Quiz Date: 2nd October 2020

Direction (1-8): Read the following passage and answer the following questions.

Energy is generated in the interior of the Sun through sequences of nuclear reactions in which four protons fuse together to form a helium-4 nucleus. These sequences are accompanied by the release of two particles known as electron neutrinos. Models suggest that 99% of the nuclear energy released by the Sun originates from three reaction sequences — collectively known as the proton–proton (*pp*) chain — that are initiated by the fusion of two protons. In a paper in *Nature*, the BorexinoCollaboration reports the first complete measurement of neutrino fluxes that originate from these three sequences, based on an analysis of more than 2,000 days of data collection. The results help us to understand the details of how and why the Sun shines.

Neutrinos interact weakly with matter, and therefore escape almost **unhindered** from the Sun's interior, to reach Earth about eight minutes later. Solar neutrinos therefore provide a direct view into the nuclear furnace in the Sun's core. The Borexino experiment detects such neutrinos and determines how much energy they have by measuring the amount of light produced when the particles interact with the detecting agent (an organic liquid, called the scintillator, which is kept underground to minimize the amount of background radiation that can interfere with the neutrino signals). In contrast to all other solar-neutrino experiments, Borexino can measure the energies of both high- and low-energy neutrinos, which makes it possible to study the structure of the solar core using a technique known as neutrino spectroscopy.

Electron neutrinos can change into two other types (or flavours) of neutrino, known as tau and muon neutrinos, as they travel to Earth, a phenomenon known as flavour oscillation. The Borexino experiment is more sensitive to electron neutrinos than to tau or muon neutrinos, and so flavour oscillation needs to be accounted for when the measured neutrino fluxes are used to calculate the fluxes produced in the Sun. Taking this into consideration, the Borexino collaborators used the measured neutrino flux to work out the total power generated by nuclear reactions in the Sun's core, with an uncertainty of about 10%, and found that this is the same as the measured photon output — thus showing that nuclear fusion is indeed the source of energy in the Sun. This value, calculated for the amount of energy produced through nuclear reactions, is comparable with previous results obtained by combining data from several neutrino-detection experiments, and places the most robust and model-independent constraints on the source of solar energy.

The findings also have interesting ramifications for neutrino physics. By combining their data with predictions from standard solar models, the collaborators determine a quantity known as the electron neutrino survival probability (which describes the probability that an electron neutrino created in the Sun will also be detected as an electron neutrino at the detector) for neutrinos produced in four reactions of the *pp* chain. The calculated survival probabilities include the best available value for low-energy neutrinos, which correspond to an energy regime in which flavour oscillation is expected to occur mostly in vacuum conditions. Combined with the survival probabilities determined for higher-energy neutrinos, the findings give strong support to our current understanding of neutrino oscillations — that is, the idea that low-energy neutrinos change flavour as they propagate through a vacuum, and that the oscillations of high-energy neutrinos are enhanced by their interactions with electrons.

The new results also shed light on a long-standing paradox in solar physics, which arises because the chemical composition of the Sun is not well established. The most-recent complete spectroscopic determinations of the Sun's metallicity (the abundance of all solar elements heavier than helium) yielded a value that is 35% lower than older spectroscopic results. Intriguingly, when numerical models of the solar interior are constructed using the lower value of metallicity as a constraint, the simulated properties are at odds with our knowledge of the Sun's interior structure (which is well characterized by helioseismological studies that analyse oscillations produced by waves that propagate through the Sun's interior). But when the older (higher) metallicity values are used, the simulations reproduce solar properties very well. This is known as the solar abundance problem and calls into question the validity

of the present models of stellar evolution, or of spectroscopic methods for determining the Sun's composition, or both.
However, the relative contributions of the three different reaction sequences in the *pp*-chain, determined from the Borexino experiment, can be used to infer the temperature in the solar core — a region that is poorly mapped by helioseismological studies. The Borexino findings hint at a core temperature that is consistent with predictions from models that assume high solar metallicity. That said, the results are not yet precise enough to provide a definite answer to the solar abundance problem, because neutrino fluxes predicted by both the high- and low-metallicity solar models are compatible with the new results.

Q1. If flavor oscillation wasn't a reality (assume, if this to be true), which of the followings would have been plausible?
(I) More solar energy per nuclear fusion reaction would be produced.
(II) The calculation of the neutrino flux produced in the Sun based on the Borexino collaborators experiment would have been more accurate.
(III) The solar abundance paradox wouldn't be there.
(a) Only (I)
(b) Only (II)
(c) Only (III)
(d) Both (I) and (III)
(e) All of (I), (II) and (III)

Q2. Which of the following statements, if true (assume all the following statements to be true), will prove that nuclear fusion reactions are ***approximately*** the only source of energy in the Sun?
(I) A highly accurate and powerful neutrino detector at Alaska didn't detect any neutrino in the solar radiations.
(II) A neutrino detector which is highly sensitive and equally sensitive to electron neutrino, tau neutrino and muon neutrino detects only electron neutrinos in the solar radiation.
(III) The power output measured for the solar radiation is equal to the value obtained for the power generated by the nuclear fusion reactions, calculated after measuring and using the value of the neutrino fluxes present in the solar radiation, which take place in the Sun.
(a) Only (I)
(b) Only (II)
(c) Only (III)
(d) Both (I) and (III)
(e) All of (I), (II) and (III)

Q3. If the experiment discussed in the passage could only measure the energies of high-energy neutrinos, but not of low-energy neutrinos (assume this to be true), then which of the following statements would be false?
(I) Nuclear Fusion is indeed the source of energy in the Sun.
(II) The Borexino Collaboration reporting the first complete measurement of neutrino fluxes that are produced in the Sun because of the three nuclear fusion reaction sequences known as proton-proton (pp) chain which takes place in the Sun.
(III) Electron neutrinos can change into two other types (or flavours) of neutrino, known as tau and muon neutrinos, as they travel to Earth, a phenomenon known as flavor oscillation.
(IV) The solar neutrinos detected by the experiment provide a direct view into the nuclear furnace in the Sun.
(a) All of (I), (II), (III) and (IV)
(b) Both (II) and (IV)
(c) Both (I) and (II)

(d) Both (I) and (III)
(e) All of (I), (II) and (III)

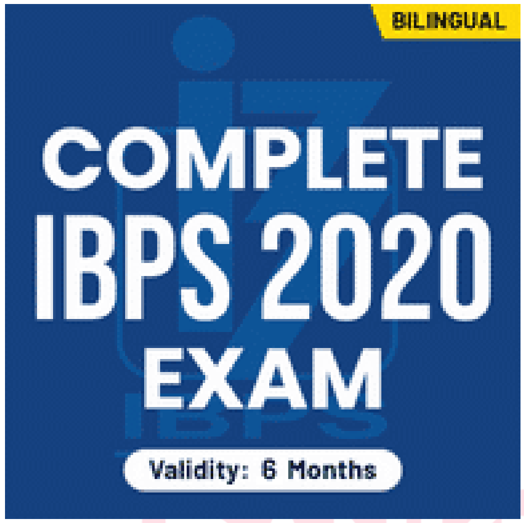
Q4. The likelihood of which of the following processes or events would get sharply reduced if there had been no vacuum in the space between the Sun and the Earth? Kindly answer the question based on the available information of the given passage.
(a) Occurrence of the Nuclear Fusion Reactions in the Sun.
(b) Creation of two electron neutrinos during the nuclear fusion reactions.
(c) Abilities of the neutrinos to escape almost unhindered from the Sun's interior to reach Earth.
(d) The occurrence of Flavours oscillation.
(e) None of the above

Q5. If human could observe the light produced by one neutrino as a pulse of Blue light observable to a human till the duration of the point of contact between the neutrino and detecting agent, then, while conducting the Borexino experiment on favourable conditions, what would be the visual spectacles of the detecting agent when it is shaped like a thin TV screen? Assume the colour of the detecting agent to be white.
(a) The screen-shaped detecting agent would turn blue uniformly across the screen during the time the experiment was being conducted.
(b) The neutrinos wouldn't produce any visual spectacle on the screen-shaped detecting agent.
(c) The neutrinos would produce sparks of blue light of equal brightness on the screen-shaped detecting agent.
(d) The neutrinos would produce sparks of blue light of unequal brightness on the screen-shaped detecting agent.
(e) None of the above.

Q6. Why could the Borexino experiment not provide a definite answer to the solar abundance problem?
(I) The neutrino fluxes predicted by both the High- and low-metallicity solar models are compatible with the total neutrino flux calculated by the Borexino experiment.
(II) The most-recent complete spectroscopic determinations of the Sun's metallicity (the abundance of all solar elements heavier than helium) yielded a value that is 35% lower than older spectroscopic results.
(III) The Borexino findings hint at a core temperature that is consistent with predictions from models that assume high solar metallicity.
(a) Only (I)
(b) Both (II) and (III)
(c) Both (I) and (III)
(d) Both (I) and (II)
(e) All of (I), (II) and (III)

Q7. If neutrinos were interacting with matter strongly, then which of the following would be true?
(I) The number of neutrinos reaching the Earth would be lesser.
(II) The Sun would have a higher value of metallicity.
(III) The Borexino experiment couldn't be able to prove if nuclear fusion reactions were indeed the reason for more than 99% of energy produced in the Sun.
(a) Only (I)
(b) Both (I) and (III)
(c) All of (I), (II) and (III)
(d) Both (II) and (III)
(e) None of (I), (II) and (III)

Q8. Which of the following words has a meaning which is SIMILAR to the meaning of the highlighted word '**unhindered**', as mentioned in the second paragraph of the passage?
(a) Viscous
(b) Cryptic
(c) Remiss
(d) Unbridled
(e) Imperious



Direction (9-15): Read the following passage and answer the following questions.
A fundamental feature of any electrical measurement is noise — random and uncorrelated fluctuations of signals. Although noise is typically regarded as undesirable, it can be used to probe quantum effects and thermodynamic quantities. Writing in Nature, SheinLumbroso et al. report the discovery of a type of electronic noise that is distinct from all others previously observed. Understanding such noise could be essential for designing efficient nanoscale electronics.
A century ago, the German physicist Walter Schottky published a **seminal** paper that described different causes and manifestations of noise in electrical measurements. Schottky showed that an electric current produced by an applied voltage is noisy, even at absolute zero temperature, when all random heat-induced motion has stopped. This noise is a direct consequence of the fact that electric charge is quantized — it comes in discrete units. Because the noise results from the granularity of the charge flow, it is called shot noise.
It was already known at the time of Schottky's work that, in systems that are in thermal equilibrium, noise with distinctly different properties from shot noise comes into play at non-zero temperatures — this is known as thermal (Johnson–Nyquist) noise. Today, shot noise is a key tool for characterizing nanoscale electrical conductors because it contains information about quantum-transport properties that cannot be revealed from mere electric-current measurements.
SheinLumbroso et al. studied junctions composed of single atoms or molecules suspended between a pair of gold electrodes. The authors fabricated the electrodes by breaking a thin gold wire into two parts and bringing the parts gently back into contact. They evaporated hydrogen molecules on to this device, which is known as a mechanically controllable break junction, so that individual hydrogen atoms or molecules were captured between the tips of the electrodes, thereby establishing an electrical contact. The resulting junctions constituted a single quantum-mechanical transport channel in which electrons could be transmitted from one electrode to the other with a probability that could be adjusted by varying the openness of the channel. This set-up provided an ideal test bed for exploring the properties of the so-far-overlooked noise contribution.

The authors observed a strong increase in electronic noise when they applied a temperature difference between the two electrodes, compared with when the electrodes were at the same temperature. The additional noise, which the authors call delta-T noise, scaled with the square of the temperature difference. It exhibited the same dependence on electrical conductance as shot noise.
SheinLumbroso and colleagues explained their finding using the quantum theory of charge transport, known as the Landauer theory, which has been developed in the past few decades. This theory incorporates both shot noise and thermal noise and has been tested intensively down to the atomic and molecular scale3. It has been found to accurately describe many experimental observations obtained when working entirely in thermal equilibrium, or when applying small voltages. The authors took a closer look at the theory and found that it includes a noise component that occurs when solely a temperature difference is applied across a junction: delta-T noise.
It is well established that an electric current can arise from a temperature difference in the absence of an applied voltage — a phenomenon called the Seebeck effect. However, delta-T noise is not the shot noise associated with this thermally induced current. The authors' results indicate that delta-T noise is larger than this shot noise, and has a different dependence on the temperature difference. Instead, the results suggest that delta-T noise arises from the discreteness of the charge carriers mediating the heat transport.
Because the Landauer theory is widely used, it is surprising that delta-T noise has not previously been observed. The importance of carefully considering all of the spatial temperature differences and resulting electric currents to understand the current flow in atomic and molecular contacts was pointed out in a 2013 paper, but implications for noise were not addressed.
SheinLumbroso et al. found that the Landauer theory accurately describes all of the characteristic properties of delta-T noise. In this sense, their experiments are yet another beautiful demonstration of the theory. But the work also conveys a key message: careful design and rigorous analysis of experiments are required when studying any of the details of quantum transport.
The authors' discovery also has practical implications. In particular, quantum-transport experiments that are not entirely in thermal equilibrium could show strongly enhanced noise, which might be mistaken for noise arising from interactions between the charge carriers or from other subtle effects. Experimentalists who wonder about finding unexpectedly high noise in their electric-current measurements might wish to revisit their set-ups to search for unintentional temperature gradients. The most practical application of the authors' work is probably that the enhanced noise could be used to detect unwanted hotspots in electrical circuits.

Q9. Which of the followings describe a/the utility/utilities of random and uncorrelated fluctuations of signals?
(a) They cause the electric current produced by an applied voltage at absolute zero temperature to get quantized.
(b) They cause Seebeck effect which is flowing of electric current across two electrodes due to temperature difference in the absence of voltage.
(c) They help in probing quantum effects and thermodynamic quantities.
(d) Both (b) and (c)
(e) None of the above

Q10. Which of the followings information has/have encouraged the author of the passage to say, '*the work of SheinLumbroso and his colleagues, as mentioned in the passage, also conveys a key message: careful design and rigorous analysis of experiments are required when studying any of the details of quantum transport*?'
(I) A 2013 paper pointed out the importance of careful consideration all of the spatial temperature differences and resulting electric currents to understand the current flow in atomic and molecular contacts but still the implications for noise were not addressed.
(II) Although Landauer theory is widely used and it accurately describes all the characteristic properties of delta-T noise, the delta-T noise has not previously been observed.

(III) The results from the experiments by SheinLumbroso and his colleagues indicate that delta-T noise is larger than shot noise and has a different dependence on the temperature difference.
(a) Only (I)
(b) Both (I) and (II)
(c) All of (I), (II) and (III)
(d) Both (II) and (III)
(e) None of these

Q11. Which of the following statements explain the cause of shot-noise?
(a) Discreetness of the charge carriers mediating the heat transport.
(b) Flow of electric charge in discrete units.
(c) Application of different temperature across the electrodes
(d) Both of (a) and (b)
(e) None of the above

Directions (12-14): Consider a single quantum-mechanical transport channel which consists of a mechanically controllable break junction. The mechanically controllable break junction has an individual hydrogen atom captured between a pair of gold electrodes which are fabricated by breaking a thin gold wire into two parts and bringing the parts gently back into contact, thereby establishing an electrical contact. The name of one of the electrodes is the electrode-A and the same for the other the electrode-B.

Q12. The temperature of the electrode-A and electrode-B is zero kelvin. The potential difference between the electrode-A and electrode-B is 4V. Which of the following electronic noises would be observed in the experiment?
(I) Shot noise
(II) Thermal noise
(III) Delta-T noise
(a) Both (I) and (II)
(b) Both (II) and (III)
(c) Only (I)
(d) Only (III)
(e) All of (I), (II) and (III)

Q13. The temperature of the electrode-A and electrode-B is zero-degree Celsius. The potential difference between the electrode-A and electrode-B is 54V. Which of the following noises would be observed in the experiment?
(I) Shot noise
(II) Thermal noise
(III) Delta-T noise
(a) Both (I) and (II)
(b) Both (II) and (III)
(c) Only (I)
(d) Only (III)
(e) All of (I), (II) and (III)

Q14.The temperature of the electrode-A is five-degree Kelvin and that of electrode-B is zero-degree Celsius. The Voltage difference between the electrode-A and electrode-B is 0V. Which of the following noises would be observed in the experiment if thermal noise arises from the random thermal motion of electrons - even at equilibrium conditions when current is not flowing?
(I) Shot noise
(II) Thermal noise

(III) Delta-T noise
(a) Both (I) and (II)
(b) Both (II) and (III)
(c) Only (I)
(d) Only (III)
(e) All of (I), (II) and (III)

Q15. Which of the following words has a meaning which is SIMILAR to the meaning of the highlighted word '**seminal**', as mentioned in the second paragraph of the passage?
(a) Remis
(b) Imperious
(c) Baleful
(d) Formative
(e) Grating

Solutions

S1. Ans. (b)
Sol. The correct answer is the option (b). The first sentence of the third paragraph tells us about what flavor oscillation is. The phenomenon in which electron neutrinos change into two other types (or flavours) of neutrino, known as tau and muon neutrinos, ***as they travel to Earth***, a phenomenon known as flavor oscillation. Now, read the third sentence of the fourth paragraph which is '*The calculated survival probabilities include the best available value for low-energy neutrinos, which correspond to an energy regime in which flavour oscillation is expected to occur* ***mostly in vacuum conditions***.' Upon read these sentences, we understand that the flavor oscillation of electron neutrinos which are produced in the sun mostly take place in vacuum conditions when they leave the Sun and travel to other places like the Earth, and it doesn't take place in the sun and/or isn't the part of the nuclear fusion reactions which take place in the sun. So, neither (I) nor (III) could be correct.
Now, read the first two sentences of the third paragraph.Upon reading them, we understand that electron neutrinos are produced during the nuclear fusion reactions which take place in the Sun and when these electron neutrinos travels from the Sun to Earth, some of them get converted to other two neutrinos, which are tau and muon. And, the Borexino experiment is more sensitive to electron neutrinos than to tau or muon neutrinos. If there were no such phenomenon as flavor oscillation, then electron neutrinos which were produced in the Sun during the nuclear fusion reactions would reach the

earth and were detected by the equipment of the Borexino experiment ***as it is*** and wouldn't get converted into the other two neutrinos. And because the detector of the Borexino experiment is ***more sensitive*** to electron neutrinos than to the tau or muon neutrinos (which wouldn't produce if flavor oscillation weren't a reality), so the calculation of the neutrino flux produced in the Sun based on the Borexino collaborators experiment would have been more accurate. Hence, the statement (II) is correct. The option (b) is the correct answer.

S2. Ans. (c)
Sol. Detecting only electron neutrinos in the solar radiation could be used to calculate the neutrino flux, and consequently could help in calculating the total energy generated ***through nuclear fusion process*** in the sun. But, this would not prove if the Nuclear Reactions produces nearly all the energy produced in the Sun. To prove if the Nuclear Fusion Reactions is the major source of solar energy or produces nearly all the energy produced in the Sun, one must prove if the energy produced through nuclear fusion reactions, which is ***calculated through measuring the neutrinos fluxes present in the solar radiation***, is equal to the ***total power output in the solar radiation.***
Among the given statements, if only statement (III) is true, one can prove that the nuclear fusion reactions are approximately the only source of energy in the Sun.
Hence, the correct answer is the option (c).

S3. Ans. (b)
Sol. The experiment discussed in the passage is the Borexino Collaboration project which detects neutrinos and determines how much energy they have, and these measurements could also be used to calculate the neutrino fluxes present in the solar radiation (or generated in the Sun, knowing both are equal). If the experiment could only detect high-energy neutrinos, then it would mean that the low energy neutrinos which were generated in the Sun after a nuclear-fusion reaction wouldn't be detected by the Borexino Collaboration project, meaning that the measurement made through using the observation made by the experiment would **not be complete.** So, the value of neutrino fluxes which were calculated through employing the observation made by the experiment **and neutrinos detected** by the Borexino collaboration project would **not be complete. So,** claiming if the Borexino collaboration made the first complete measurement of neutrino fluxes that are produced in the Sun would be **wrong**. Also, because the Borexino collaboration experiment detects **incomplete neutrinos**. Therefore, **claiming** if the solar neutrinos (or neutrinos present in the Sun) provide a direct view into the nuclear furnace in the Sun would also be **wrong**.
The abilities or inabilities of an experiment can't change the attributes of things which are observed. So, the inabilities of the experiment won't change the source of energy in the Sun. Neither would it change the abilities of the electron neutrinos to change into two other types of neutrino, known as tau and muon neutrinos.
Hence, the Statements (II) and (IV) would be false, and the option (b) is the correct answer.
S4. Ans. (d)
Sol. Let's try to find out the occurrence of which of the given events depends on the vacuum in the space between the Sun and the Earth. And we have to answer the question based on the information available in the passage.
Does the nuclear fusion reaction which take place inside the Sun depend on the vacuum in the space between the Sun and the Earth?
No. The passage doesn't mention any of the above. So, the option (a) is incorrect.
Does the creation of the two electron neutrinos during the nuclear fusion reactions depend on the vacuum in the space between the Sun and the Earth?
The two electron neutrinos are the products of the nuclear fusion reactions which take place in the Sun as given in the first paragraph. Because the given passage doesn't mention about the dependence of the nuclear fusion reactions which take place in the Sun on the vacuum in the space between the Sun and the Earth, so the by-products of the same nuclear fusion reactions shouldn't depend on the vacuum.
So, the option (b) is also incorrect.

Kindly read the first sentence of the second paragraph which is '*Neutrinos interact weakly with matter…*' If there wouldn't be vacuum in the space between the Sun and the Earth, then there would be matter in the space between the Sun and the Earth. But **the neutrinos interact weakly with matter and the same neutrinos escape the interior of the Sun *unhindered.*** So, had there been matter or no vacuum in the space between the Earth and the Sun, the neutrinos would not interact with the matter and should reach the Earth unhindered in the same way as the neutrinos escape the inner core of the Sun.
So, the option (c) is also incorrect.
Now, kindly read the third sentence of the fourth paragraph which is '*The calculated survival probabilities include the best available value for low-energy neutrinos, which correspond to an energy regime in which flavour oscillation is expected to occur **mostly in vacuum conditions.***' The statement seems to suggest that '*low-energy neutrinos correspond to an energy regime in which flavor oscillation is expected to occur mostly in vacuum conditions'.* Meaning, Favourable conditions for the occurrence of flavor oscillation are: *neutrinos having a certain energy level which correspond to a certain energy regime*; second is the presence of *vacuum.* If the vacuum in the space between the Sun and the Earth is replaced with matter, then the likelihood of the occurrence of the Flavour Oscillations should decrease sharply.
Hence, the option (d) is the correct answer.

S5. Ans. (d)
Sol. The correct answer is the option (d).
As mentioned in the third sentence of the second paragraph, the Borexino experiment detects neutrinos and determine how much energy they have by measuring the amount of light produced when the particles interact with the detecting agent. The question asks us to assume that a human could observe the light produced by the neutrinos when they interact with the detecting agent, the colour of the light produced when a neutrino interact with the detecting agent is ***blue***, the detecting-agent is shaped like a thin TV screen, and the colour of the screen-shaped detecting-agent is white. The last sentence of the second paragraph tells us that the Borexino can detect both high- and low-energy neutrinos. From the paragraph 2, we also understand that the amount of light produced by a neutrino while it interacts with the detecting agent would reflect the energy it has. This would mean that a low-energy neutrino should produce an amount of light ***different*** from that produced by a high-energy neutrino. So, while conducting the borexino experiment, the screen-shaped detecting agent should be illuminated with sparks of blue light of ***unequal brightness.***
Hence, the option (d) is the correct answer.

S6. Ans. (a)
Sol. The answer to the question can be determined from the last sentence of the last paragraph which is '*That said, the results are not yet precise enough to provide a definite answer to the solar abundance problem, because neutrino fluxes predicted by both the high-and low-metallicity solar models are compatible with the new results*'.
Hence, the statement (I) is the correct reason and the option (a) is the correct answer.

S7. Ans. (b)
Sol. The answer to the question can be found from the second paragraph. The first sentence says, '*Neutrinos interact weakly with matter, and therefore escape almost unhindered from the Sun's interior, to reach Earth about eight minutes later.*' Were neutrinos interacting highly with matter, and it might not be possible for them to reach Earth in large numbers as a significant proportion of them would have transformed to something else due to their interaction with matters present in the interior of the Sun. If the number of neutrinos which were reaching the Earth are lesser than the number of neutrinos produced in the Sun due to the nuclear fusion reaction, then the flux calculated by the Borexino experiment would be less than the neutrino flux generated in the Sun Core and hence, the ability of the Borexino experiment to use the measured neutrino flux to work out the total power generated by nuclear reactions in the Sun's core would be less. Hence, the Borexino experiment couldn't be able to prove if nuclear fusion reactions produce more than 99% of energy produced in the Sun.

Hence, the statements (I) and (III) are correct, and the option (b) is the correct answer.

S8. Ans. (d)
Sol. Unhindered [adjective] means '*not hindered or obstructed*';
Viscous [adjective] means '*having a thick, sticky consistency between solid and liquid*';
Cryptic [adjective] means '*having a meaning that is mysterious or obscure'*;
Remiss [adjective] means '*lacking care or attention to duty; negligent*';
Imperious [adjective] means '*arrogant and domineering*';
Unbridled [adjective] means '*unconstrained*; *uncontrolled*';
From above, we can say that the option (d) is the correct answer.

S9. Ans. (c)
Sol. The answer to the question can be derived from the second sentence of the first paragraph which says, '*although noise is typically regarded as undesirable, it can be used to probe quantum effects and thermodynamic quantities.'*
Hence, the option (c) is the correct answer.

S10. Ans. (b)
Sol. The answer to the question can be found from the seventh, ninth and tenth paragraphs. Kindly notice the following sentences:
Seventh Paragraph, last sentence: *The authors took a closer look at the theory (Landuer theory) and found that it includes a noise component that occurs when solely a temperature difference is applied across a junction: delta-T noise*.
Ninth Paragraph, whole paragraph: *Because the Landauer theory is widely used, it is surprising that delta-T noise has not previously been observed. The importance of carefully considering all of the spatial temperature differences and resulting electric currents to understand the current flow in atomic and molecular contacts was pointed out in a 2013 paper, but implications for noise were not addressed.*
Tenth paragraph, first sentence: *SheinLumbroso et al. found that the Landauer theory accurately describes all of the characteristic properties of delta-T noise.*
The Landauer theory is known for many years, has been widely used and includes a noise component that occurs when solely a temperature difference is applied across a junction: delta-T noise. But still the delta-T noise is observed ***only*** recently which is somewhat surprising and reflects that rigorous analysis while conducting the experiments relating to the Landauer experiment were not made.
It seems that in that respect, the author of the passage made the highlighted sentence in the paragraph.
Hence, the option (b) is the correct answer.

S11. Ans. (b)
Sol. The answer of the question can be derived from the second-last and last sentence of the second paragraph, '*This noise is a direct consequence of the fact that electric charge is quantized—it comes in discrete units. Because the noise results from the granularity of the charge flow, it is called shot noise.'*
From above, it can be understood that the option (b) is the correct answer.

S12. Ans. (c)
Sol. The correct answer is the option (c). The correct answer to the question can be derived from the second, third and fourth sentences of the paragraph 2. It is given to us that the temperature of the electrodes A and B is zero kelvin or absolute zero, and there is a potential gradient between the two electrodes. At a temperature of absolute zero, there won't be any thermal-noise (as discussed in the paragraph 3), and because there is an absence of temperature gradient across the electrodes, so the Delta-T noise would also be absent. So, the only noise which would be observed must be the ***Shot-noise***.
Hence, the option (c) is the correct answer.

S13. Ans. (a)

Sol. Zero-degree Celsius is ***different*** from Zero-degree Kelvin. Zero-degree Celsius is **not** an absolute-zero temperature. So, the equipment is ***both*** at a ***temperature greater than absolute-zero and at a temperature-equilibrium***.
The answer to the question can be derived upon reading the second and the third paragraphs.
Upon reading the paragraph 2, we understand that there is an electronic noise, called ***shot noise***, associated because of the voltage difference across the electrodes, which is observed even at temperature of absolute-zero.
Upon reading the third paragraph, we understand that in systems that are in thermal equilibrium at non-zero temperatures (temperature greater than absolute-zero or zero-degree Kelvin), noise with distinctly different properties from shot noise comes into play which is known as ***thermal noise***.
The given system is at a thermal equilibrium at a temperature greater than absolute-zero and there is a voltage gradient across the electrodes.
So, the noises which should be observed in the experiment are ***shot noise*** *and* ***thermal noise***.
Hence, the option (a) is the correct answer.

S14. Ans. (e)
Sol. The answer to the question can be derived from when the sixth paragraph is read along with the first five paragraphs.
The first sentence of the sixth paragraph says, '*The authors observed a* ***strong increase in electronic noise****when they applied a temperature difference between the two electrodes, compared with when the electrodes were at the same temperature.*'
The phrase '*strong increase in electronic noise*' means that the noise which is observed (when there is a temperature gradient across the electrodes) ***in addition to the other noises.***
The voltage gradient across the electrodes causes ***shot noise***. Because the temperature of both the electrodes is greater than 0-degree Kelvin (absolute-zero). So, there will be ***thermal noise***.
The presence of temperature gradient across the electrodes would cause ***Delta-T noise***.
From above, we understand that all the three noises would be observed.
Hence, the correct answer is the option (e).

S15. Ans. (d)
Sol. Seminal [adjective] means 'Strongly influencing later developments';
Remis [adjective] means '*lacking care or attention to duty' negligent*';
Imperious [adjective] means '*arrogant and domineering*';
Baleful [adjective] means '*having a harmful or destructive effect*';
Formative [adjective] means '*Serving to form something, especially having a profound influence on a person's development*';
Grating [adjective] means '*irritating*';
From above, we understand that the word 'formative' has a meaning similar to the word 'seminal' and hence, the option (d) is the correct answer.