Exame de Proficiência em Língua Inglesa

Período 2019.2

Data: 03/12/2019

*Read the text bellow and answer the following questions:

<u>TEXT 1:</u> **Half of the 2019 Nobel Prize in Physics was awarded to James Peebles "for theoretical discoveries in physical cosmology" and the other half is shared by Michel Mayor and Didier Queloz "for the discovery of an exoplanet orbiting a solar-type star"**

When we look at the night sky, we see not only the Moon but hundreds or thousands of stars — maybe even one of the brighter planets in our Solar System. It's hard to grasp that this visible matter makes up a mere five per cent of our Universe. With the remainder thought to be dark matter and dark energy, we seem to know little about the Universe. However, to honour the knowledge that we have, this year's Nobel Prize in Physics was awarded to James Peebles, Michel Mayor and Didier Queloz "for [their] contributions to our understanding of the evolution of the Universe and Earth's place in the cosmos".

An early indication for the origin of our Universe was the suggestion by Robert Dicke, James Peebles, Peter Roll and David Wilkinson that the cosmic microwave background could originate from a hot Big Bang. But this would not remain Peebles's only important contribution to modern cosmology. Throughout his career, many more publications ranging from the cosmic microwave background to galaxy formation followed.

One of his most notable works, carried out jointly with Jeremiah Ostriker, was the discovery that large amounts of dark matter must be present in the halo of spiral galaxies such as the Milky Way as otherwise the flat galactic disk would be unstable. In 1982, Peebles's studies of non-relativistic or cold dark matter (CDM) laid the foundations for the standard model of cosmology — the ΛCDM model. Apart from standard baryonic matter, this model incorporates CDM and dark energy associated with the cosmological constant Λ, which Peebles put back on the map after its famous dismissal by Albert Einstein.

Whereas Peebles shaped our current understanding of how galaxies and galaxy clusters form, Mayor's and Queloz's discovery influenced our knowledge of planet formation. When the two started their monitoring campaign, planets outside our Solar System (exoplanets) orbiting a pulsar had been discovered, but not in orbit around a solar-type star. Periodic variations in the radial velocity of the star 51 Pegasi revealed such a planetary companion, 51 Pegasi b. The exoplanet's mass was estimated to be at least half of Jupiter's — a puzzling observation in light of the short orbital period of around four days.

The discovery of 51 Pegasi b posed a riddle to planet formation as its separation from 51 Pegasi was too small for the planet to be Jupiter-like. The authors speculated that the exoplanet might have been formed from a stripped brown dwarf. Since Mayor's and Queloz's observations, thousands of exoplanets have been discovered and continue to inspire advances in planetary formation models.

Despite this huge leap in understanding of our Universe, plenty of discoveries are still waiting to be made — from the exact process of planet formation to figuring out what dark matter is made of. Whatever we'll find along the way, we know that it all started with the Big Bang.

1) Mark the alternative(s) that is (are) CORRECT, according to TEXT 1 (more than one alternative can be marked):

a) Visible matter constitutes most of the content of our Universe.

b) The prediction of the Cosmic Microwave Background radiation was Peebles's only important contribution to Modern cosmology.

c) The ΛCDM model takes into account cold dark matter, dark energy and baryonic matter.

d) Michel Mayor and Didier Queloz shared alone the 2019 Nobel Prize in Physics for the discovery of an exoplanet orbiting a solar-type star

e) The mass of the exoplanet discovered by Mayor and Queloz was as big as the one of the planet Jupiter.

2) Mark the alternative(s) that is (are) INCORRECT, according to TEXT 1 (more than one alternative could be marked):

a) 51 Pegasi b was the exoplanet discovered to be the planetary companion of the star 51 Pegasi.

b) In the ΛCDM model the cold dark matter is associated with the cosmological constant.

c) James Peebles alone won half of the 2019 Nobel Prize in Physics for theoretical discoveries in Cosmology.

d) Cold dark matter is a relativistic matter.

e) Only few discoveries need to be made to complete the understanding of our Universe.

3) What is the main idea of TEXT 1?

a) All we know about the evolution of our Universe and the existence of other planets (exoplanets) is that it all started with the Big Bang.

b) The are planets orbiting a solar-type star outside our Solar-System.

c) The existence of dark matter and dark energy in our Universe, besides the standard baryonic matter.

d) The 2019 Nobel Prize in Physics for both the understanding of the dynamics and contents of our Universe and the existence of planets (exoplanets) outside our Solar System.

e) The complete understanding of our Universe.

4) Write down (in English) an adequate title for the text above. The title must contain a minimum of *five* words and a maximum of *ten* words.

5) If you were asked to classify the subarea(s) of the research(s) described in TEXT 2, which one would you choose?

a) General relativity e astronomy

b) Cosmology and astronomy

c) Quantum field theory and cosmology

d) Quantum mechanics and astronomy

e) Biophysics and quantum field theory

*Consider the text below to answer the following questions:

TEXT 2: A vacuum as described by quantum mechanics is perhaps the most fundamental but mysterious state in physics. The discovery of correlations between electric-field fluctuations in such a vacuum represents a major advance.

A surprising result in quantum mechanics is that a vacuum is not empty. Particles can appear out of nothing for very short periods of time. This phenomenon can be understood as a consequence of the energy–time uncertainty principle, whereby restriction of a measurement to an extremely short time interval leads to large fluctuations in energy in the interval. Although indirect effects of these 'virtual' particles are well studied, it is only by probing a vacuum on very short timescales that the particles become 'real' and can be directly observed. But do these particles appear completely randomly, or are they correlated in space and time?

One way to measure correlations in fields is through interference, such as in the double-slit experiment of British physicist Thomas Young. In this experiment, light waves pass through two slits and interfere with each other to produce an interference pattern on a screen. This simple, but profound, experiment was originally developed to probe wave effects and was later used to illuminate the duality between particles and waves in quantum physics. In the past, variations of the double-slit experiment have been realized for photons, electrons, atoms

and large molecules. Current attempts are even looking for multipath interferences for biological objects, such as viruses.

6) According to TEXT 2, it is correct to say that:

a) Quantum vacuum does not exist.
b) The double-slit experiment revels the absence of interference patterns in light waves.
c) The uncertainty principle allows particles to be created out of nothing for very shot periods of time.
d) The quantum vacuum is completely empty.
e) The discovery of electric-field correlations is not important.

7) Write down (in English) an adequate title for TEXT 2. The title must contain a minimum of *five* words and a maximum of *ten* words.

8) If you were asked to classify the subarea of the research described in TEXT 2, which one would you choose?

a) General relativity
b) Cosmology
c) Quantum field theory
d) Quantum mechanics
e) Biophysics

*Consider the text below to answer the following questions:

<u>TEXT 3:</u>The cosmic microwave background (CMB) consists of residual light from the Big Bang that permeates all space. The photons comprising this almost-uniform radiation background are the universe's oldest, having journeyed nonstop for nearly 14 billion years.

The CMB offers a powerful way to study the cosmos, and astronomers have scrutinized it with steadily mounting precision ever since its discovery a half-century ago. The results have been consistent with "cosmic inflation," a 1979 theory positing that the universe underwent a brief period of explosive growth in its earliest moments after the Big Bang. This violent expansion supplied the driving force behind the Big Bang, laying the foundation for the galaxies and other celestial structures we see today.

But scientists want proof. Theorists predict that the inflationary burst would have unleashed gravitational waves that would, in turn, leave an imprint in the CMB's light taking the form of a faint, swirling pattern called B-modes. This is the telltale signature of inflation that astronomers now seek — and that they had thought, initially, they'd found in 2014.

The measurement, however, is extremely challenging: Investigators look for tiny variations in the CMB, on the order of 1 part per 100,000. Our views of the Big Bang's vestigial light, moreover, are obscured by sources from our own galaxy: the dust and so-called synchrotron emissions from cosmic rays.

Astronomers need to map out these "foreground" sources in excruciating detail to separate them from useful signals. The BICEP group's current strategy is to employ multiple telescopes tuned to various frequencies of light — in this case 95, 150, 215 and 231 GHz — whereas the BICEP2 results unveiled in 2014 were based on measurements at just one frequency, 150 GHz. "By measuring at different frequencies, you can see what gets brighter at higher frequencies [dust] and what gets dimmer at lower frequencies [synchrotron radiation]," explains Kovac. "What stays uniform is the CMB itself."

Today’s enhanced BICEP search uses five additional linked telescopes, each comparable to BICEP2, located at the Keck Array a couple of hundred yards away. The telescopes continuously move back and forth over the same small patch of sky, looking for minute deviations from average. More detectors means more data, which, in turn, leads to a greater ability to discern subtle patterns.

9) According to TEXT 3, it is INCORRECT to affirm that:

a) CMB is the oldest radiation ever detected in the Universe.

b) It is predicted that gravitational waves from inflation leave an imprint on CMB.

c) Gravitational waves produced by the onset of inflation have been detected.

d) The BICEP group uses more than one telescope to try to detect gravitational waves from inflation.

e) It is necessary to separate foreground sources from the true gravitational waves signals.

10) If you were asked to classify the subarea of the research described in TEXT 2, which one would you choose?

a) General relativity

b) Gravitational wave astronomy

c) quantum field theory

d) general relativity

e) cosmology

11) Write down (in English) an adequate title for TEXT 3. The title must contain a minimum of *five* words and a maximum of *ten* words.

12) After reading TEXTS 1, 2 and 3, use few statements (in English) to express your opinion about which related research you considered more relevant.