143° from the earthquake, where waves arrive weakly or not at all
- 26: The kind of wave shown here, bent sharply by the core

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

The trouble with the obvious

In 1949 the sociologist Paul Lazarsfeld reviewed a large wartime study of American soldiers, and did something in the review that has been quoted ever since. He listed six of its findings. Better-educated men, he wrote, showed more psychological problems during service than less-educated men; men from the southern states coped better with the tropical heat than men from the north; white privates were keener on promotion than black privates; soldiers were more anxious to get home while the fighting continued than after the surrender. None of it, he observed, was surprising. Anyone could have said as much, he suggested, without spending public money on a survey and a research team and several years.

Then he told the reader that every one of the six was the opposite of what the study had found. The real results were the reverse in each case, and if the reader had been given those instead, they would have seemed equally obvious and equally not worth the cost. That is the whole argument and it has never been answered. If a finding and its exact inverse both feel like common sense, then the feeling is not evidence about the world; it is a report on how easily we construct an explanation once we have been handed a conclusion.

The mechanism was named later. Told an outcome, people reliably remember having expected it, and they are not lying. Asked in advance to estimate the probability of an event, and asked again afterwards what they had estimated, subjects consistently report a figure closer to what happened than the one they actually gave. The prior state of one's own mind is reconstructed from the present one, and the reconstruction is not available for inspection from the inside; it does not feel like a reconstruction, it feels like a memory. This is why the sensation of obviousness carries so much confidence and so little information.

The damage runs in two directions and the second is less often noticed. The first is that useful work gets dismissed: a study is called trivial because its result can be narrated afterwards, and the narration is mistaken for a prediction that was never made. The second is that false claims are protected. Anything asserted as common sense arrives already immune, because to question it is to look slow, and a great deal of confident nonsense about how people learn, how organisations work and what motivates employees has travelled for decades on precisely that ticket, unexamined because examining it looked unnecessary.

It would be convenient to conclude that common sense is worthless, and that is the error waiting on the other side. Most of what anybody knows about other people is common sense, it is usually right, and it has to be, because a person who had to run a controlled trial before deciding whether a colleague was annoyed would not get through the morning. A body of practical knowledge that works nearly always for the ordinary case is a considerable achievement, and dismissing it wholesale is the vanity of people who have recently learned about a bias.

The honest position is narrower. Common sense is reliable for the cases it was built on, which are individual, immediate and local, and it degrades sharply when it is asked about systems, aggregates and the long run. Predicting that a friend will be irritated is the sort of thing it does well. Predicting what a tax change does to employment, or which of two teaching methods produces better readers at fourteen, is the sort of thing it does badly while feeling exactly the same from the inside, and the identical feeling is the problem.

There is also a defence against it that costs almost nothing. Write the prediction down before the result is known. Where that is impossible, present the inverse alongside the finding and ask people which they would have expected, which is Lazarsfeld's device turned into an instrument. Anyone who says a result is obvious can then be asked a single question: would you have said the same of the opposite? The question is not rhetorical, it is answerable, and the answer is usually informative about the speaker.

Some social science really is trivial, and the complaint is sometimes correct rather than a symptom of hindsight. The point is not that the objection is always wrong. It is that the objection cannot be settled by consulting the feeling, because the feeling is generated after the fact by the same machinery that would have generated it for the opposite result. A test that cannot distinguish a finding from its own reverse is not a test, whatever else it may be, and the confidence with which it is applied is no help at all.

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 common sense is worthless.
- 28** The writer accepts that people who misremember their own predictions are not being dishonest.
- 29** Lazarsfeld's review was criticised by the authors of the study.
- 30** The writer believes the charge of triviality against social science is always a symptom of hindsight.
- 31** The writer holds that common sense works better for immediate cases than for large systems.

Questions 32–35

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

List of Words

- A inverse
- B confidence
- C prediction
- D memory
- E immune
- F trivial
- G narration
- H instrument

Lazarsfeld's device

Lazarsfeld printed six findings that readers would call obvious, then revealed that each was the **32** of the real result. The sensation of obviousness therefore carries a great deal of **33** and very little information. One consequence is that good work is dismissed because a result can be narrated afterwards and the **34** is mistaken for a prediction nobody made. Another is that false claims arrive already **35**

Questions 36–40

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

- 36** What was the point of Lazarsfeld listing six findings before correcting them?
- A To show that the study had made errors.
 - B To show that a result and its opposite can both feel obvious.
 - C To show that surveys are a waste of public money.
 - D To show that soldiers were poorly understood by researchers.
- 37** Which position does the writer reject?
- A That some social science is genuinely trivial.
 - B That practical knowledge of other people is usually correct.
 - C That an idea should be accepted because questioning it looks slow.
 - D That people cannot inspect how their own expectations have changed.

- 38** According to the passage, what happens when subjects are asked afterwards what probability they had given?
- A They report the figure they actually gave.
 - B They refuse to answer.
 - C They report a figure nearer to the outcome than the one they gave.
 - D They report a figure further from the outcome than the one they gave.
- 39** What does the writer propose as the cheapest defence?
- A Writing the prediction down before the result is known.
 - B Repeating every study twice.
 - C Refusing to publish results that sound obvious.
 - D Training researchers in statistics.
- 40** Which of the following best expresses the writer's conclusion?
- A A test that cannot separate a finding from its reverse is not a test.
 - B Social science should be exempt from criticism.
 - C Common sense should be replaced by controlled trials in daily life.
 - D Hindsight bias explains every objection to research.