ASTROCHALLENGE 2015 MCQ ROUND (JUNIOR)

INSTRUCTIONS

- This paper consists of 14 printed pages, excluding this cover page.
- Do **NOT** turn over this page until instructed to do so.
- You have 2 hours to finish all questions in this paper. If you think there is more than one correct answer, choose the most correct answer.
- At the end of the paper, submit this booklet together with your answer script.
- Your answer script should clearly indicate your name, school, and team.
- It is <u>your responsibility</u> to ensure that your answer script has been submitted.

1) Why is Singapore (actually) a good location to observe the night sky?
   A. Because Singapore is near the equator and we can see nearly all stars from there
   B. Because Singapore has stable temperatures which is good for telescopes
   C. Because Singapore does not have 4 seasons which can affect observations
   D. Because Singapore is close to sea which is better for observation (less hindrance)
   E. Singapore is never good for observation

2) The lit face of the Moon is always facing the…
   A. West
   B. East
   C. North
   D. South
   E. Sun

3) Which of the following constellations are NOT parts of Argo Navis, once defined as the largest constellation?

   I. Carina
   II. Cetus
   III. Eridanus
   IV. Puppis
   V. Vela

   A. I, IV and V only
   B. II and III only
   C. I, III and IV only
   D. III, IV and V only
   E. All of the constellations are part of Argo Navis.

4) Which of the following statements is definitely false?
   A. Chondrules are round, grain-like structures formed from molten rock that are subsequently accreted and found in Chondrites, which are primarily non-metallic meteorites.
   B. Abundance of the heavier elements in universe is primarily influenced by nucleosynthesis processes happening in stars and supernovas.
   C. The solar corona surrounding our Sun is potentially millions of degree Kelvin hotter than the Sun's surface, and till today remains a controversial topic in thermodynamics.
   D. To compensate for irregularities in the Earth's rotation, 'leap seconds' have been added to ensure the Coordinated Universal Time (UTC) is as close to the mean solar time as possible.
   E. The Newtonian telescope is a refracting telescope (dioptric) with a convex primary lens and a concave secondary lens.

5) Arrange the following famous comet events in their order of occurrence, from the earliest in human history (on the left) to the most recent (on the right)

I. Shoemaker-Levy 9 fragments and collides with Jupiter
II. The last time mankind saw Halley's comet in the night sky
III. Deep Impact crashes on to comet Tempel 1
IV. Comet Hale-Bopp breaking records as a comet with the longest visible period in the sky
V. comet C/2014 Q2 Lovejoy reaches perihelion
VI. Rosetta mission succeeds with Philae landing on comet 67P/Churyumov–Gerasimenko

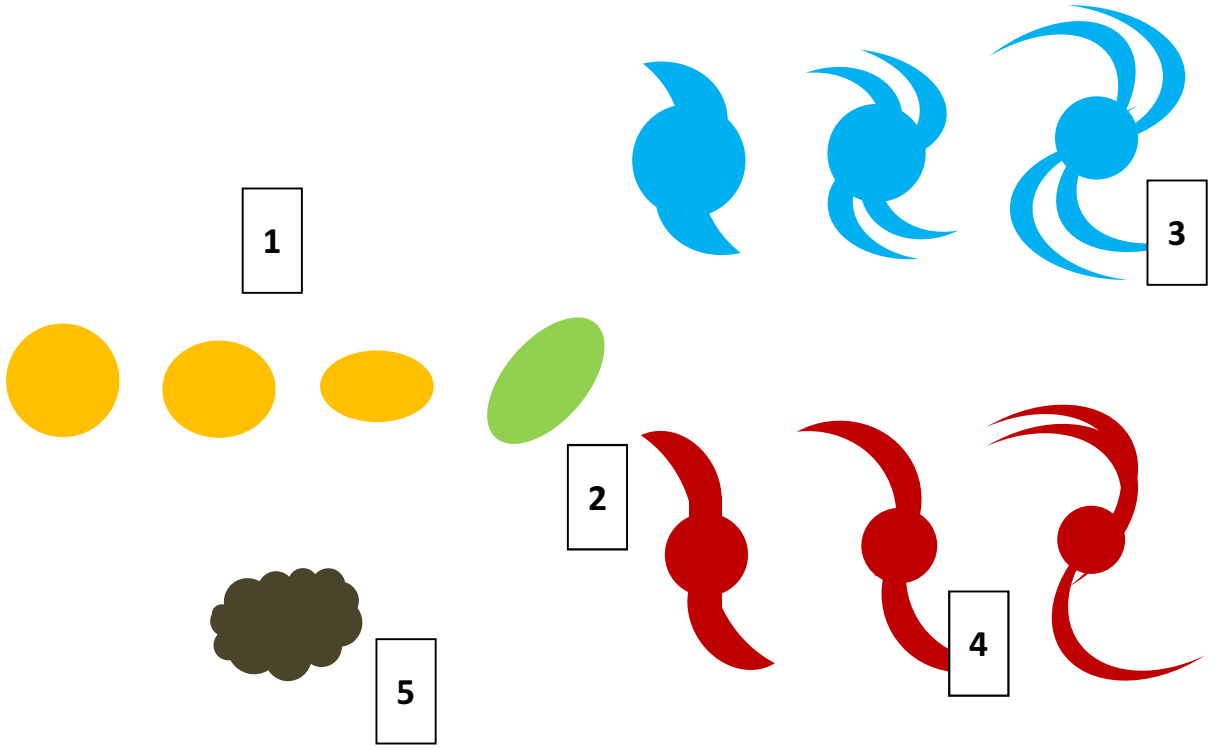
A. I, II, III, IV, V, VI
B. II, I, IV, III, VI, V
C. II, VI, IV, I, III, V
D. V, VI, III, IV, I, II
E. IV, II, III,I, V, VI

6) Which of the following Paradox(es) is/are correctly defined?

I. Olber's Paradox, also referred as the dark night sky paradox, proposes that if the universe was indeed static and unchanging with an infinite number of stars, the night sky ought to be bright and covered with stars, not dark as it currently is.
II. The Faint Young Sun Paradox questions the apparent contradiction between presence of liquid water on early Earth and the lower solar energy output as well as luminosity of the sun in its early stage.
III. Fermi's Paradox indicates the contradiction between high probability estimates for the existence of alien civilisations and humanity's lack of contact with any such civilisation.
IV. The Heat Death Paradox states that if the universe was indeed eternal, it ought to have reached a state of thermodynamic equilibrium ('Heat death') at some point in time.
V. The Algol Paradox shows an apparent contradiction in the differing stages of stellar evolution of many binary stars despite their formation occurring at the same time.

A. I and III only
B. I, II, and III
C. IV and V only
D. I, III and IV
E. All of the above

Refer to the following stylized Hubble Tuning Fork diagram for question 7.



7) Which of the following is an inappropriate designation?

A. 1 – E0, Elliptical galaxy
B. 2 – L0, Lenticular galaxy
C. 3 – SAc, Spiral galaxy
D. 4 – SBb, Spiral barred galaxy
E. 5 – Not originally part of the Hubble Tuning Fork (IR, Irregular galaxy)

8) Which of the following prominent stars is incorrectly matched to its classification on the Hertzsprung–Russell diagram?

A. Aldebaran: Spectral class G, Yellow giant
B. Barnard's Star: Spectral class M, Red dwarf
C. Canopus: Spectral class F, White supergiant
D. Deneb: Spectral class A, Blue-white supergiant
E. There isn't a mistake in all of the above listed stars

9) Which of the following observations is NOT valid evidence that suggests that the Earth is spherical in shape?

A. Observation of the shadow of the Earth via a lunar eclipse
B. The observation by a traveller that the peak of mountains or masts of ships often appear first over the horizon
C. The retrograde motion of other planets in the solar system, such as Mars
D. Different constellations are observed at the same time by two observers in two differing geographical locations at varying latitudes
E. Different shadows are cast by two sundials in different geographical locations at the same latitude

10) Which of the following locations in our Solar system is described incorrectly?

A. Mercury – The closest planet to the Sun, it thus has the highest average surface temperature of all the planets in the Solar system.
B. Titan – Mie Scattering and absorption due to its atmospheric composition is a likely explanation for its characteristic orange colour.
C. Io – As a result of tidal heating and friction, it is the most volcanically active object in our Solar system.
D. Saturn – A gas giant with well-defined rings and a lower total density compared to water.
E. Eris – A dwarf planet and Trans-Neptunian Object larger than Pluto.

11) A scientist proposed the following story on how life could have originated on Earth:

"Despite the vastness of space, the elements left by the death of a star, coupled with varying conditions of heat and pressure lead to the formation of many astounding molecules essential for life. These molecules might have accreted on a passing comet or asteroid. In turn, these visitors from space happen to land on a nursery we call Earth – which, over time, molecules begin to take form, assemble and develop into the very first cellular life on Earth."

Which of the following concepts have been demonstrated in his story?

I. Abiogenesis
II. An Ephemeris
III. Faculae
IV. (Pseudo) Panspermia
V. The Synodic Period

A) I and II only
B) I and IV only
C) III and IV only
D) II, III and V
E) I, II, III and IV

12) Viewing a total solar eclipse can lead to serious injuries and/or damage valuable equipment if done improperly. Which of the following are inappropriate ways of viewing a solar eclipse?

I. Naked eye observation
II. Viewing through a telescope with a solar filter placed over the aperture
III. Viewing through a telescope with a solar filter placed over the eyepiece
IV. Viewing through a telescope with a H-α etalon placed on the aperture
V. Observing with thick sunglasses

A. II, III & IV
B. I & V
C. I, IV & V
D. I, III & V
E. All of the listed methods are safe and appropriate

13) Despite its location within the Habitable Zone, Mars today is a dry and barren world. According to our current understanding, what is the most likely reason why Mars does not possess liquid water on its surface?

A. Most liquid water was forcibly ejected/vaporised by a series of impacts that reshaped the northern hemisphere of Mars.
B. Due to the lack of geologic activity, Martian volcanoes did not spew sufficient water vapor to allow liquid water to exist
C. The minerals of Mars react quickly with free water, suggesting that whatever water existed quickly reacted with these minerals.
D. Mars was too hot from the heat of its formation to allow liquid water to exist. By the time Mars had cooled down, most of its water had evaporated into outer space.
E. Due to Mars lacking a magnetic field, its atmosphere was eroded by the solar wind. Eventually, the atmosphere became too thin to support liquid water on the surface.

14) During an overnight observation session in December, a local astronomy club painstakingly recorded its observations. However, those notes ended being mixed up with observation logs from previous months. Which of the following objects is unlikely to have been observed during this December night?

A. Lagoon Nebula (M8) in Sagittarius
B. Orion Nebula (M42) in Orion
C. The Double Cluster (C14) in Perseus
D. The Andromeda Galaxy (M31) in Andromeda
E. Praesepe (M44) in Cancer

15) Choose the most appropriate statement.

The first few exoplanets discovered by astronomers tended to be _____ because _____

A. Hot and small, they were the easiest to discover via direct imaging
B. Large slow moving planets, they create the largest dips through the transit method
C. Massive and close to their host stars, they were the easiest to find through the radial velocity technique
D. Located in other galaxies, the exoplanets created the largest signals through gravitational microlensing
E. Super Earths, SETI efforts have allowed us to focus our efforts on promising candidates

16) Which of the following best describes the reason for which a protoplanet is spherical in shape?

A. The increasing rotational velocity about the axis of rotation causes it to be slightly flattened out along the poles, being slightly wider at the equator.
B. Chemical bonds of the elements that make up the protoplanet maintain its spherical shape against the force of gravity.
C. A molten interior (the core) allows the force of gravity to reshape the protoplanet. The attraction of gravity is counterbalanced by a hydrostatic pressure gradient.
D. The heat of collisions along with radioactivity of the elements found in the protoplanet melts it completely into a spherical shape.
E. As liquid particles accrete in the protoplanetary disk, surface tension ensures the resultant body solidifies as a spherical object

17) Body A is in a 3:5 mean-motion orbital resonance with Planet B, which has a semi major axis of 10 AU. That is, if Planet B makes 5 full orbits, body A will have made 3 full orbits. The semi major axis of Body A is then approximately:

A. 6 AU
B. 7.1 AU
C. 14.1 AU
D. 16.7 AU
E. 360 AU

18) Which of these statements are untrue about merging galaxies?

A. These collisions are more likely to occur at the cores of galactic superclusters
B. The large tidal forces experienced by the galaxies pulls large streamers of material away from the host galaxy, causing tidal tails
C. Most of the gas clouds in these galaxies gravitationally interact and/or collide with other gas clouds, triggering star formation
D. A significant number of stars collide with each other during these interactions, resulting in supernovae
E. Stars may be ejected from these galaxies during these mergers

19) Which of these statements about the seasons on Earth are true?

A. Summer in the Northern Hemisphere is slightly longer than Summer in the Southern Hemisphere
B. The Earth is further away from the Sun during the Winter solstice, making winters in the Northern Hemisphere colder than it would be otherwise.
C. The seasons occur only because the axial tilt changes the amount of time the Sun remains above the horizon.
D. The seasons only occur because the eccentricity of Earth's orbit change the amount of heat Earth receives from the Sun
E. None of the above statements are true

20) Given that Castor has RA 07h 34m 36s /DE +31°53' 17.8160" and is located in the constellation Gemini, which of the statements below are true?

A. Castor is circumpolar from Singapore
B. The Geminids are most easily seen in the Southern Hemisphere
C. The best time to view Gemini is in spring
D. Castor is invisible from the Southern Hemisphere
E. None of the above are true

21) Suppose we compressed the entire history of the Universe into a single calendar year. In doing so, the first stars would only form in:

A. January
B. February
C. March
D. April
E. June

22) At greatest elongation, what phase would Venus appear to be in?
    A. New/ Crescent
    B. Half-lit
    C. Gibbous
    D. Full
    E. As a planet, Venus has no phases

23) If there were 2 super-Earths orbiting our Sun with a semi-major axis of 200 & 250 AU respectively, their orbital periods will approximately be:
    A. 14.1 and 15.8 years
    B. 200 and 250 years
    C. 2830 and 3950 years
    D. 40,000 and 62,500 years
    E. Insufficient information, it depends on their mass and orbital eccentricity

24) Planetary differentiation refers to:
    A. Differentiating and identifying planets during observation sessions
    B. Processes that created terrestrial planets near the Sun, and gas giants further out
    C. The process of taking the derivative of the planetary mass balance function
    D. The process where planets develop a core, mantle and crust
    E. Processing techniques that distinguish between noisy data and actual exoplanets

25) In order to see a crescent Jupiter through my telescope, I must wait till...
    A. Jupiter is at opposition
    B. Jupiter is at inferior conjunction
    C. Jupiter is at superior conjunction
    D. Jupiter is above the horizon
    E. I own a spaceship that can cruise to the stars

26) The apparent magnitude of Regulus is 1.35 while Merak has an apparent magnitude of 2.35. This means that:

    A. The luminosity of Regulus is 2.5 times greater than Merak
    B. The luminosity of Regulus is 2.5 times smaller than Merak
    C. Merak appears 2.5 times brighter to us than Regulus
    D. Merak appears 2.5 times dimmer to us than Regulus
    E. None of the statements above are true.

27) What are the most common elements in the universe?
    A. Hydrogen, Carbon
    B. Helium, Boron
    C. Carbon, Nitrogen
    D. Hydrogen, Helium
    E. None of the above

28) Why do stars twinkle at night?

A. Because of the disturbance of other stars.
B. Because stars do not shine sometimes.
C. Due to Earth's rotation
D. Because of atmospheric turbulence.
E. Because the sun is too bright.

29) Suppose you were at a typical observing site in Singapore. Which of these objects are observable and visible to the naked eye in practice?

A. Polaris, α UMi
B. Acrux, α Cru
C. Uranus
D. Proxima Centauri
E. Ring Nebula, M57

30) I wish to determine the exact distance of a globular cluster located in the outlying regions of the Milky Way. Which method is most likely to give me an accurate estimate of its distance?

A. Type Ia supernovae
B. Parallax
C. Tip of the Red Giant Branch distance indicator
D. Hubble's Law
E. Tully-Fisher Relation

31) As far as we know, which planet contains the largest volcano in the solar system?

A. Mercury
B. Venus
C. Earth
D. The Moon
E. Mars

32) Relative to the time the moon takes to orbit the earth, the period of the moon's rotation on its axis is

A. much shorter
B. roughly the same
C. much longer
D. sometimes longer, sometimes shorter
E. any of the above, depending on the time of the year

33) Choose the right statement
   A. For the moon to produce a solar eclipse, it must be in the Sun's direction as the Sun in the sky, that is, it must be at full moon phase
   B. A star that sets at 10 pm tonight will set later tomorrow
   C. During opposition, Mars is in its closest distance to Earth
   D. At the South Pole in December, the Sun is always below the horizon
   E. During its orbit around the Sun, Earth moves most slowly at its perihelion

34) Polaris(the Pole star) appears almost stationary across a night because
   A. Earth is not moving with the respect of Polaris
   B. Earth is almost along the axis of rotation of Polaris
   C. Polaris is almost along the axis of rotation of Earth
   D. Both Polaris and Earth have the same velocity with respect to the Milky Way
   E. None of the above

35) The sun's energy comes from
   A. nuclear fission
   B. gravitational contraction
   C. the fusion of hydrogen to helium
   D. the fusion of helium to carbon
   E. the fusion of carbon to neon/magnesium/sodium

36) The farthest South that an observer on the Earth can see Polaris is approximately
   A. Arctic Circle
   B. Antarctic Circle
   C. Equator
   D. The Tropic of Cancer
   E. The Tropic of Capricorn

37) A star has a temperature of 3000 K and 100 times more luminosity than the Sun. What is the radius of the star, in terms of solar radii (R_{sun})?
   A. $4R_{sun}$
   B. $5R_{sun}$
   C. $20R_{sun}$
   D. $40R_{sun}$
   E. $80R_{sun}$

38) Earth receives around 1380 watts/m2 of energy from the Sun. How much energy does Saturn receive from the Sun? (Given that Saturn's semi-major axis is 9.5 AU)
   A. 6.2 watts/m2
   B. 9.3 watts/m2
   C. 15.29 watts/m2
   D. 18.37 watts/m2
   E. 20.59 watts/m2

39) The absolute magnitude of a star is M =−2 and the apparent magnitude is m = 8. What is the distance of the star?

A. 1 kpc
B. 1.2 kpc
C. 1.4 kpc
D. 1.6 kpc
E. 1.8 kpc

40) As a first approximation, the same lunar features always seem to be facing the Earth. This is because

A. Libration ensures that the same lunar features are always visible
B. The surface of the moon appears the same at all sides.
C. The moon is tidally locked to Earth. This results in the moon having an equal rotational period and orbital period.
D. The moon orbits without rotating. As such, the same side always faces the Earth.
E. Due to the Moon illusion, we only appear to see the same side of the Moon

41) Stars can be categorized according to their apparent properties. One such group is known as variable stars. As the name suggests, stars under this category vary in brightness. What may be a possible reason why these stars can vary significantly in brightness?

A. Some stars have binary or multiple companion stars that orbit around them. These stars can block our view of the star and make them appear less bright.
B. High altitude winds in the atmosphere can cause powerful turbulence, leading to scintillation and changing the brightness of the star.
C. Different astronomers who observed these stars at different locations were actually affected by different levels of light pollution. As a result, it made the star seem to vary in brightness by different people.
D. This is because the distance between the Earth and the star varies with time, leading to noticeable brightness variations
E. None of the above are true

42) Suppose we shrunk the Sun to the size of a grapefruit (10 cm diameter). At this scale, we can estimate the distance to the Large Magellanic Cloud to be on the order of:

A. 1 million grapefruits laid end to end, aka 100 km
B. 1 billion grapefruits laid end to end, aka 10^5 km
C. 1 trillion grapefruits laid end to end, aka 10^8 km
D. 1 quadrillion grapefruits laid end to end, aka 10^{11} km
E. 1 quintillion grapefruits laid end to end, aka 10^{14} km

43) This used to be Einstein's telescope. What type of telescope did he own?

A. A Schmidt-Cassegrain catadioptric telescope
B. A Dobsonian
C. A Newtonian reflector
D. A 1-element refractor
E. A Ritchey-Chretien

44) If you split sunlight through a prism, you might notice that the resultant spectrum is incomplete: prominent dark lines are visible in the spectrum. Why is this so?

A. The sun is not a perfect black body: it only emits light at certain quantized wavelengths, creating dark lines at regular intervals
B. The sun is deficient in certain elements: thus it is incapable of emitting light at certain wavelengths, creating the dark lines
C. Certain atoms/molecules in the sun's outer atmosphere preferentially absorb and reemit specific wavelengths of light
D. Earth's atmosphere preferentially absorbs light at certain wavelengths. The reduced transmittance at these wavelengths generates the dark lines.
E. Imperfections in the prism preferentially absorb light at certain wavelengths

45) Suppose we doubled the mass of the Sun. What effect would NOT occur?

A. The luminosity of the Sun would increase
B. The gravitational force exerted by the Sun on the Earth at 1AU is doubled
C. As it has now exceeded the Chandrasekhar limit, the Sun will eventually collapse into a neutron star
D. The surface temperature of Earth would increase
E. All of the above effects would occur

46) If the Moon has RA 18h 18m 46s/DE +18° 12’ 43’’ and Venus has RA 10h 12m 8s/DE +13° 16’ 41’’, which of the following scenarios cannot possibly be witnessed anywhere on Earth for that certain day?

A. The Moon and Venus are always below the horizon on this day
B. The Moon and Venus never set on this day
C. Venus rises at around 3 pm, the Moon rises at around 5 am
D. Venus rises at around 5 am, the Moon rises at around 3 pm
E. All of the above scenarios can be witnessed at different locations on Earth at this day

47) The Pleiades (M45) is one of the most prominent star clusters in the night sky. In fact, they are easily seen with the naked eye, even in light-polluted Singapore! In which constellation are the Pleiades found?

A. Orion
B. Sagittarius
C. Leo
D. Taurus
E. Andromeda

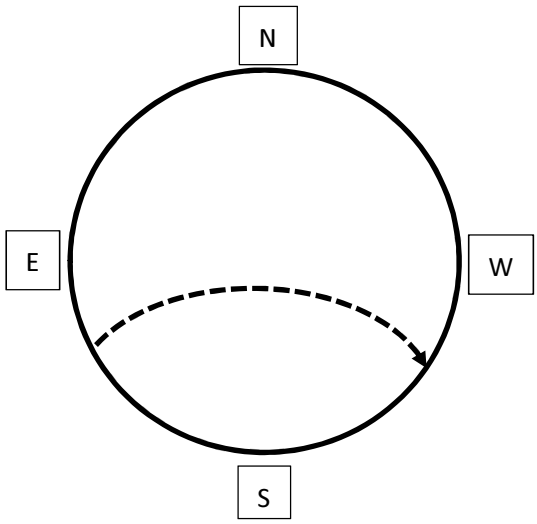
48) The current star classification system that we are using (OBAFGKM) is based on the _____ of stars.

A. Luminosity
B. Radius
C. Temperature
D. Distance
E. Stage of life

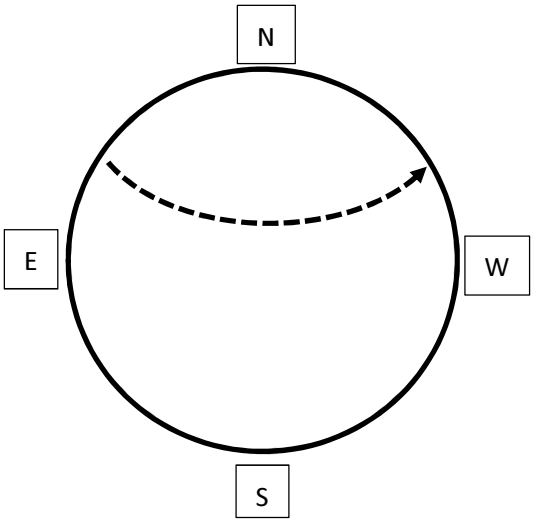
49) The Cosmic Microwave Background (CMB) is thought to largely represent:

A. The light emitted from the Big Bang itself
B. The light emitted from the first stars
C. The light emitted from the surface of last scattering
D. The light emitted from Big Bang Nucleosynthesis
E. The light emitted from baryogenesis - the creation of the first protons/neutrons

50) Suppose you are on the Equator at June 22nd. Over the course of a day, approximately how does the Sun appear to move across the sky?



Option A



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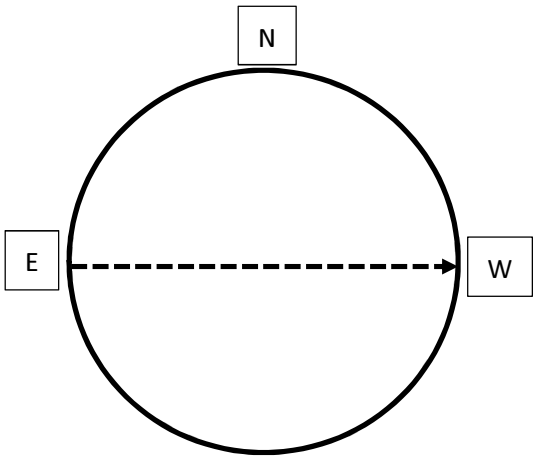

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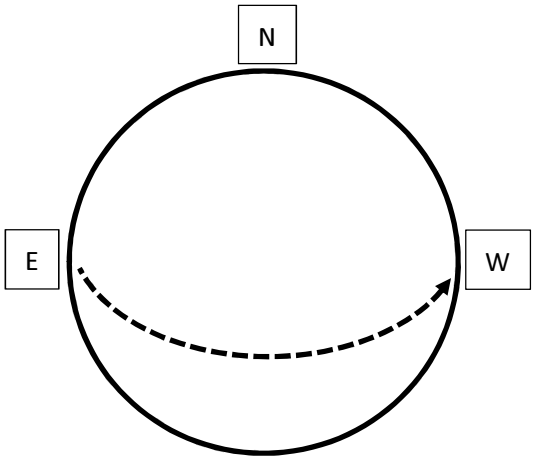

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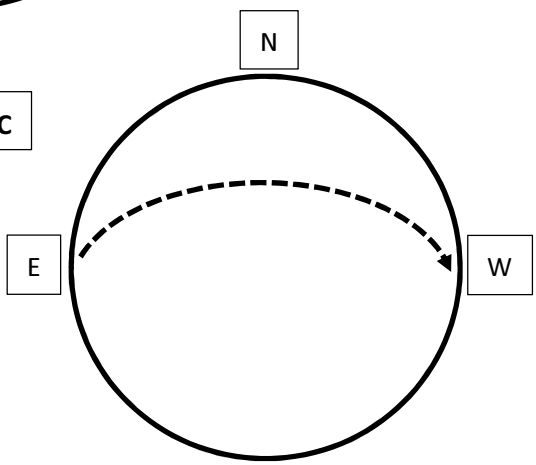

Option E