

Academic Reading Paper 12

Concrete, Resistance and Marks

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 concrete that improves with age

Concrete is the most used manufactured material on earth and one of the least durable things people build with. A modern marine structure — a pier, a sea wall, a bridge footing — is designed for a service life of between fifty and a hundred years, and much of it does not reach that. Seawater carries chloride, chloride reaches the steel reinforcement inside, the steel rusts, rust occupies more space than steel, and the concrete is split from within by its own skeleton.

The Roman harbour works do not do this. Structures at Baiae and along the Italian coast have stood in the sea for two thousand years, and where they have failed it has usually been because somebody quarried them. That contrast was noticed a long time ago and explained lazily, with vague references to lost skills, until it became possible to drill the Roman material and look. The Roman engineers were not pursuing durability for its own sake either. Harbour concrete had to be placed into moving water, where a mixture that set slowly and tolerated being wet was worth a great deal more than one that reached full strength quickly on dry land.

The recipe was known in outline from Vitruvius, who wrote it down in the first century before Christ. The Romans mixed lime with volcanic ash from the region around Pozzuoli, near Naples, added chunks of volcanic rock as aggregate, and packed the mixture into wooden forms in the sea. What Vitruvius could not say was why it worked, and the assumption for most of the twentieth century was that the ash simply made a better version of the reaction that modern cement performs.

Drilled cores told a different story. A team led by Marie Jackson, publishing in 2017, found crystals growing in the Roman cement that have no business being there. Seawater percolating through the material had dissolved components of the volcanic ash and reprecipitated them as aluminous tobermorite and phillipsite, interlocking plates that grow into the pores and the cracks. In modern concrete, seawater is the agent of destruction. In this material it is a reagent, and the structure has been slowly strengthening for twenty centuries. The growth is concentrated where the material has cracked, which in a conventional structure is the weakest place and in this one is where the repair is happening.

A second mechanism was described in 2023. Roman mortar contains small white lumps of lime, which had been read for years as evidence of careless mixing. A group at MIT argued instead that they are deliberate: mixing with quicklime at high temperature leaves these clasts distributed through the matrix, and when a crack opens and water reaches one, it dissolves and recrystallises as calcium carbonate, sealing the crack. They tested it by cracking samples made both ways and running water through them. The samples with the lime clasts closed within two weeks. The samples without them did not close at all.

The obvious question is why nobody simply uses the Roman method, and the answer is that it would be a poor material for almost everything now built with concrete. It gains strength over years rather than days, and a construction schedule cannot wait. It contains no steel, so it cannot carry tension, which

rules out every beam, floor slab and tall frame in modern practice. And it depends on a particular volcanic ash that is not available in most of the world. There is also nothing in the method that solves the corrosion problem, for the plain reason that the problem does not arise in a material containing nothing that corrodes.

What the work is actually for is different, and it matters more than a replacement recipe would. Cement manufacture produces something like eight per cent of global carbon dioxide emissions, most of it from the chemistry of making lime rather than from the fuel. A concrete that lasted three times as long would cut that by cutting how often things are rebuilt, and both of the Roman mechanisms are candidates for being engineered into modern mixes rather than copied wholesale. The saving would not be in the mixing. It would be in the interval between demolitions, which is a quantity almost nobody costs when a structure is being designed.

There is a broader point in the sequence. The lime clasts were visible in every sample anybody had ever looked at, and were catalogued for a century as a defect. What changed was not the evidence but the question, which stopped being how closely the Romans approximated modern practice and became what they were doing that modern practice does not.

Questions 1–6

Complete the table below.

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

Two kinds of marine concrete		
	Modern	Roman
Designed life	between fifty and 1 years	still standing after two thousand years
What seawater does	carries chloride to the steel, which 2 and splits the concrete	dissolves the ash and grows new crystals
Key ingredient	Portland cement and steel reinforcement	lime plus volcanic 3
Self-repair	none	lumps of lime dissolve and recrystallise as calcium 4
Test result	cracks did not close	cracked samples closed within 5

Why not switch	—	gains strength over years, and carries no 6 because it contains no steel
----------------	---	---

Questions 7–13

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.

- 7** In modern marine concrete the reinforcement contributes to the failure of the structure.
- 8** Vitruvius explained why the Roman mixture resisted seawater.
- 9** Jackson's team found that seawater damages the Roman material more slowly than modern concrete.
- 10** The white lumps in Roman mortar had previously been thought to come from a particular quarry.
- 11** The MIT group tested their explanation by making samples with and without lime clasts.
- 12** Most of the carbon dioxide from cement manufacture comes from the fuel used to heat the kilns.
- 13** The white lumps had been noticed by researchers long before their function was understood.

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

Resistance came first

- A** The usual account of antibiotic resistance runs as a morality tale. Wonder drugs arrived, doctors and farmers used them carelessly, bacteria adapted, and the drugs stopped working. Every clause of that is true except the third, and the third is where the whole picture goes wrong. Bacteria did not adapt to antibiotics. They already had the genes, and what human use did was decide which of them would spread. The distinction is not pedantic. If resistance is created by use, careful use might prevent it. If it is selected by use, careful use can only slow the spread of something that is already there, which is a different target and a less comfortable one.
- B** The evidence for that is not subtle. In 2011 a Canadian group extracted DNA from bacteria recovered from permafrost sediments about thirty thousand years old and found genes conferring resistance to several classes of antibiotic, including one to which resistance is usually described as a recent development. A year later another team sampled bacteria from a cave system in New Mexico that had been isolated from the surface for four million years and had never encountered a human, let alone a prescription. Most of the strains they cultured were resistant to multiple antibiotics, and some to compounds that had been synthesised in a laboratory.
- C** This makes sense once the origin of the drugs is remembered. Most antibiotics are not inventions but discoveries: they are compounds that soil organisms make to compete with one another, and they have been doing it for a very long time. Any organism producing such a compound must be immune to it, and its neighbours are under continuous pressure to become so. The genes were in the world before the pharmacy was. So were most of the compounds. Several classes in clinical use are minor variations on molecules that soil bacteria have been making for tens of millions of years, which is roughly how long the arms race has been running.
- D** Alexander Fleming saw the consequence before most people had taken the first dose. Accepting the Nobel Prize in 1945 he warned that penicillin could be bought by anyone, that a man might give himself too little to kill the organisms while giving it enough to teach them, and that the man who died of a resistant infection contracted this way would have a death for which somebody was morally responsible. The clinical era of the drug was two years old.
- E** The laboratory had seen it even earlier. In 1940, before penicillin had been given to a single patient outside a trial, Edward Abraham and Ernst Chain reported an enzyme produced by a common gut bacterium that destroyed the compound. The paper attracted little attention, since there was as yet nothing to protect.
- F** What turns an ancient gene into a clinical crisis is that bacteria do not only inherit downwards. Genes travel sideways, on small loops of DNA that pass between cells and between species, so a resistance gene selected in an organism of no medical interest can appear the following year in one

that matters. This is why resistance to a new drug can emerge in several unrelated species at once, which no account based on separate mutations can explain. The loops often carry several resistance genes together, so pressure from one drug can select for resistance to others the organism has never encountered.

G Against all this the supply of new drugs has behaved strangely. Between the early nineteen-sixties and the turn of the century no new class of antibiotic effective against the harder group of bacteria reached the clinic at all — a gap of about forty years, in a period when almost every other area of medicine was transformed. The reason is not scientific difficulty alone. It is that an antibiotic is the only product a company can be asked to develop on the understanding that the health system will then try not to use it. Nor was the gap a matter of nobody looking. Screening programmes ran throughout it, and what they mostly returned were compounds already known or compounds too toxic to give to a person.

H That is a real contradiction rather than a rhetorical one. A new antibiotic is valuable precisely because it is held back for the infections nothing else will treat, so the volume that would repay the development is the volume nobody wants sold. Several small firms that succeeded in getting a new antibiotic approved went bankrupt shortly afterwards. The remedies now being tried decouple the payment from the quantity: a health service pays a fixed annual sum for access to a drug regardless of how many doses it uses, which is an odd arrangement and a rational one.

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** an explanation of why resistance can appear in several species at the same time
- 15** a warning issued before most people had used the drug
- 16** a reason why the drugs' effects were already present in nature
- 17** a description of samples taken from a place cut off from the surface
- 18** an account of why a successful product can ruin its maker

Questions 19–22

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

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

NB You may use any letter more than once.

List of People

- A** Alexander Fleming
- B** Abraham and Chain
- C** the Canadian permafrost team

- 19** He said that a person underdosing themselves would be teaching the bacteria.
- 20** They described an enzyme that destroyed the drug before any patient had received it.
- 21** They recovered resistance genes from material tens of thousands of years old.
- 22** He attached moral responsibility to a death from a resistant infection.

Questions 23–26

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

- 23** The writer says the usual account of resistance is wrong because
 - A** antibiotics were never effective.
 - B** bacteria already carried the genes before the drugs were used.
 - C** farmers were not responsible for any of it.
 - D** resistance has not in fact increased.
- 24** The cave in New Mexico had been isolated for
 - A** thirty thousand years.
 - B** four million years.
 - C** forty years.
 - D** two thousand years.
- 25** Why did the 1940 paper attract little attention?
 - A** Its authors were unknown.
 - B** The enzyme could not be isolated.
 - C** There was nothing yet that needed protecting.
 - D** Penicillin had already failed in trials.

- 26** The writer describes the new payment arrangements as
- A** unworkable in practice.
 - B** strange but sensible.
 - C** a temporary measure.
 - D** the cause of the discovery gap.

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

What a grade does

Marks are younger than most people assume. For most of the history of universities, a student was examined aloud, in front of people who already knew them, and the outcome was reported as a description. The practice of reducing a performance to a number on a scale is usually traced to Cambridge at the end of the eighteenth century, where a tutor named William Farish is credited with introducing quantitative marking, and to Yale, which was using a four-point scale from the seventeen-eighties. Whatever the exact first instance, the technique is about two hundred and thirty years old, and it arrived as an administrative convenience rather than as an educational theory.

That origin explains what a grade is good at. It compresses a body of work into one symbol so that the symbol can be moved around: compared with another student's, added to others, sent to an institution that will never see the work itself. Nothing else does that job. An examiner's paragraph about a piece of writing cannot be averaged, cannot be ranked, and cannot be read by an admissions office processing forty thousand applications. The grade is a compression format, and like every compression format it is defined by what it throws away.

What it throws away is the reason for it, which would be tolerable if the compression were free. There is reasonable evidence that it is not. In a study by Ruth Butler in the late nineteen-eighties, schoolchildren were given a task and then received one of three kinds of response: written comments alone, a grade alone, or both. The children who received comments alone improved on the next task. Those who received grades did not, and — this is the part that unsettles teachers — neither did those who received comments and a grade together. The grade appeared to absorb the attention that the comments needed. The finding is not that children dislike marks. It is that the presence of a mark seems to change what a comment is for, turning it from an instruction into an explanation of the number.

A plausible explanation is that the two things point a student in different directions. A comment is about the work and invites a question about how to do it better. A grade is about the student and invites a question about how they compare. Once the second question is available, it is more interesting, and it is answerable immediately, whereas the first requires effort with no closure. Nobody in this account is being lazy. The signal is simply louder.

It would be easy to run from here to the conclusion that grading should be abolished, and it is worth stopping, because the argument against grades is usually made by people who are not the ones it would cost. Places at universities are scarce, jobs are scarce, and something has to allocate them. A system with no comparable signal does not become a system in which merit is invisible; it becomes one in which merit is assessed by reputation, by the name of a school, by a letter from somebody the admissions tutor happens to know. Those channels are not more accurate than a grade. They are considerably less available to people without connections, which is precisely why the examination and the mark were introduced in the first place.

The useful question is therefore not whether to grade but how often, and for what. A grade is a certification, and certification is needed at the point where an allocation is made. A comment is feedback, and feedback is needed continuously while the work is being learned. Most institutions attach the two together and deliver both at every stage, which gives the certification a frequency it does not need and gives the feedback a competitor it cannot survive.

Separating them is not difficult and has been done. Work can be commented on without a mark for most of a course, with grading reserved for the assessments that certify. Marks can be withheld until comments have been read and responded to, which some departments enforce by releasing the two on different days. Both arrangements are administratively duller than the alternative and both produce measurably more engagement with the comments, which is the entire object of writing them. The objection raised to them is almost never that they fail. It is that they require somebody to hold two pieces of information apart for a fortnight, and institutions prefer to do everything at once.

The deeper point is that a grade is not a measurement of a student. It is a measurement of a performance, in a format designed for transport rather than for accuracy, and it was adopted because it made a bureaucracy possible. That is a perfectly respectable reason for a thing to exist. It is not a reason to organise learning around it.

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** Marking on a numerical scale has been standard practice for most of the history of universities.
- 28** The writer thinks grading should be abolished.
- 29** Butler's study has been repeated in other countries.
- 30** The writer accepts that some allocation of scarce places requires a comparable signal.
- 31** The writer believes examinations should be replaced by continuous assessment.

Questions 32–36

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

List of Words

- A convenience
- B theory
- C compression
- D expansion
- E comments
- F grades
- G certification
- H feedback
- I reputation
- J accuracy

What the mark is for

Quantitative marking arrived as an administrative **32** rather than as an educational idea, and it works as a form of **33**, defined by what it discards. Butler's study suggests that a mark delivered alongside written **34** removes the benefit those would otherwise have. The writer's proposal is that a mark belongs at the point of **35**, while **36** is needed continuously while something is being learned.

Questions 37–40

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

Endings
A cannot be averaged, ranked or read at scale.
B invites a student to ask how they compare rather than how to improve.
C would be assessed instead by reputation and connections.
D produce more engagement with the comments than the usual arrangement.
E show that grading has no effect on learning at all.
F were introduced to make examinations shorter.
G prove that comments are unnecessary.

- 37 An examiner's written paragraph
- 38 A grade, unlike a comment,
- 39 Merit in a system with no comparable signal
- 40 Arrangements that separate marks from feedback