

Academic Reading Paper 18

Dykes, Lead and Prediction

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.

The night the sea came over

On the night of 31 January 1953 a deep storm crossing the North Sea met a spring tide, and the water piled up in the narrowing funnel between Britain and the Low Countries until it stood several metres above its ordinary level. It came ashore in the dark, on a Saturday night, against a coast whose defences had been patched rather than maintained through a war and the years of shortage that followed. In the Netherlands one thousand eight hundred and thirty-six people died and about a hundred and fifty thousand hectares went under salt water. Three hundred and seven died in England, and more than two hundred at sea.

The dykes did not fail the way people imagine. Most of them were built of clay and turf, shaped to hold water back on the seaward face, and what happened was that the surge came over the top and ran down the inland side, cutting the earth away from behind until the wall collapsed into the gap. A structure perfectly adequate to the pressure of the sea was destroyed by water arriving on the side it had never been designed to face. Once one section went, the water spread inland across country that lies below sea level and had nothing else in the way.

Nor was there any warning worth the name. Forecasters knew a severe storm was coming and said so, but the surge itself peaked between midnight and dawn, and the machinery for telling ordinary people anything at that hour did not exist. Radio stations had closed for the night. The telephone exchanges were not staffed for it. A system did exist for warning shipping, because ships were what the state had historically thought it was protecting, and the people asleep behind the dykes were not part of it. Where anyone was warned at all it was because a local official had looked at the water himself and gone out on a bicycle.

What the Dutch did next is the part worth studying. A Delta Commission was appointed within three weeks and given a question that no government had put in that form before. Not how high should the dykes be, which had always been answered by building them a little higher than the worst flood anyone could remember, but how safe is it worth being.

A mathematician named David van Dantzig turned that into arithmetic. Raising a dyke costs a known amount per metre. A flood costs a very large but estimable amount, in property and in lives, to which a value must be assigned whether or not anybody wants to say so out loud. Multiply the cost of the flood by the probability of it happening in a given year and compare that with the cost of the extra metre, and there is a height at which further building stops being worth it. The answer is not a wall that cannot be overtopped, because no such wall exists at any price. It is an explicit statement of how much risk the country is choosing to keep.

The numbers that came out of it are still in force. The densely populated western provinces are defended to a standard of one flood in ten thousand years. Other stretches of coast are built to one in four thousand, and the river dykes inland to between one in twelve hundred and fifty and one in two thousand, on the reasoning that fewer people and less value stand behind them. Those are not engineering limits. They are prices, arrived at deliberately, and written into law.

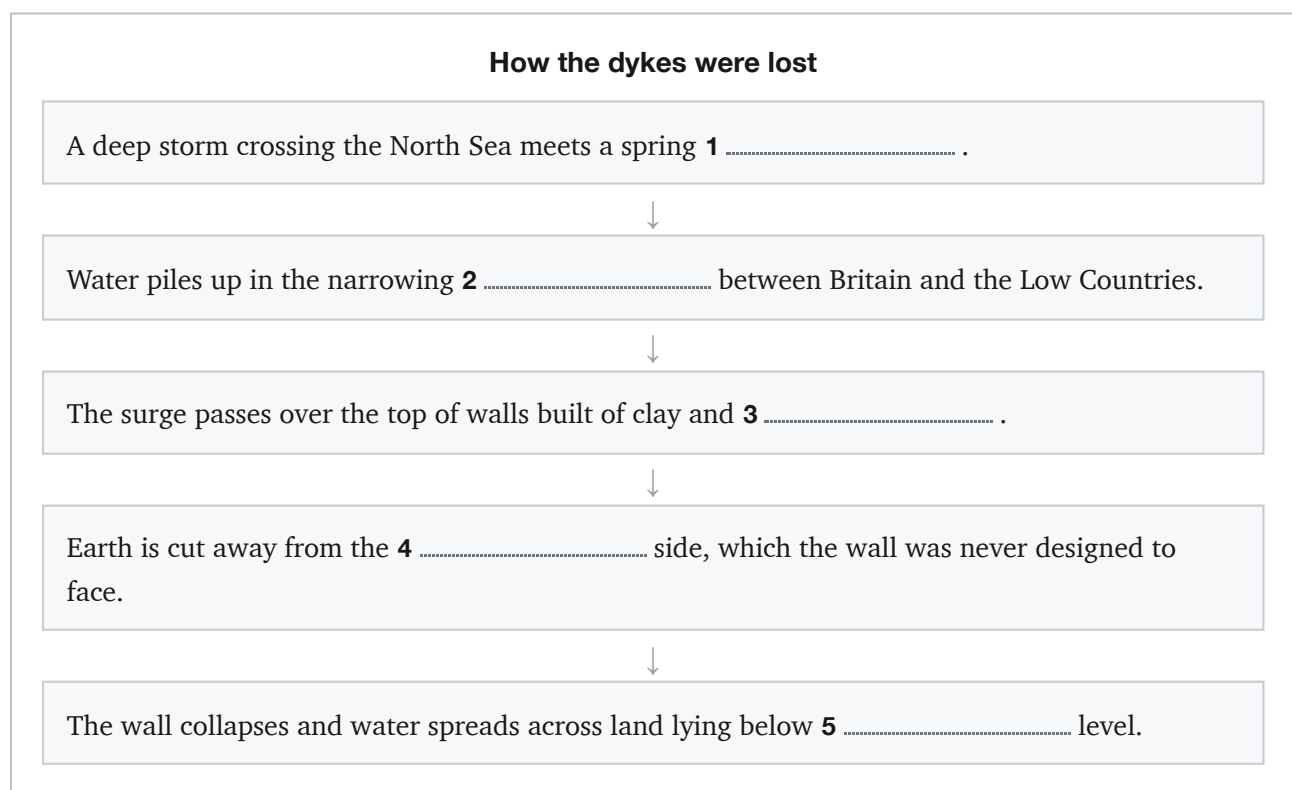
The building took forty years. Estuaries were dammed and the coastline shortened by some seven hundred kilometres, on the principle that the cheapest defence is a shorter one. The largest of the works was meant to be a solid dam across the Eastern Scheldt, and it was redesigned after a long public argument into a barrier of sixty-two gates that stands open in ordinary weather, because sealing the estuary would have killed its tides and the shellfish industry that depended on them. That decision cost several times what the dam would have cost.

The last piece, finished in 1997, guards the waterway to Rotterdam, which cannot simply be closed because the port is the reason the country can pay for any of this. Two curved gates, each about as long as the Eiffel Tower is tall, lie in dry docks on either bank and swing out to meet in the channel when a computer decides the forecast has crossed a threshold. It has shut against a storm twice in its working life. That is the intended rate. A barrier that closed often would be a barrier built too low, and one that never closed would be an admission that the money need not have been spent.

Questions 1–5

Complete the flow-chart below.

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



Questions 6–9

Complete the table below.

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

The standards the Delta Commission set		
Area defended	Accepted chance of a flood in any year	Reasoning
The western provinces	one in 6 years	densely populated
Other stretches of 7	one in four thousand years	—
River dykes inland	one in twelve hundred and fifty to one in 8 years	fewer people and less 9 stand behind them

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** Forecasters were aware that a severe storm was approaching.
- 11** The Delta Commission's standards represent the highest level of protection engineering can achieve.
- 12** The Eastern Scheldt barrier is the longest structure in the Delta Works.
- 13** The Rotterdam barrier has closed against storms less often than intended.

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

The man who measured the Earth and found the lead

- A** In 1921 a General Motors engineer named Thomas Midgley found that adding a small quantity of tetraethyl lead to petrol stopped engines knocking. It worked, it was cheap, and it was patentable, which ethanol was not. Within three years workers at the plants making it were dying, five at one refinery alone, and others were removed to asylums. The industry conceded that handling the concentrate was dangerous and maintained that the exhaust was not, and on that distinction the additive stayed in fuel for the next sixty years. Midgley himself appeared before reporters, poured the liquid over his hands and breathed its vapour for a minute to demonstrate its safety, then spent the following year recovering from lead poisoning somewhere out of public view.
- B** The scientific defence of it was constructed by Robert Kehoe, a physician who ran the laboratory the industry funded. His argument had a shape that is worth understanding, because it was not stupid. Lead, he showed, is present in everybody; it occurs naturally; the levels found in Americans were not elevated compared with the levels found in Americans. Absent evidence of harm at those levels, the additive should be presumed safe, and the burden lay on anyone who said otherwise. For four decades that position held, and it held because nobody could produce the one thing that would have broken it.
- C** What was missing was a baseline. Kehoe was comparing contaminated people with other contaminated people and finding, correctly, no difference. To show that modern humans carried too much lead, somebody had to know how much a human carried before there was any industry, and no such measurement existed. It was not a question anyone in public health was equipped to ask. Answering it needed somebody who could measure quantities far below the level at which the measuring itself starts adding lead to the sample, and no laboratory in medicine was built to that standard or had any reason to be.
- D** It was answered by a geochemist who was not interested in health at all. Clair Patterson, working at Caltech, was trying to establish the age of the Earth by measuring lead isotopes in a meteorite, and his results kept coming out wrong because lead from the laboratory itself was getting into his samples. Removing it consumed years. He rebuilt the room, distilled his own reagents, and produced what amounted to the first ultra-clean laboratory, and in 1953 he obtained a figure of four and a half billion years that has not needed serious revision since.
- E** Having spent that long learning exactly how much lead the modern world deposits on everything it touches, he turned the same equipment on the world itself. Lead in the surface water of the ocean, he found, was many times higher than in the deep water beneath it, which made no sense unless it had arrived recently from above. Ice laid down in Greenland showed the same thing on a timeline:

a slow rise through the industrial period and a sharp climb after the 1920s. He published the comparison in 1965. The natural human burden, it turned out, was a small fraction of the burden Kehoe had been calling normal.

- F** The industry's response was to attack him rather than the measurements, and he lost contracts and committee seats for some years. What the measurements could not do on their own was show harm, and that came from a different direction. Herbert Needleman collected the milk teeth that schoolchildren shed, measured the lead laid down in the dentine, and compared children at the high and low ends. Those with more lead scored lower on tests of intelligence and were rated as less attentive by teachers who had not been told which children were which. The teeth mattered because they record exposure over years rather than the level circulating on the morning of the test, which is all a blood sample can give.
- G** Removal followed, slowly, and produced the cleanest natural experiment public health has. As the lead content of American petrol fell through the late 1970s and early 1980s, average blood lead in the population fell with it, by something close to eighty per cent, and the two curves track each other so closely that the graph is now used to teach what a dose-response relationship looks like when you can see one.
- H** Two cautions are worth keeping. The effect on any individual child was modest; it is at the scale of a population, where a few points are shifted across tens of millions of people, that it becomes enormous. And the further claim that leaded petrol explains the rise and fall in violent crime across the same decades goes well beyond what these studies establish, however neatly the curves line up. The lesson that does hold is about Kehoe's standard rather than his conclusion. Demanding to be shown the data is a reasonable position, until the contamination you are arguing about has got into the instruments, the samples and the idea of normal.

Questions 14–18

Reading Passage 2 has eight sections, A–H.

Which section contains the following information?

Write the correct letter, A–H.

NB You may use any letter more than once.

- 14** a public demonstration intended to show that a substance was harmless
- 15** a reason why the necessary measurement could not have come from medicine
- 16** two limits on how far the findings can be pushed
- 17** a comparison between two depths of the same ocean
- 18** an explanation of why a particular kind of sample was chosen

Questions 19–22

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

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

List of People	
A	Thomas Midgley
B	Robert Kehoe
C	Clair Patterson
D	Herbert Needleman

- 19** He argued that those claiming harm carried the burden of proof.
- 20** He established a figure for the age of the Earth that still stands.
- 21** He compared children at opposite ends of a range of exposure.
- 22** He found a use for a substance that could be patented, unlike its rival.

Questions 23–26

Complete the sentences below.

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

- 23** Kehoe was comparing contaminated people with people who were also , and correctly found no difference.
- 24** Ice laid down in Greenland showed a sharp climb after the
- 25** After publishing, Patterson lost contracts and for some years.
- 26** Average blood lead in the American population fell by close to per cent.

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

Why prediction is the wrong test

There is a test that gets applied to any field whose standing is in doubt, and it is always the same one. Can it predict? Economics is dismissed for failing to see a crash coming. Epidemiology is dismissed when a forecast range turns out to be wide. Psychology, nutrition and climate science all get measured against the same rule, and the rule feels obvious: a subject that understands its material should be able to say what happens next. It is the test a person reaches for when they suspect they are being asked to take something on trust, which is a reasonable suspicion and a bad instrument.

The trouble is that the sciences nobody doubts fail this test badly. Evolutionary biology cannot tell you which species will exist in a million years. Geology cannot tell you when the next large earthquake will strike a named fault, and says so. Medicine cannot tell you which particular smoker will develop cancer, only what proportion will. If prediction were really the criterion, we would have to demote the theory of evolution and keep astrology, which predicts constantly.

What those subjects do instead is forbid. Plate tectonics does not say when California will move; it says that a large earthquake cannot originate in the middle of a stable continental block, and if one did the theory would be finished. Evolution does not say what will evolve; it says that no rabbit will be found in Precambrian rock. Thermodynamics does not tell you what your engine will do; it rules out an entire class of engines in advance, and it has never been caught out. A theory earns its standing by the size of the space it closes off. The larger that space, the more ways there are for the world to embarrass the theory, and the more we have learned when it declines to.

This was the original point, and it has been mislaid. Karl Popper's criterion was falsifiability, which is a statement about prohibition: a theory is scientific to the extent that it says what cannot be observed, so that observing it would kill the theory. Somewhere between the philosophy and the newspapers this turned into a demand for successful forecasts, which is a different and much weaker thing. A model that forecasts well by fitting whatever has happened so far forbids nothing at all, and will go on forecasting well until the day it matters.

The confusion is easiest to see in the standard objection to climate science, which is that the same people cannot say whether it will rain on Thursday. That is true and it is not a criticism, because the two statements are answers to different questions. Predicting the trajectory of a particular system through a chaotic regime and predicting the statistics of that system under a changed constraint are separate problems, and being bad at one implies nothing whatever about the other. A physicist who cannot say where one molecule will be can still tell you the pressure in the container to as many decimal places as you like. Nobody regards that as a failure of physics, and the only reason the equivalent looks like a failure elsewhere is that the questions have not been kept apart.

It would be convenient to stop there, and it would be wrong, because the opposite error is at least as common and rather more comfortable. Once a field is allowed to say that prediction is not its business, it acquires a licence to explain anything after the fact and risk nothing in advance. Some of psychoanalysis worked this way, and parts of macroeconomics still do: whatever happens, the framework can accommodate it, and every outcome is confirmation. A theory that cannot fail is not modest. It is empty, and it is usually empty in a way that suits somebody.

So the test is worth replacing rather than abandoning. Ask what a claim forbids. Ask whether anybody has gone and looked for the forbidden thing, and what would count as finding it. Ask, separately, whether the field is being used to forecast a trajectory or to bound a distribution, because those licence different decisions and the second is far more often available than the first. A flood defence does not need to know when the storm will come; it needs to know the distribution of storms, which is a question the science can answer and the forecast cannot.

None of this rescues every field that is currently accused of predicting badly. Some of them do forbid very little, and the accusation lands. But it should land for that reason, and not because a subject has been asked to do the one thing its material does not permit, and then blamed for the honesty of the answer.

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 believes a field should be judged by whether its forecasts come true.
- 28** The writer thinks the instinct behind the prediction test is understandable.
- 29** Popper's work is now more widely read than it was in his lifetime.
- 30** The writer accepts that some fields deserve the criticism they receive.
- 31** The writer says every field accused of predicting badly has been treated unfairly.

Questions 32–36

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

List of Words

- A forbids
- B forecasts
- C distribution
- D trajectory
- E empty
- F modest
- G pressure
- H confirmation

A better question to ask

The writer argues that a theory earns its standing not by what it predicts but by what it
32 Popper's criterion was about prohibition, but in ordinary use it became a
demand for successful **33** Predicting the **34** of one system
through a chaotic regime is a different problem from bounding a **35**, and the
second is more often available. But a framework that can accommodate any outcome is not
cautious; the writer calls it **36**

Questions 37–40

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

- 37** Why does the writer mention astrology?
- A To show that prediction alone cannot be the mark of a science.
 - B To argue that astrology deserves more study.
 - C To give an example of a theory that forbids a great deal.
 - D To explain why evolution is hard to test.

- 38** According to the passage, plate tectonics earns its standing because it
- A says when California will move.
 - B rules out large earthquakes inside stable continental blocks.
 - C has produced accurate forecasts for named faults.
 - D explains earthquakes after they have happened.
- 39** What is the writer's point about the physicist and the molecule?
- A Physics is more advanced than climate science.
 - B Chaotic systems cannot be studied at all.
 - C Being unable to track one member of a system does not prevent describing the whole.
 - D Pressure is easier to measure than position.
- 40** Which of the following best states the writer's conclusion?
- A Ask what a claim rules out, and whether anyone has looked.
 - B No field should be judged on its forecasts.
 - C Fields that predict badly should be abandoned.
 - D Falsifiability has been disproved.