

Academic Reading Paper 13

Paper, Swarms and Repairs

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 century of books that are falling apart

A book printed in 1490 can usually be handled. A book printed in 1890 often cannot: the pages have gone brown at the edges, and a leaf turned carelessly breaks along the fold rather than bending. This is the wrong way round, and the reason is a change in what paper is made of that happened in between.

For most of its history in Europe, paper was made from rags. Worn-out linen and cotton were sorted, soaked, beaten to a pulp and formed into sheets, and the result is chemically about as stable as a material can be, which is why the incunabula survive. The difficulty was supply. Rag was a traded commodity with a fixed quantity, and by the middle of the nineteenth century the printing industry was consuming it faster than a population could wear out its shirts. Mills advertised for rags, collectors went door to door, and prices rose for decades. The trade had its own vocabulary and its own scandals. Rag was imported, sorted by grade, adulterated, and on occasion taken from the dead, and several countries banned its export outright in order to protect their own mills.

The first substitute was mechanical. In 1844 Friedrich Gottlob Keller, in Saxony, patented a method of pressing logs against a wet revolving grindstone, tearing the wood apart into fibres. Groundwood pulp is very cheap and it works: the newspaper industry runs on it to this day. What it does not do is last, because grinding separates the fibres without removing the lignin that binds them in the tree, and lignin in the presence of light and air produces the yellowing everybody has seen on a newspaper left on a windowsill.

Chemistry followed. In 1867 Benjamin Tilghman patented a process in which wood chips are cooked under pressure in calcium bisulphite, which dissolves the lignin and leaves the cellulose fibres long and intact. Sulphite paper is a serious material rather than a cheap one. Then in 1879 Carl Dahl patented the process that eventually took over, cooking the chips in sodium hydroxide and sodium sulphide instead. He called it kraft, the German for strength, because the fibre it produces is stronger; it also tolerates resinous woods that defeat the sulphite process, and, decisively, the cooking chemicals can be recovered from the spent liquor and used again.

None of that is what ruined the books. The damage came from something added at the end. Paper made for writing or printing has to be sized, so that ink sits on the surface instead of spreading into the fibres, and from early in the nineteenth century the standard sizing was rosin fixed with alum. Alum in the presence of moisture produces sulphuric acid, in small quantities, inside the sheet. Acid breaks the long cellulose chains into short ones, and a short-chained fibre has no strength. The process is slow, it is invisible for decades, and it does not stop.

The scale of the consequence took a century to become apparent. By the nineteen-eighties, major research libraries were reporting that a large proportion of their holdings printed since about 1850 had become too brittle to issue to a reader, and the proportion was rising every year. A book does not announce

this. It sits on a shelf looking exactly as it did, and fails the first time somebody opens it properly. Nor is the problem confined to books. Newspapers, letters, maps and the working records of institutions were all made on the same material during the same century.

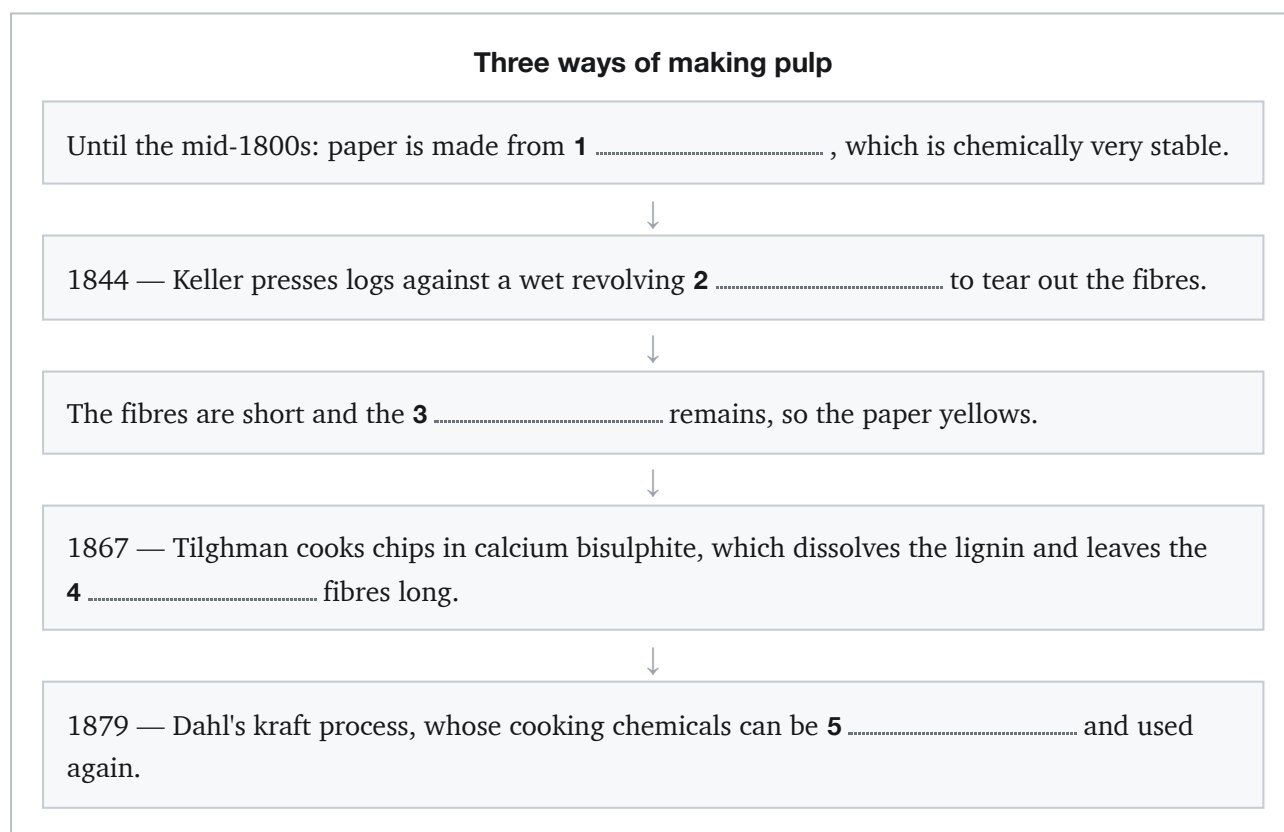
The responses fell into two kinds. One was to treat what already existed, by exposing whole collections to an alkaline agent that neutralises the acid in the sheet. The early attempts were difficult — a programme using diethyl zinc, run in a converted space facility, ended in an explosion in the mid-nineteen-eighties — and later methods using milder compounds are now in routine use, though they can only stop the decay rather than reverse it. The other response was to stop making the problem. From 1984 a standard for permanent paper specified an alkaline reserve and a minimum life expectancy, and books printed to it carry a small infinity symbol on the copyright page.

There is a tidy irony in the sequence, and it is worth resisting the tidy conclusion. The medieval sheet lasts because rag is cellulose and nothing was done to it. The industrial sheet fails not because wood is inferior — kraft paper made without acid sizing is perfectly durable — but because a cheap solution to a printing problem was adopted for a century and a half before anybody costed its consequences. The material was not the mistake. The additive was. The other lesson is about how long a consequence can take to arrive. The sizing was adopted for reasons that were sound at the time, and the bill for it fell due a hundred years after everyone who had chosen it was dead.

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 notes below.

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

Why the books fail

The cause

- Paper for writing and printing has to be sized so that ink does not spread.
- From early in the nineteenth century, sizing used rosin fixed with **6**
- With moisture this produces small quantities of **7** inside the sheet.

The remedies

- Existing collections can be treated with an **8** agent that neutralises the acid.
- From 1984 a standard for permanent paper requires an alkaline reserve and a minimum **9**

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** Keller's groundwood process was patented in 1867.
- 11** The kraft process succeeded partly because its chemicals did not have to be bought again for each batch.
- 12** Deacidification treatments are more expensive than reprinting a brittle book.
- 13** The passage concludes that wood pulp is an inherently unsuitable material for books.

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

How a swarm chooses a house

- A** When a honeybee colony divides, about half the workers leave with the old queen and hang in a cluster on a branch, perhaps ten thousand of them, with no shelter and a few days of food inside them. In that time they must find a cavity to live in and agree on it. The decision is consequential: a colony in a cavity that is too small, too damp or too exposed will not survive the winter. Nobody is in charge of making it. The queen takes no part, and there is no individual in the cluster with an overview of the options.
- B** That the choice is made at all was established by Martin Lindauer in the nineteen-fifties. He noticed that some bees returning to a settled swarm were performing the waggle dance — the movement by which foragers advertise the direction and distance of a food source — but were coming back dusty rather than laden, and that following them led to holes in walls and hollow trees rather than to flowers. The dance was being used to advertise real estate.
- C** The detailed account came from Thomas Seeley, who worked for decades on an island off the coast of Maine with almost no natural cavities on it, so that every site available to a swarm was one he had built and could measure. A few hundred bees from each swarm act as scouts. A scout that finds a cavity spends up to an hour inspecting it, walking the interior surfaces and making short flights inside, and emerges having assessed its volume, the size and height of the entrance, and whether it is dry. Colonies do best in something near forty litres, and the scouts' preferences match that closely. The assessment is careful rather than casual: the estimate of volume a scout arrives at is accurate enough that swarms reliably reject a cavity half the size of the one they need, and do so without any means of measuring it directly.
- D** What she does on returning is the part that makes the system work. She dances, and the number of circuits she performs is proportional to how good she judged the site to be. A scout advertising an excellent cavity may dance a hundred circuits; one advertising a mediocre cavity may dance ten. Other scouts follow the dance, fly out, and assess the site for themselves rather than taking her word for it, which means a poor site cannot be talked up by an enthusiast.
- E** The second mechanism is subtraction. Each time a scout returns from a site she has already advertised, she dances for it less: the number of circuits falls by a roughly fixed amount on every trip, so her support for it dies out after a handful of visits unless she is replaced by new recruits. Support for a mediocre site therefore decays on its own, while support for a good one is renewed faster than it decays. Nothing has to be rejected. It simply runs out.
- F** The decision itself is not a consensus. Seeley found that scouts returning to a site count the other scouts present, and that when the number at one site reaches somewhere around fifteen or twenty simultaneously, that site is chosen — the scouts begin producing a signal that warms the whole

swarm for flight, and the cluster lifts off. A quorum is reached long before every scout has visited every option, which is why the choice takes hours rather than days. Counting is also easier than comparing. A scout has only to notice how crowded her own site has become, which requires no memory of anywhere else and no way of describing one place to another.

- G** A third mechanism was described later and is the one that surprised the field. A scout dancing for one site will approach a bee dancing for a different site, butt her with her head and produce a brief vibration, and the effect of this stop signal is to shorten the recipient's dancing. Bees inhibit competing options directly. Seeley's group, working with engineers and neuroscientists, pointed out that this is structurally the same as what happens in a primate brain making a decision between two targets, where populations of neurons excite their own option and inhibit the alternative, and that both systems avoid the same failure — deadlock between two nearly equal choices.
- H** The swarms get it right most of the time. In experiments offering a set of cavities of known quality, swarms chose the best available site in the large majority of trials, using a procedure in which no participant compares the options, no participant is informed of the outcome, and no participant is in a position to be wrong about more than the one cavity she has seen.

Questions 14–19

Reading Passage 2 has eight sections, A–H.

Choose the correct heading for sections A–C, E, G and H from the list of headings below.

Write the correct number, I–XII.

List of Headings

- i A decision with nobody making it
- ii A decision made by the queen
- iii Noticing that a familiar signal had a second use
- iv Noticing that a familiar signal had been misread
- v Measuring the site, and what the scouts prefer
- vi Measuring the swarm, and what the colony prefers
- vii Support that fades unless it is renewed
- viii Support that grows unless it is stopped
- ix Suppressing the alternative directly
- x Ignoring the alternative entirely
- xi How often the procedure gets it right
- xii How often the procedure is used

14 Section A

15 Section B

- 16** Section C
- 17** Section E
- 18** Section G
- 19** Section H

Questions 20–23

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

Match each statement with the correct researcher, **A–B**.

NB You may use any letter more than once.

List of Researchers	
A	Martin Lindauer
B	Thomas Seeley

- 20** He established that dancing bees were advertising places to live.
- 21** He worked at a site chosen because it had almost no natural cavities.
- 22** He identified the number of scouts at which a site is chosen.
- 23** He drew a comparison between the swarm and the brain.

Questions 24–26

Complete the sentences below.

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

- 24** A scout advertising an excellent cavity may dance as many as a hundred
- 25** Bees that follow a dance go and assess the site for themselves, so a poor site cannot be by an enthusiast.
- 26** A scout shortens another's dancing by butting her with her head and producing a brief

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

In defence of maintenance

The word innovation has not always been a compliment. For several centuries in English it meant something close to dangerous meddling: an innovator was a person introducing novelty into religion or government, and the term appeared mostly in accusations. Its transformation into a word that no organisation can now write a strategy without is recent, and it happened without anybody deciding it should.

The transformation matters because of what it has crowded out. Andrew Russell and Lee Vinsel have argued that the overwhelming majority of the people who work with technology do not invent it; they keep it running. There are far more people maintaining lifts, water mains, aircraft, roofs and software than there are designing new ones, and their work is what determines whether anything designed last decade is still doing anything today. That work is almost entirely absent from how technological progress is described, funded and rewarded. The imbalance shows in the language too. There is a word for the person who designs a system and a set of words for the person who keeps it running, and only the first of them is ever used as a compliment.

Some of the absence is a measurement problem. Innovation has convenient proxies — patents filed, products launched, firms founded, papers cited — and each can be counted and compared. Maintenance has none. A bridge that does not fall down generates no data point, and a water system that delivers water quietly for another year is not an event. The result is a literature in which the things that can be counted appear to be the things that matter, which is a general hazard rather than one peculiar to this field.

The rest of the absence is an incentive. A new hospital wing has a ribbon and a photograph; a replaced heating system has neither, and both come out of budgets that behave differently. Capital spending on something new is often easier to authorise than operating spending on something old, because the first can be presented as an investment and the second looks like a cost. Deferring maintenance therefore has an immediate benefit to whoever defers it and a delayed cost to whoever is in the post afterwards, which is a structure that reliably produces backlogs, and does.

It is worth being careful here, because the argument has an unattractive version, and the unattractive version is the one that usually gets made. Not everything old should be maintained. A maintenance case can be a way of protecting an arrangement that ought to be replaced, and appeals to keeping things running have been used to resist changes that were necessary and overdue. Somebody has to decide what is worth keeping, and that decision is not made easier by insisting that keeping is virtuous.

Nor is the argument against innovation, which would be silly. Antibiotics, water treatment, structural steel and the transistor were not maintenance. The claim is narrower: that a culture which describes only the new as progress will systematically underinvest in the conditions that let the new keep working, and

will then be surprised by the results. A society can be simultaneously very good at inventing things and very bad at owning them.

What follows is unglamorous, which is the recurring difficulty with this whole subject. Count it: require the deferred maintenance backlog to be stated in the same document as the capital programme, in the same units, so that a decision to build something new is visibly a decision about something old. Fund it on the same terms, so that a replacement is not disadvantaged against an addition by the accounting. And stop using innovative as a synonym for good, which is a habit of language that quietly does a great deal of budgetary work. None of these is difficult. Each is resisted, and the resistance is generally expressed as a concern about priorities, which is precisely the thing at issue.

The deepest version of the point is not about money. Almost everything that exists was made by somebody who is gone, and the question of what a generation owes to what it inherited is older than any technology. Maintenance is the form that obligation takes when the inheritance is physical. It is not conservative, since it makes no claim that the thing should never change. It is only the observation that a thing you have decided to keep requires somebody to keep it, and that this somebody has been made almost invisible by the way we have chosen to talk.

Questions 27–32

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 word innovation has always carried a positive meaning in English.
- 28** The writer argues that innovation has been harmful and should be discouraged.
- 29** Russell and Vinsel have proposed a method for measuring maintenance work.
- 30** The writer accepts that some things being maintained ought instead to be replaced.
- 31** The writer thinks capital budgets should be abolished.
- 32** The writer holds that describing maintenance as conservative is a mistake.

Questions 33–36

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

Endings

- A can be counted, while maintenance produces no data point.
- B benefits whoever defers it and costs whoever follows them.
- C can be used to protect something that ought to be replaced.
- D makes a decision to build visibly a decision about something old.
- E shows that new construction is always wasteful.
- F was invented to describe religious reform.
- G proves that counting is the wrong way to make decisions.

- 33 The proxies available for innovation
- 34 Putting off repair work
- 35 An appeal to keeping things running
- 36 Stating the maintenance backlog beside the capital programme

Questions 37–40

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

- 37 According to the passage, an innovator in earlier English was
 - A a person introducing novelty into religion or government.
 - B a person who repaired public works.
 - C a title given by a government.
 - D a rare and admired figure.
- 38 Why does the writer mention a bridge that does not fall down?
 - A To show that bridges are well maintained.
 - B To give an example of work that produces nothing to count.
 - C To argue that safety standards have improved.
 - D To explain why capital budgets exist.
- 39 The writer describes a society that invents well but maintains badly as
 - A impossible.
 - B a contradiction that will resolve itself.
 - C a state that can exist simultaneously.
 - D the inevitable result of capitalism.

- 40** Which of the following best states the writer's conclusion?
- A** New technology should be developed more slowly.
 - B** Maintenance is a form of the obligation owed to what was inherited.
 - C** Counting is the only reliable basis for public decisions.
 - D** Innovation and maintenance are the same activity.