

Academic Reading Paper 11

Gears, Feathers and Filters

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 machine from the wreck

In the spring of 1900 a boat of Greek sponge divers, sheltering from a storm off the small island of Antikythera, put a man over the side to see what was below. He came up describing a slope of bodies, which turned out to be bronze and marble statues from a ship that had sunk there some two thousand years before. The salvage that followed produced the finest haul of ancient sculpture recovered from the sea, and among it, unremarked for months, a corroded lump about the size of a large book. When it dried it split, and inside were the teeth of a bronze gearwheel.

Nothing like it was supposed to exist. The technology of the ancient Mediterranean was understood to include the lever, the screw and the water-wheel, and to stop well short of the precise interlocking gear trains that appear in Europe in the fourteenth century. The obvious conclusions were that the object had fallen into the wreck later, or that it was not what it appeared to be, and both were argued for decades by people who had not looked closely. The position was easier to hold than it should have been, because nobody could see inside the fragments, and the object was too fragile and by then too famous to be taken apart to find out.

What survives is eighty-two fragments, containing at least thirty gearwheels cut from a single sheet of bronze, with teeth filed by hand at about a millimetre and a half apart. The first sustained attempt to understand it was made by Derek de Solla Price, who X-rayed the fragments and published his account in 1974. He established the essential point: the object is a mechanism in which a single input drives many outputs at different rates, which is to say a calculating machine, and it was made somewhere around the second century before Christ.

The reading of the details had to wait for equipment nobody could carry. In 2005 a team led by Tony Freeth and Mike Edmunds arranged for an eight-tonne microfocus computed-tomography machine to be built and shipped to Athens, so that the fragments could be scanned without moving them out of the country. The scans resolved the tooth counts on gears buried inside the corrosion and, with a separate imaging technique that lights a surface from many angles in turn, more than doubled the amount of readable Greek text on the plates.

What the machine did can now be described with some confidence. A hand crank on the side turned a main drive wheel. On the front face, two concentric scales carried pointers: an outer ring divided into the twelve signs of the zodiac, and inside it a ring of three hundred and sixty-five days for the Egyptian calendar, which could be rotated to correct for the quarter-day the calendar ignored. Pointers showed the positions of the sun and moon, and a small ball, silvered on one side and blackened on the other, rotated to display the phase.

The back was where the difficult astronomy was. Two spiral dials were cut into the plate. The upper one runs through two hundred and thirty-five cells in five turns, which is the Metonic cycle: two hundred and thirty-five lunar months fit almost exactly into nineteen solar years, so a pointer travelling that spiral reconciles the two calendars. The lower spiral has two hundred and twenty-three cells, the Saros cycle, after which the sun, moon and earth return to nearly the same alignment and the pattern of eclipses repeats; small inscribed glyphs on that dial predict the eclipses themselves. A subsidiary dial named the four-yearly games, including the Olympiad.

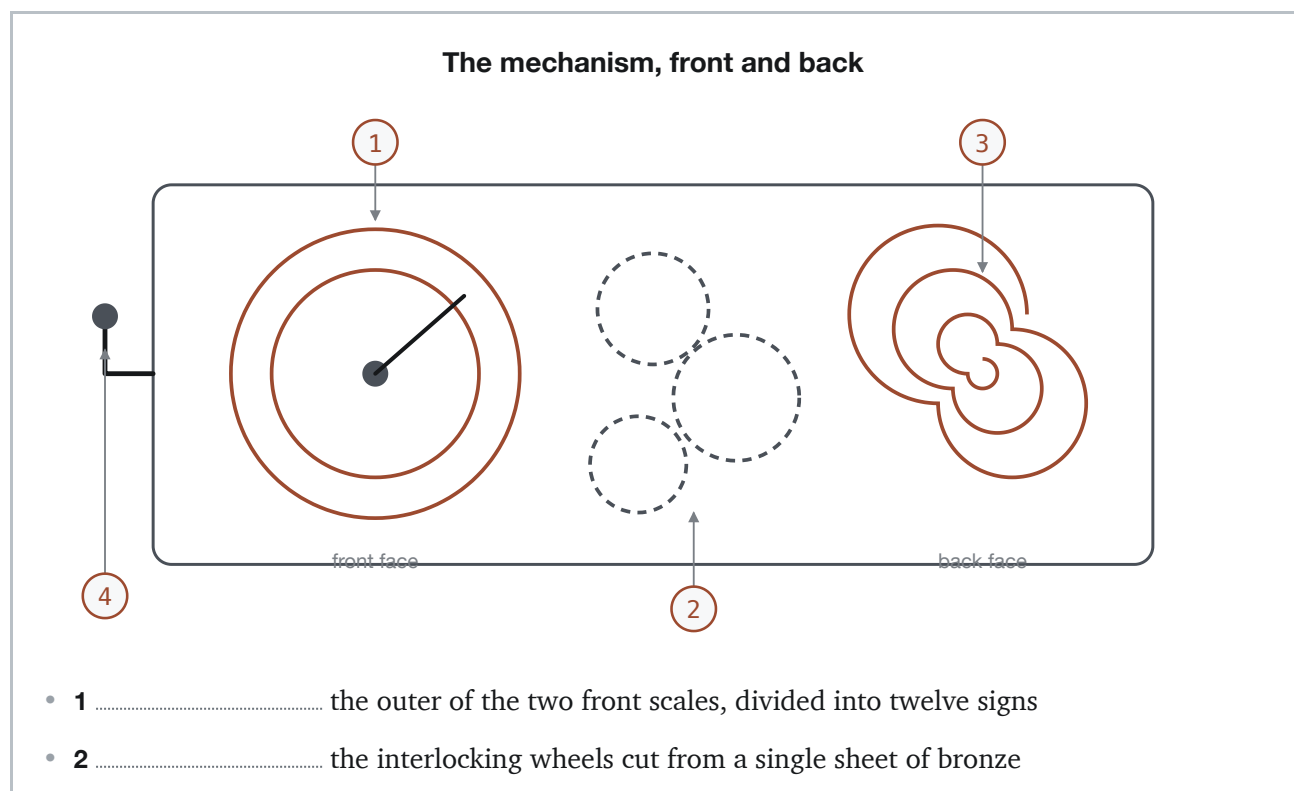
One detail is admired more than any other. The moon does not move at a constant rate against the stars, and the mechanism reproduces the variation using a pin on one gearwheel running in a slot cut into another, mounted slightly off-centre, so that the second wheel speeds up and slows down through each revolution. That is a mechanical solution to a problem in observational astronomy, built by somebody who understood both.

The uncomfortable part of the story is what comes next, which is nothing. No object of remotely comparable complexity survives from the following thousand years, and no text describes one clearly enough to be certain it existed. Whether the mechanism was a singular achievement or the one survivor of a tradition that left no other trace is not something the evidence can settle, and it is the question everybody who works on it is really asking. It is not a comfortable one for a discipline that reconstructs the past out of whatever happens to have lasted.

Questions 1–4

Label the diagram below.

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



- 3 the shape of each of the two dials on the back
- 4 what the operator turned to drive the whole mechanism

Questions 5–9

Complete the notes below.

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

What the dials counted

The front

- Pointers show the positions of the sun and the moon.
- The inner ring of 365 days is the 5
- A small ball, silvered on one side, shows the moon's 6

The back

- The upper spiral has 235 cells and reconciles the lunar month with the 7 year.
- The lower spiral has 223 cells and its inscribed glyphs predict 8

The clever part

- The moon's changing speed is reproduced by a pin running in a 9 cut into another wheel.

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 Eighty-two gearwheels have survived from the mechanism.
- 11 Price established that the object was a calculating machine before its tooth counts could be read.
- 12 The scanning equipment was built more cheaply than the team had expected.
- 13 Objects of similar complexity survive from the centuries after the mechanism was made.

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

What colour was a dinosaur?

- A** For most of the history of the subject, the colour of an extinct animal was treated as permanently unknowable, and the illustrations in books were understood to be inventions. An artist would look at a skeleton, decide whether the creature seemed more like a lizard or a bird, and choose accordingly; the greens and browns that fill a century of dinosaur books are a record of that decision and of nothing else. There was no dishonesty in it. There was simply no evidence, and everybody said so.
- B** The evidence turned out to have been sitting under microscopes for thirty years, misidentified. Fossil feathers and skin sometimes preserve dense fields of microscopic bodies about a thousandth of a millimetre long, and these had been described repeatedly as fossilised bacteria — the residue of decay rather than of the animal. In 2008 Jakob Vinther, examining a Cretaceous feather, argued that they were nothing of the kind. They were melanosomes: the organelles that carry melanin pigment, which are found in the feathers of living birds and which survive fossilisation because melanin does.
- C** That reidentification mattered because melanosome shape is not arbitrary. In living birds the organelles carrying black and grey pigment are elongated, like short sausages, while those carrying reddish-brown pigment are close to spherical, and the relationship is consistent enough across species to be used in reverse. A fossil field of elongated bodies indicates a dark feather; a field of spheres indicates a rufous one. The inference runs from a shape that can be measured to a colour that cannot.
- D** The first full reconstruction followed quickly. In 2010 a team working on *Anchiornis huxleyi*, a small feathered dinosaur from China, sampled melanosomes from dozens of points across a single specimen and mapped the results onto the body. The animal came out predominantly grey, with black-and-white banding across the wings and a rufous crest on the head. Another group, working on *Sinosauropteryx* in the same year, reconstructed a tail banded in ginger and white. These were not artists' impressions. They were measurements with error bars. The two reconstructions also agreed with one another in a way that mattered: applied by different groups to different animals, the method produced patterns — bands, crests, contrasts between one body region and the next — rather than the uniform colouring that an artefact of preservation would be expected to give.
- E** The claim did not go unopposed, and the objection was serious rather than reflexive. Theagarten Lingham-Soliar argued that the microscopic bodies could still be bacteria, or the remains of collagen fibres broken down, and that the resemblance to melanosomes was being assumed rather than demonstrated. The reply that carried the field was not about the bodies themselves but about their

arrangement: bacteria colonising a carcass would not align themselves with the internal structure of a feather, and would not be distributed in patterns that stop and start at the boundaries between one part of the animal and another. A banded tail is not a bacterial preference.

- F** There are limits, and they are worth stating because the popular accounts tend not to. Only melanin-based colours can be read this way. The reds and yellows that many living birds obtain from carotenoids in their food leave no structure behind at all, and neither do most blues, which in birds are produced not by pigment but by the way light scatters in the tissue. A dinosaur reconstructed as grey and rufous may have been grey and rufous. It may also have carried colours the method cannot see.
- G** A separate caution comes from the artists rather than the chemists. Mark Witton and John Conway have pointed out that palaeoart has a habit of shrink-wrapping: drawing the skin tight over the bones so that every ridge and socket shows, which is not how living animals look. A hippopotamus reconstructed by that convention from its skeleton alone would be unrecognisable. Fat, muscle bulk, loose skin and display structures leave little or no trace, and their absence from a fossil is not evidence of their absence from the animal.
- H** Taken together the two cautions point the same way. The colour work is a genuine advance, and it has converted a question everybody agreed was unanswerable into one with partial answers and stated uncertainties. What it has not done is make the pictures true. It has made a specific and limited part of them evidence-based, which is a smaller claim and a much more useful one.

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 century of honest guessing
- ii A century of deliberate invention
- iii Evidence that had been misread
- iv Evidence that had been destroyed
- v Why the shape of the structure matters
- vi Why the size of the structure matters
- vii An objection, and the reply that answered it
- viii An objection that was never answered
- ix A warning from the illustrators
- x A warning from the chemists
- xi What the method has and has not achieved
- xii What the method will achieve next

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–C.

NB You may use any letter more than once.

List of Researchers

- A Jakob Vinther
- B Theagarten Lingham-Soliar
- C Witton and Conway

20 He argued that structures long taken for bacteria were pigment-carrying organelles.

21 He maintained that the identification had been assumed rather than shown.

22 They warned that reconstructions cling too closely to the skeleton.

23 He suggested the microscopic bodies might be broken-down collagen.

Questions 24–26

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

List of Words

- A** shape
- B** size
- C** arrangement
- D** abundance
- E** carotenoids
- F** melanin
- G** scattering
- H** fat

What can and cannot be recovered

The method works because melanosomes survive fossilisation and because their

24 indicates which pigment they carried. The objection that they were bacteria was answered by pointing to their **25** within the feather and across the body.

What cannot be recovered are colours produced by **26** in the diet, and most blues, which are produced by the scattering of light rather than by pigment at all.

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

The trouble with talent

In 1985 three Canadian researchers looked at the birth dates of players in junior ice hockey leagues and found something that should not have been there. The players were not born evenly through the year. They were bunched into the first months of it, and the bunching was severe: in the most selective leagues, roughly four times as many players had been born in the first quarter of the selection year as in the last. Nothing about January makes a better hockey player. What January does is make a child eleven months older than a teammate born in December, in a system that puts them in the same age group and then chooses between them.

The mechanism is not mysterious and it compounds. At nine, an eleven-month advantage in growth is a large advantage in size, coordination and confidence. The bigger child is picked for the better team, where the coaching is better, the practice is more frequent and the games are harder. A year later the gap in ability is real rather than developmental, and it now has a cause that has nothing to do with the birthday. Selection has manufactured the difference it believed it was detecting. The effect has since been found in football, in tennis, in cricket and, at smaller magnitudes, in school examination results across a great many countries.

It is worth being careful about what this shows, because the argument is often overstated in both directions. It does not show that ability is entirely made. Individual differences are real, they are visible early in some domains, and no serious account of expertise denies them. What it shows is narrower and more awkward: that a selection system with a fixed cut-off date will systematically mistake maturity for aptitude, and that everything downstream of the selection will then confirm the mistake.

The wider argument about how far practice accounts for expertise has been running for thirty years and has not been settled. Anders Ericsson's work on violinists in the early nineties established that the best performers had accumulated far more hours of focused, effortful practice than the good ones, and the finding was popularised into a claim that practice was very nearly everything. A later meta-analysis by Brooke Macnamara and colleagues, pooling a large number of studies, put the proportion of variation in performance explained by practice at around a fifth to a quarter in music and sport, and considerably less in some other fields. Practice matters greatly and does not matter exclusively.

But the disagreement about that proportion is less interesting than it looks, because it is not what the word talent is doing in ordinary use. When a coach or an examiner or a hiring committee says a person is talented, the statement is almost always made after the fact, about somebody who has already been selected, already been trained, and already been given opportunities that were not equally available. The word describes the output of a process while appearing to describe an input to it.

Once that is seen, the biases in the process become the interesting question, and they are knowable. Birth month is one. Family income is a larger one, because early specialised coaching is expensive and unevenly distributed. Proximity matters: a child two hours from the nearest good coach in their sport is not in the system at all. Early specialisation itself is a bias, since it selects for children who happened to encounter the activity young, and there is reasonable evidence that late specialisers do better in the long run in several sports. None of these is a hypothesis about human nature. Each is a measurable property of a selection system, and each can be checked in the records that system already keeps.

What follows is a set of practical changes rather than a philosophy. Band children by developmental stage rather than by birth year, which is harder administratively and removes the effect almost entirely where it has been tried. Judge candidates on rate of improvement rather than current level, since improvement is far less contaminated by starting advantages. Select later, and select more than once, so that a single assessment at a single age is not disposing of people. Where selection must be early, keep the door open afterwards.

None of this is an argument that everybody is the same, and it should not be read as one. It is an argument that the word talent, as used, is doing a job it is not fit for. It converts the result of a filter into a property of a person, and it does so in a way that quietly removes the filter from the discussion. Whatever is or is not innate, the filter is ours, we built it, and it can be built differently.

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** Ericsson himself claimed that practice accounted for almost all of expert performance.
- 28** The writer thinks differences between individuals are largely invented by selection.
- 29** The relative age effect has been studied more thoroughly in hockey than in other sports.
- 30** The writer accepts that selecting people later would be administratively harder.
- 31** The writer believes competitive sport should be organised without any selection at all.
- 32** The writer holds that the word talent describes an outcome while appearing to describe a cause.

Questions 33–36

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

- 33** In the 1985 study, players born in the first quarter of the selection year
- A outnumbered those born in the last quarter by about four to one.
 - B made up about a quarter of the players.
 - C were about eleven months older than the average player.
 - D performed four times better than the others.
- 34** According to the passage, the Macnamara meta-analysis found that practice explains
- A almost all of the variation in music and sport.
 - B roughly a fifth to a quarter of the variation in music and sport.
 - C none of the variation in any field.
 - D more in education than in sport.
- 35** Why does the writer mention the distance to a coach?
- A To show that coaching quality varies between regions.
 - B To give an example of a knowable bias in the selection process.
 - C To argue that rural children are more determined.
 - D To explain why early specialisation is expensive.
- 36** Which of the following best expresses the writer's conclusion?
- A Innate ability plays no part in expert performance.
 - B Practice is the only factor that can be changed.
 - C The selection filter is something we designed and can redesign.
 - D Talent should be measured earlier and more often.

Questions 37–40

Complete the sentences below.

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

- 37** The writer says that selection has manufactured the difference it believed it was
- 38** A system with a fixed cut-off date will mistake maturity for
- 39** The writer proposes judging candidates on their rate of rather than on their current level.
- 40** Banding children by developmental stage removes the effect almost entirely where it has been