Write an analysis on each of the texts. It is not compulsory for you to address the guiding questions in your answers.

TEXT A

[20 marks]

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NATURE | EDITORIAL

A question of time

Timekeeping is boosted by the advent of an optical clock based on strontium atoms.

22 January 2014

When the history of the twenty-first century comes to be written, one of the most puzzling questions asked will be why, well into the information age, millions of people still paid to dial a number on their phone to find out the time. Almost 80 years after its formation, the UK speaking clock, the world's original telephone time service, remains an essential part of British life. This is despite the near ubiquity of time displays — not least on the mobile phones that people discard to call 123 from a fixed line.

For some people, at some times, accuracy matters. Peaks in the use of the speaking clock come, for instance, on New Year's Eve, or when the clocks are put forward and back by an hour to mark, respectively, the start and end of British Summer Time.

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- Precise atomic clock may redefine time
- Atomic clocks use quantum timekeeping

There is another way, at least in Britain. BBC Radio regularly broadcasts the same time signal used to set the speaking clock — affectionately known as the pips. Indeed, it has become as much a feature of some shows as the content planned around it. Time is more than a British institution; it is woven into the cultural fabric of everyday life.

The pips are drawn from an atomic clock held at the National Physical Laboratory (NPL) in Teddington, near London. One of the most accurate in the world, the NPL clock is tuned to the regular bursts of light emitted by caesium atoms when they are excited by microwaves. The clock would lose roughly one second every 138 million years — a sufficient degree of accuracy for a bleary-eyed hour-late commuter who forgot to set their clock the night before, but not accurate enough for some.

In a paper published on *Nature*'s website this week, time lords in the United States describe the latest

advance in chronometry, and one that is as superior to the atomic pips as those pips were to the mechanical devices they replaced (B. J. Bloom *et al. Nature*http://dx.doi.org/10.1038/nature12941; 2014). The researchers have built a timepiece based not on caesium but on strontium. More importantly, it uses much higher, optical frequencies. This gives such devices, called optical clocks, greater accuracy than those that rely on microwaves. The new optical clock, for example, would not lose one second even if it were to run for 5 billion years.

It is also extremely stable — another key measure of timekeeping. (Accuracy defines how closely a clock's output matches the desired time signal, whereas stability is a measure of how steady that output is. A clock that loses precisely one second each day is inaccurate but stable, for example.)

The unveiling of the super-accurate strontium optical clock comes just a few months after a related group revealed a device based on ytterbium. Other laboratories across the world have their own designs. Inevitably, the increased precision and reliability of optical clocks are fuelling debate about whether they could be used to set the ultimate time, and redefine the second. (There are no official plans to do so, but plans are afoot to redefine other SI units.) These are heady times for metrology: a World View on page 455 describes attempts to measure another fundamental constant: Big *G*.

Nature has a particular stake in the race to develop new atomic clocks. Back in January 2003, we published a News Feature that surveyed the scene and tried to predict what would happen (D. Adam *Nature* **421,** 207–208; 2003). Within a decade, the piece suggested, optical clocks could rise to prominence and raise fresh debate about the definition of the second. A ten-year event horizon is a staple of scientific journalism, and most promised breakthroughs fail to materialize on deadline. The latest development in atomic timekeeping, by contrast, has arrived bang on time. Well, almost.

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In what ways does the use of language in this article help to interest and entertain the reader?