UPSC Essentials | Daily subject-wise quiz : Science and Technology MCQs on Polar Satellite Launch Vehicle, HeLa cells and more (Week 111)

Are you preparing for UPSC CSE Prelims? Check your progress and revise your topics through this quiz on Science and Technology.

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With reference to the Hoyle–Narlikar theory of gravity, consider the following statements:

1. Mach's principle states that the mass of every object in the universe is affected by its interaction with every other object was central to the Hoyle-Narlikar gravity theory.

2. Einstein was greatly inspired by the principle and incorporated it into his theory.

3. The Hoyle-Narlikar theory of gravity proposed a "creation field" (C-field), a hypothetical negative-energy field responsible for the continuous creation of matter.

Which of the statements given above is/are correct?

(a) 1 and 2 only

(b) 2 only

(c) 2 and 3 only

(d) 1, 2 and 3

Explanation

— Jayant Narlikar, an eminent Indian astronomer, science communicator, and Padma Vibhushan recipient, died at the age of 87.

— He was best known for proposing the Hoyle-Narlikar theory of gravity (also known as conformal gravity), which he developed in 1964 with English astronomer and professor Fred Hoyle. The hypothesis intended to improve upon Albert Einstein's General hypothesis of Relativity, which was published in 1915.

— Mach's principle, which states that every object's mass is changed by its interaction with every other object, is central to the Hoyle-Narlikar gravity theory. The notion profoundly intrigued Einstein, but he was unable to incorporate it into his theories. Hence, statement 1 is correct and statement 2 is not correct.

— The Hoyle-Narlikar gravity theory also proposed a "creation field" (C-field), which is a hypothetical negative-energy field that is responsible for the continual formation of matter. This helps to explain the steady-state cosmology, which holds that the universe has no beginning and would exist indefinitely. Hence, statement 3 is correct.

— The Hoyle-Narlikar theory of gravity was not widely accepted, particularly following the discovery of cosmic microwave background (CMB) radiation in 1965. The CMB, also known as an echo or shockwave of the Big Bang, is a cooled remnant of the first light to flow freely throughout the cosmos.

Therefore, option (a) is the correct answer.

Which of the following missions of the Polar Satellite Launch Vehicle (PSLV) have failed?

1. EOS-07 mission

2. Inaugural flight in 1993

3. C-39 mission

Select the correct answer using the codes given below:

(a) 1 only

(b) 2 and 3 only

(c) 1 and 3 only

(d) 3 only

Explanation

— The Indian Space Research Organisation's (ISRO) 101st satellite launch failed. The Earth observation satellite EOS-09 was aboard the PSLV-C61 (Polar Satellite Launch Vehicle).

— This was the 63rd PSLV launch. Since their introduction in the 1990s, PSLVs have only failed twice – the first during the inaugural flight in 1993 and in 2017, when the C-39 mission was unsuccessful. Here is why PSLVs have become reliable for India's Space agency and what happened during the two failed missions.

— ISRO has three types of launchers: the PSLV, the Geosynchronous Satellite Launch Vehicle (GSLV), and the Geosynchronous Satellite Launch Vehicle Mk-III (LVM3). Variants are chosen based on the cargo weights and the orbit they will reach.

— PSLV: Satellites used for navigation, mapping, or other functions must be transported into space by launch vehicles or rockets such as the PSLV. The rockets feature powerful propulsion systems that create massive amounts of energy, which is required to lift large things such as satellites into space while resisting the Earth's gravitational pull.

Therefore, option (b) is the correct answer.

With reference to the stars, consider the following statements:

1. Regardless of duration, all stars survive by maintaining a balance between two competing forces: the inward pull of gravity and the outward pressure produced by nuclear energy.

2. In the dense core of a star, nuclear fusion converts hydrogen into helium.

3. When a star's fuel is exhausted, gravity takes over — and then the nature of its death depends entirely on its mass.

How many of the statements given above are correct?

(a) Only one

(b) Only two

(c) All three

(d) None

Explanation

— The stars in the sky seem to shine forever, but they too are subject to lifespans determined by their mass and internal physics. Some last for billions of years and others are transitory in comparison, with far shorter lifetimes.

— Regardless of duration, all stars survive by maintaining a balance between two competing forces: the inward pull of gravity and the outward pressure produced by nuclear energy. Hence, statement 1 is correct.

— In the dense core of a star, nuclear fusion converts hydrogen into helium. This process occurs when extremely high temperatures and pressures allow atomic nuclei, which are ordinarily repelled by positive charges, to collide and fuse, releasing massive energy. That energy heats the surrounding gas, resulting in thermal and radiation pressure that prevents gravitational collapse. Hence, statement 2 is correct.

— This beautiful explanation of how stars glow was not previously known. Only in 1938, while taking a train to Ithaca, New York, did German-American physicist Hans Bethe scribble down the equations detailing how nuclear fusion powers stars, a breakthrough that earned him the Nobel Prize and resolved one of astrophysics' most pressing mysteries.

— But even fusion has its limits. When a star's fuel is exhausted, gravity takes over — and then the nature of its death depends entirely on its mass. Hence, statement 3 is correct.

Therefore, option (c) is the correct answer.

Consider the following statements about HeLa cells:

1. They were the first successfully cloned human cells.

2. These cells contributed to the identification of the Bovine Papillomaviruses (BPV) as the primary cause of many types of cervical cancer.

Which of the statements given above is/are correct?

(a) 1 only

(b) 2 only

(c) Both 1 and 2

(d) Neither 1 nor 2

Explanation

— The HeLa cell line is one of the most important cell lines in the history of medical science and has been the foundation for some of the most significant advances in this field.

— HeLa cells were the first successfully cloned human cells, and Jonas Salk used them to test the polio vaccine. Hence, statement 1 is correct.

— Furthermore, they contributed to the identification of the human papillomavirus (HPV) as the primary cause of many types of cervical cancer, including the one that killed Lacks, and were instrumental in the development of the HPV vaccine, which earned its creator, Harald zur Hausen, the Nobel Prize in Medicine in 2008. Hence, statement 2 is not correct.

Therefore, option (a) is the correct answer.

With reference to the JN.1 variant of COVID, consider the following statements:

1. It is a sub-lineage of the Omicron variant.

2. This variant is distinguished by its heightened transmissibility and potential to evade immune responses, even in the vaccinated population.

3. JN.1 is most likely to affect the elderly individual and those with underlying health conditions.

Which of the statements given above are correct?

(a) 1 and 2 only

(b) 2 and 3 only

(c) 1 and 3 only

(d) 1, 2 and 3

Explanation

— The JN.1 variant is not entirely new, it is a sub-lineage of the Omicron variant that has been circulating globally for some time.

— This version is distinguished by its heightened transmissibility and potential to evade immune responses, even in the vaccinated population, according to Dr Harish Chafle, senior consultant, intensivist chest physician, bronchoscopist, and sleep disorders expert at Gleneagles Hospital in Parel, Mumbai. Hence, statement 2 is correct.

— JN.1 is a sublineage of the Omicron type that is currently being closely monitored by the World Health Organisation. Hence, statement 1 is correct.

— JN.1 is most likely to impact people with low immune systems, the elderly, and those who have pre-existing health issues.Children and healthy adults may also get the virus, but they are likely to recover without significant consequences. Hence, statement 3 is correct.

Therefore, option (d) is the correct answer.

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