Dear IB-Y2 senior,

You will need to get started on this work now in order to be prepared when you return. If you wait until the last minute of your summer vacation, you will probably not get the work finished. You need to focus on mastering the material over the summer. On the first day back, you are expected to submit your work. You will receive a grade for this assignment. To avoid receiving a zero on your first grade, schedule a couple of hours of your summer holidays to complete the summer assignment. This will be your first grade upon your return (NO EXCUSES).

There are two assignments; Write all your answers on a separate sheet of paper and submit it.
+
I have also posted this information on G-classroom, for your reference. You can also access G-classroom for the details on these assignments.
Thanks,

Dr. Gopalsingh
IB Physics

REFERENCE:

1. **I have uploaded a copy of your Oxford-IB DP textbook on G-classroom. You have to refer page 307 to 351 to answer the questions.**
2. **You may also refer the given link to study and answer the questions: Topic 8: Energy Production**

https://www.ib-physics.net/topic-8-energy-production

SUMMER ASSIGNMENT #1

Topic 8 – Energy production :

Note: Show formulas, substitutions, answers (in spaces provided) and units!

Topic 8.1 – Energy sources

The following questions are about Sankey diagrams and power generating schemes.

The following questions are about energy sources.

1. List the sun-derived energy sources. Circle the ones that produce CO_2 during usage.
2. List the non-sun-derived energy sources. Circle the ones that produce CO_2 during usage.
3. Outline and distinguish between renewable and non-renewable energy sources.

4. Why is coal better than buffalo chips for powering a locomotive?
5. Why is petroleum better than coal for powering a car?
6. Why is petrol preferable a nuclear reactor for use in a locomotive?
7. Why is a nuclear reactor preferable to oil for use in a submarine?
8. Describe the environmental problems associated with the recovery of fossil fuels and their use in power stations.

The following questions are about nuclear power generation.

9. Distinguish between controlled nuclear and uncontrolled nuclear fission.
10. Describe what is meant by fuel enrichment and why it is necessary.
11. List two processes for enriching uranium.
12. Discuss the role of the moderator and the control rods in the production of controlled fission in a thermal fission reactor.
13. Discuss the role of the heat exchanger in a fission reactor.
14. Discuss safety issues and risks associated with the production of nuclear power.
15. Describe how the neutrons in the reaction may initiate a chain reaction?
16. Discuss the role of the moderator and the control rods in the production of controlled fission in a thermal fission reactor.

The following questions are about wind generators.

17. Outline the basic features of a wind generator.
18. Explain why it would be unwise to make a power grid having all wind generators.

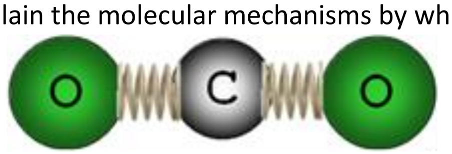
The following questions are about hydroelectric power systems.

19. Why is a dam a good component in a power grid?
20. Calculate the potential energy yield of this hydroelectric scheme.

Topic 8.2 – Thermal energy transfer

The following questions are about the greenhouse gases.

1. Explain the molecular mechanisms by which greenhouse gases absorb infrared radiation.



2. Rank (from highest to lowest in importance) the main five greenhouse gases which absorb thermal (IR) radiation.

SUMMER ASSIGNMENT #2: Notes on Option D: Astrophysics

Note: (1) You may also want to refer the posted textbook page # 641 to 665 for answers. (2) I have also shared related notes along with this assignment.

Notes

D.1 – Stellar quantities - 15 hours SL

Essential idea: One of the most difficult problems in astronomy is coming to terms with the vast distances in-between stars and galaxies and devising accurate methods for measuring them.
Nature of science: Reality: The systematic measurement of distance and brightness of stars and galaxies has led to an understanding of the universe on a scale that is difficult to imagine and comprehend.
Data Booklet reference:

• d (parsec) = 1 / p (arc-second)
• $L = \mathrm{s}AT^4$
• $B = L / (4\mathrm{p}d^2)$

D.2 – Stellar characteristics and stellar evolution

Essential idea: A simple diagram that plots the luminosity versus the surface temperature of stars reveals unusually detailed patterns that help understand the inner workings of stars. Stars follow well-defined patterns from the moment they are created out of collapsing interstellar gas, to their lives on the main sequence and to their eventual death.
Nature of science: Evidence: The simple light spectra of a gas on Earth can be compared to the light spectra of distant stars. This has allowed us to determine the velocity, composition and structure of stars and confirmed hypotheses about the expansion of the universe.
Understandings: • Stellar spectra; • Hertzsprung–Russell (HR) diagram; • Mass–luminosity relation for main sequence stars • Cepheid variables; • Stellar evolution on HR diagrams ;• Red giants, white dwarfs, neutron stars and black holes ; • Chandrasekhar and Oppenheimer–Volkoff limits

Data Booklet reference:
• $\mathrm{l}_{max}T = 2.9´10^{-3}$ m K
• L µ $M^{3.5}$

D.3 – Cosmology

Essential idea: The Hot Big Bang model is a theory that describes the origin and expansion of the universe and is supported by extensive experimental evidence.
Data Booklet reference:
• $z = \mathrm{Dl} / \mathrm{l}_0$ » v / c
• $z = R / R_0 – 1$
• $v = H_0d$
• T » $1 / H_0$

Summary of knowledge /Notes

■ **16.1 Stellar quantities**

■ Nebulae are enormous diffuse ‘clouds’ of interstellar matter, mainly gases (mostly hydrogen and helium) and dust. Large nebulae are the principal locations for the formation of stars.

■ Over a very long period of time, gravity pulls atoms closer together and eventually they can gain very high kinetic energies (that is, the temperature becomes extremely high – millions of kelvin) if the overall mass is large. The hydrogen nuclei (protons) can then have enough kinetic energy to overcome the very high electric forces of repulsion between them and fuse together to make helium. When this happens on a large scale it is called the birth of a (main sequence) star.

■ A main sequence star can remain in equilibrium for a long time because the gravitational pressure inwards is balanced by thermal gas pressure and radiation pressure outwards.

■ Many spots of light that seem to be stars are in fact binary stars, with two stars orbiting their common center of mass.

■ The forces of gravity cause billions of stars to collect in groups (galaxies), orbiting a common center of mass. Galaxies also form into groups called clusters of galaxies. These clusters are not distributed randomly in space and are themselves grouped in super clusters (the largest structures in the universe).

■ Stars formed from the same nebula within a galaxy may also form groups called stellar clusters, which are bound together by gravity and move together. Globular clusters contain large numbers of stars so that gravity forms them into roughly spherical shapes. Open clusters are newer and have fewer stars in less-well-defined shapes.

■ Stellar clusters should not be confused with constellations, which are simply patterns of stars as seen from Earth. The stars in a constellation may have no connection to each other and may not even be relatively close, despite appearances.

■ Planetary systems, like our solar system, are formed around some stars in the same process that created the star. The planets move in elliptical paths with periods that depend on the distance from the star. Comets are much smaller than planets, with typically much longer periods and more elliptical paths. When they are close to the Sun (and the Earth) they may become visible to us, and may have a ‘tail’ of particles created by the solar wind.

■ Astronomers use several different units for measuring distance. The light year, ly, is defined as the distance travelled by light in a vacuum in 1 year. The astronomical unit (AU) is equal to the mean distance between the Earth and the Sun. The parsec (pc) = 3.26 ly.

■ The order of magnitude of the diameter of the observable universe is 1011 ly. A typical galaxy has a diameter of about 104 ly and the distance between galaxies is typically 107 ly.

■ The measurement of astronomical distances is a key issue in the study of astronomy. The distance to nearby stars can be calculated from a measurement of the parallax angle between their apparent positions (against a background of more distant, fixed stars) at two times separated by 6 months.

■ One parsec is defined as the distance to a star that has a parallax angle of one arc-second.

■ d (parsec) = 1/p (arc-seconds)

■ For stars further away than a few hundred parsecs the stellar parallax method is not possible because the parallax angle is too small to measure accurately.

■ The apparent brightness, b, of a star (including the Sun) is defined as the intensity (power/ perpendicular receiving area) on Earth. The units are Wm–2.

■ The luminosity, L, of a star is defined as the total power it radiates (in the form of electromagnetic waves). It is measured in watts, W.

■ Understanding the relationship between luminosity and apparent brightness is very important in the study of astronomy – apparent brightness, b = L/4πd2, where d is the distance between the star and Earth. This assumes that the radiation spreads equally in all directions without absorption in the intervening space. For very distant stars this assumption can lead to inaccuracies.

■ The luminosity (power) of a star can be determined from the Stefan–Boltzmann law (Chapter 8): $P = e\sigma AT^4$, which reduces to $L = \sigma AT^4$ if we assume that stars behave like perfect black bodies and so have emissivity of 1.

■ **16.2 Stellar characteristics and stellar evolution** ■ Intensity–wavelength graphs are very useful for representing and comparing the black-body radiation from stars with different surface temperatures. Such graphs can be used to explain why stars emit slightly different colors. ■ Wien's displacement law (Chapter 8) can be used to calculate the surface temperature of a star if the wavelength at which the maximum intensity is received can be measured: $\lambda_{max}T = 2.9 \times 10^{-3}$mK. ■ The elements present in the outer layers of a star can be identified from the absorption spectrum of light received from the star. ■ Stars that are formed from greater masses will have stronger gravitational forces pulling them together. This will result in higher temperatures at their core and faster rates of nuclear fusion. More massive main sequence stars will have bigger sizes, higher surface temperatures, brighter luminosities and shorter lifetimes. ■ For main sequence stars the approximate relationship between mass and luminosity is represented by the equation $L \propto M^{3.5}$. ■ The Hertzsprung–Russell (HR) diagram is a common way of representing different stars on the same chart. The (logarithmic) axes of the diagram are luminosity and temperature (reversed). The sizes of different stars can be compared if lines of constant radius are included on the diagram. ■ The majority of stars are located somewhere along a diagonal line from top-left to bottom right of the HR diagram. This is called the main sequence. The only basic difference between these stars is their mass – which results in different luminosities and temperatures because of the different rates of fusion. ■ Other types of stars, like red giants, white dwarfs, supergiants and Cepheid variables (on the instability strip) can be located in other parts of the HR diagram. ■ The outer layers of Cepheid variable stars expand and contract regularly under the competing influences of gravity and thermal gas pressure. The period of the resulting changes in the observed apparent brightness is related to the star's luminosity and represented in a well-known relationship, so that a Cepheid's luminosity can be determined from its period. b = L/4πd2 can then be used to determine the distance, d, to the star and therefore the galaxy in which it is situated. ■ Inaccuracies in the data involved mean that these estimates of distance, especially to the furthest galaxies, are uncertain. This uncertainty has been a significant problem when estimating the age of the universe. ■ When the supply of hydrogen in a main sequence star reduces below a certain value, the previous equilibrium is not sustained and the core will begin to collapse inwards. Gravitational energy is again transferred to kinetic energy of the particles and the temperature of the core rises even higher than before. This results in the outer layers of the star expanding considerably and, therefore, cooling. It is then possible for the helium in the core to fuse together to form carbon and possibly some larger nuclei, releasing more energy so that the star becomes more luminous. So, the star has a hotter core but it has become larger and cooler on the surface. Its color therefore changes and it is then known as a red giant (or a red supergiant).

 ■ After nuclear fusion in the core finishes, if the original mass of a red giant star was less than a certain value (about eight solar masses), the energy that is released as the core contracts forces the outer layers of the star to be ejected in what is known as a planetary nebula. The core of the star that is left behind has a much reduced mass. It is small and luminous and is described as a white dwarf. A white dwarf star can remain stable for a long time because of a process known as electron degeneracy pressure. The Chandrasekhar limit is the maximum mass of a white dwarf star (= 1.4 × solar mass). ■ Red giants with original masses heavier than eight solar masses are known as red supergiants, but electron degeneracy pressure is not high enough to prevent further collapse and the resulting nuclear changes in the core produce a massive explosion called a supernova. ■ If the core, after a supernova, has a mass of less than approximately three solar masses (called the Oppenheimer–Volkoff limit), it will contract to a very dense neutron star. It can remain stable for a long time because of a process known as neutron degeneracy pressure. If the mass is larger than the Oppenheimer–Volkoff limit, the core will collapse further to form a black hole. ■ The changes to stars after they leave the main sequence can be traced on the HR diagram.

■ 16.3 Cosmology ■ When the line spectra emitted from galaxies are compared with the line spectra from the same elements emitted on Earth, the observed wavelengths (and frequencies) are slightly different. In most cases there is a very small increase (shift) in wavelengths, $\Delta\lambda$. Because red is at the higher wavelength end of the visible spectrum this change is commonly known as a 'red-shift'. More precisely, red-shift is defined by $z = \Delta\lambda/\lambda 0$, where $\lambda 0$ is the wavelength measured at source. ■ Red-shift occurs because the distance between the galaxy and Earth is increasing. This is similar to the Doppler Effect in which the wavelength of a source of sound that is moving away from us is increased. ■ If the shift is to a longer wavelength (a red-shift), we know that the motion of the star or galaxy is away from Earth. We say that the star is receding from Earth. ■ When the light from a large number of galaxies is studied, we find that nearly all the galaxies are receding from Earth, and each other. This can only mean that the universe is expanding. ■ The magnitude of the red-shift, z (= $\Delta\lambda/\lambda 0$), can be shown to be approximately equal to the ratio of the recession speed to the speed of light ≈ v/c. This equation can be used to determine the recession speed of galaxies, but it cannot be used for galaxies that are moving at speeds close to the speed of light. ■ The light from a small number of stars and galaxies is blue-shifted because their rotational speed within their galaxy or cluster of galaxies is faster than the recession speed of the whole system. ■ A graph of recession speed, v, against distance from Earth, d, shows that the recession speed of a galaxy is proportional to its distance away. This is important evidence for the Big Bang model of the universe – the universe began at one point at a particular time (13.8 billion years ago) and has been expanding ever since. This was the creation of everything, including both space and time. ■ Hubble's law is $v = H_0 d$ where H_0 is known as the Hubble constant (the gradient of the graph). The current value of the Hubble constant is not precisely known because of uncertainties in measurements of v and d. This equation can be used to estimate the age of the universe ($T = 1/H_0$), although it would wrongly assume that the universe has always been expanding at the same rate. ■ It is important to understand that space itself is expanding, rather than galaxies expanding into a pre-existing empty space. The universe has no centre and no visible edge. ■ The discovery of cosmic microwave background (CMB) radiation coming (almost) equally from all directions (isotropic) confirmed the Hot Big Bang model of the universe. The radiation is characteristic of a temperature of 2.76K, which is the predicted temperature Summary of knowledge 55 to which the universe would have cooled since its creation. Alternatively, the current wavelength of CMB can be considered as a consequence of the expansion of space (the wavelength emitted billions of years ago was much smaller). ■ Astronomers use the cosmic scale factor, R, to represent the size of the universe – R (at a time t) = the separation of two galaxies at time t the separation of the same two galaxies at some other selected time (usually now, so that the value of R now is 1). ■ Red-shift is related to the cosmic scale factor by $z = (R/R0) - 1$, where R0 was the value of R at the time the radiation was emitted. ■ Possible futures of the universe depend on if, and how, the expansion will continue. Simplified graphs of size of the universe (or cosmic scale factor) against time can be used to show the basic possibilities. They also represent different possibilities for the previous rates of expansion. ■ The luminosities of Type Ia supernovae are known to be (almost) all the same, so that their distances from Earth can be calculated. However, recent measurements of their associated red-shifts suggest that these very distant stars are further away than the Hubble law predicts. In other words, the universe is expanding quicker than previously believed – the universe is 'accelerating'. It had been assumed that the forces of gravity would reduce the rate of expansion of the universe. ■ The concept of 'dark energy' existing in very low concentration throughout space has been proposed as a possible explanation for the increasing rate of expansion of the universe.

ASSIGNMENT # 2 starts here: **Write definitions, mathematical equations, and examples:**

1. Accelerating universe
2. Apparent brightness, b
3. Astronomical unit (AU)
4. Big Bang model
5. Binary star system
6. Black hole
7. Blue-shift
8. Cepheid variable star
9. **Chandrasekhar limit**
10. Comet
11. Constellation
12. Cosmic microwave background (CMB)
13. Cosmic scale factor, R
14. Cosmology
15. Dark energy
16. Electron degeneracy pressure
17. Expansion of the universe
18. Hertzsprung–Russell (HR) diagram
19. Hubble's law
20. Interstellar matter
21. Isotropic
22. Light year, ly
23. Luminosity, L
24. Main sequence
25. Mass–luminosity relationship
26. Milky Way
27. Prtostar
28. Neutron stars
29. Nuclear fusion
30. **Pulsar**
31. Oppenheimer–Volkoff limit
32. Parallax angle (stellar), P
33. Parsec, pc
34. Period, T
35. Planetary nebula
36. Proton-Proton cycle
37. Plasma State of matter
38. Radiation pressure
39. Recession speed
40. Red giant (and red supergiant) stars
41. Red-shift Displacement
42. Wien's law
43. White dwarf stars
44. Universe
45. Supernova
46. Super cluster (of galaxies)
47. Main sequence star
48. Stellar spectra
49. Stellar equilibrium
50. Open clusters