Chapter 24: Space Science

P24

(A) Stars & Galaxies

1. What is meant by stellar evolution?

The process from the birth to the death of a star is called stellar evolution.

2. What is a protostar?

A protostar is a large mass that forms by contraction of the gas mostly hydrogen.

3. How is a protostar formed?

OR

How is a star born?

The birth of a star begins when a gaseous cloud of hydrogen contracts due to gravity. The gaseous cloud contracts due to its own gravity. As the cloud contracts, there is increase in density which leads to increase in pressure. Gradually a spherical mass is formed at the centre of the cloud.

4. How does a protostar attain a steady state?

When a protostar continues to contract, its temperature increases to millions of degrees. The density at the centre increases as the matter is compressed. When the temperature reaches about 10 million Kelvin, some of the hydrogen nuclei fuse to form Helium nuclei producing large quantity of heat, light and radiation. The force acting outwards and the gravitational pull balances it. Thus the star reaches a steady state.

5. In which stage is the Sun?

Sun has been in the steady stage for about five billion years.

6. How does a star change from steady state to red giant stage? OR Briefly explain how a red giant is formed.

A star on reaching the steady state will start giving out steady energy. As the radiation pressure increases beyond the opposing gravitational pull, the star begins to swell. As a result of this the temperature decreases and hence emits red light. This stage of star is called Red giant.

7. Briefly explain the formation of planetary nebula.

After the red giant stage the star envelope expands, the core contracts, the temperature reaches 108 Kelvin. Helium starts converting into carbon in the core. When all the helium gets converted to carbon, the core cannot contract further. Due to the outward force, the outer envelope gets detached and thrown out into space. This stage is called planetary nebula.

8. Briefly explain the formation of white dwarf.

If a star has a mass less than 1.4 times the mass of the sun, the star collapses under gravity. Due to the high temperature, the star glows with white light of high frequency. This stage is known as white dwarf.

9. What is Chandrashekar's limit?

The value 1.4 times the mass of the sun is known as Chandrashekar's limit.

10. Write the contribution of S.Chandrashekar in the field of astronomy.

Dr.S.Chandrashekar developed the theory of white dwarf and showed that if mass of a star is greater than 1.4 times the mass of the sun, its life will end by collapsing into a black hole.

11. Name the stages of stellar evolution of sun like stars in the galaxy.

Protostar ⟶ Steady state ⟶ Red giant ⟶ Planetary nebula ⟶ White dwarf

12. Name the stages of stellar evolution of massive stars.

Protostar ⟶ Steady state ⟶ Red giant ⟶ Supernova ⟶ Neutron star or Black hole

13. Briefly explain the evolution of stars which are more massive than the sun.

Stars which are 5 times more massive than the sun evolve in different way after the red giant stage. Several stages of nuclear reactions get ignited one after the other. The carbon nuclei produced during the fusion of helium forms carbon core. The carbon nuclei in the core fuse and liberate energy. Heavier elements like oxygen, magnesium and silicon. The fusion continues till element iron is formed. The star explodes as a supernova.

14. What is a supernova?

The explosion of a star that is 5 times or more massive than the sun is called supernova.

15. What is a neutron star? How is it formed?

A star whose core contains only neutrons is called neutron star.

If the remnants of supernova condense to a core composed of tightly packed neutrons, then it becomes a neutron star.

16. What is a pulsar?

Fast spinning neutron stars emitting radiation in pulses are called pulsars.

17. What are quasars?

Quasar is the short form of “Quasi Stellar radio sources”. Quasars are galaxies that are thousand times brighter than ordinary galaxies which emit radiowaves.

18. Briefly explain the evolution of stars which are 30 times the mass of the sun.

OR

What is a black hole? How is it formed?

A black hole is a region of intense gravitational field.

If a star has a mass of 30 times the mass of the sun, then the remnants of the supernova explosion compress into a very small region of intense gravitational field.

19. What properties of a black hole can be recognized?

Density and gravity of a black hole can be recognized.

20. Why cannot the properties like temperature, pressure or chemical composition of black holes be determined?

No information in the form of light or radio waves comes out of black hole. Hence we cannot determine the properties of a black hole except density and gravity.

21. How is the presence of black holes detected?

The presence of a black hole can be inferred from the gravitational force it exerts on bodies close to it.

22. When can sun become a black hole?

Sun would become a black hole if it is compressed to a radius of 3km.

23. Why do stars differ in their colour?

Stars differ in their colour because of different surface temperatures.

24. On what factor does the colour of a star depend?

Colour of a star depends on the surface temperature.

25. How is the temperature of stars determined?

Analysis of the lines of spectrum of a star helps us to identify the elements present in the star. The intensity distribution of these elements decides the apparent colour of the star.

26. Write the temperature of the following stars and their colour.

Betelgeuse, Arcturus, Sun, Sirius, Rigel

Star	Temperature	Colour
Betelgeuse	2000K to 3500K	Red
Arcturus	3500K to 5000K	Orange yellow
Sun	5000K to 6000K	Yellow
Sirius	6000K to 10,000K	Yellowish white
Rigel	10,000 to 50,000K	Bluish white

27. What is a galaxy?

A galaxy is a huge collection of stars held together by gravitational force.

28. How can we know the information about the velocities of galaxies?

The velocity of galaxies can be known by studying the spectral lines.

29. What is the name of our galaxy? What type of galaxy is it?

Our galaxy is called Milky Way. It is a spiral galaxy.

30. Write short notes on Milky Way galaxy.

a) Milky Way galaxy is a spiral galaxy.
b) Its diameter is about one lakh light years.
c) It appears like a flat disc with a central bulge when viewed from the edge.
d) Its central thickness is 6000 light years.

e) Sun is located about 28,000 light years from the centre.

f) It takes about 250 million years to go around the centre of our galaxy.

31. How are galaxies classified?

The three fundamental types of galaxies are:

a) Elliptical galaxy

b) Spiral galaxy

c) Irregular galaxy

32. Differentiate between elliptical and spiral galaxy.

Elliptical galaxy	Spiral galaxy
They are relatively dim	They are bright
They are difficult to see	They are most beautiful to see
They have older stars	They have newly formed stars

33. What is the essence of big bang theory?

Edwin Hubble, an American astronomer studied various galaxies and showed that the universe is expanding. At the beginning of the universe, all the matter comprising of stars and galaxies were compressed into a fiery ball. The fire ball exploded with a bang which started the expansion of the universe. This is the essence of big bang theory.

34. What is the evidence for the expanding universe?

The red shift of galaxies shows that they are moving away from us at enormous speeds.

35. State Hubble's law.

The velocity of recession of a celestial body is proportional to its distance from us

36. Which are the two factors that are related to one another according to Hubble's law?

Velocity of celestial bodies and distance from earth.

(B) Rockets & Artificial Satellites

37. How is a rocket different from an aircraft?

Aircraft uses oxygen in the atmosphere where as a rocket has to carry the necessary oxidizer to burn the fuel.

38. How are rockets able to operate in space?

Rockets are able to operate in vacuum or space as they carry oxidizer to burn the fuel.

39. What is an oxidizer?

The substance that provides oxygen to burn the fuel is called oxidizer.

40. What is a propellant?

The mixture of oxidizer and fuel is called propellant.

41. Name some rocket propellants.

a) Liquid hydrogen & liquid oxygen
b) Kerosene & liquid oxygen
c) Hydrazine & nitric acid
d) Synthetic rubber & liquid oxygen
e) Cellulose base compound & liquid oxygen
f) Polybutadiene& acrylic acid with aluminium percolate

42. On what principle does the launching of rocket work?

Launching of rocket works on the principle of Newton's Third law of motion & the law of conservation of momentum.

43. State the principle of conservation of momentum.

The total momentum of the system is conserved when the net force acting on the system is zero.

44. Explain how the principle of conservation of momentum is involved in rocket working.

During firing of rocket, the fuel burns & is converted into gases at high pressure. The gases escape from the nozzle of rocket with a high velocity. The rocket acquires an equal momentum in opposite direction.

45. Define payload.

The scientific instruments which is usually placed in the front region of the rocket is called payload.

46. State the factors on which the acceleration of rocket depends.

a) Amount of fuel burnt
b) Exhaust velocity
c) Mass of the rocket

47. Define thrust on the rocket.

Thrust on the rocket is the product of rate of fuel consumption and velocity of exhaust gases.

Thrust = Rate of fuel consumption x Exhaust velocity

Thrust = $R \times V_{ex}$

48. Mention the practical aspects to be considered while launching a rocket.

a) As the rocket consumes fuel every instant, its mass goes on decreasing.
b) The acceleration due to gravity changes continuously as the rocket ascends.
c) The atmosphere offers resistance in the lower layers of atmosphere.

49. Define payload ratio.

The ratio of payload mass (m) to the ratio of the fuel mass (M) is called payload ratio.

$$\text{Payload ratio} = \frac{\text{Payload mass}}{\text{Fuel mass}} = \frac{m}{M}$$

50. Explain the parts of a single stage rocket.

A single stage rocket consists of:

a) Payload – The scientific instruments placed in the front portion of rocket.

b) Propellant – Fuel & oxidizer is called propellant.

c) Valves – The quantity of propellant reaching the engine is controlled by the valves.

d) Engine – It is the most important part of a rocket. It is a chamber where combustion of fuel takes place.

e) Nozzle – Burning of fuel in the engine produced gases which escape at high pressure through the nozzle which in turn helps to lift the rocket.

51. What is meant by streamlining of rocket? What is its function?

The characteristic external shape of the rocket is called streamlining of rocket.

Streamlining of rocket minimizes the friction of air. It also gives stability to the rocket when it moves in the earth's atmosphere.

52. Draw a neat diagram of a single stage rocket and label the parts.

53. Define orbital velocity.

The velocity of the satellite along a circular path is called orbital velocity. It is denoted by Vo.

54. Derive an expression for the orbital velocity of a body revolving around the earth at a height 'h'.

We know that centripetal force $F_{cp} = \frac{MV_o^2}{R+h}$ ----------(1)

Gravitational force $= F_g = \frac{GMm}{(R+h)^2}$ ----------(2)

Equating (1) and (2)

$$\frac{MV_o^2}{(R+h)} = \frac{GMm}{(R+h)^2}$$

Cross multiplying

$MV_o^2 (R+h)^2 = GMm (R+h)$

$$V_o^2 = \frac{GM}{(R+h)}$$

$$V_o = \sqrt{\frac{GM}{(R+h)}}$$

Where V_o=orbital velocity
G= Gravitational constant
M=Mass of earth
R=Radius of earth
h=height above the surface of earth

55. Write the formula for orbital velocity of an artificial satellite very close to the earth.

$$V_o = \sqrt{\frac{GM}{R}} \text{ or } V_o = \sqrt{Rg} \text{ where } g = \frac{GM}{R^2}$$

56. Mention the factors on which the orbital velocity depends.

a) Mass of the body

b) Distance of the object from the center of the body.

57. Give reason: A single stage rocket cannot be used to place satellites into orbit.

A single stage rocket cannot lift the satellite to greater heights.

58. What are multistage rockets?

Several rockets joined one on top of another to provide the necessary power is called multistage rocket.

59. Why are multistage rockets used to launch space vehicles?

A single stage rocket cannot lift heavy load to a greater height. Hence multistage rockets are used.

60. Explain the working of multistage rockets.

A multistage rocket consists of several rockets joined together one on top of another. When a multistage rocket is launched, the first stage engine begins. After travelling a certain distance, the first stage detaches from the rocket system. The engine of the second stage begins. It carries the rocket to a certain height and detaches itself. Now the 3rd stage starts and so on. Generally first stage is massive and other stages are smaller.

61. What are the advantages of multistage rockets?

a) Multistage rockets reduce the fuel consumption slightly.
b) Removal of each stage decreases the dead weight (empty tanks) of the system.
c) They can carry heavy load to greater height.
d) It increases the efficiency of the rocket.

62. What is meant by escape velocity of earth? What is its value?

The minimum velocity with which a body must be projected so that it escapes from the gravitational field of earth is called escape velocity. It is denote by Ve. The value of escape velocity is 11.2 km/s.

63. What are the factors that the value of escape velocity?

The escape velocity of an object from earth depends upon the radius of the earth and acceleration due to gravity and is independent of the mass of the object.

64. Why does a slow moving object thrown upwards fall back to the earth?

Slow moving objects fall back to earth because it cannot escape from the earth's gravitational field.

65. Write the formula for escape velocity.

$V_e = \sqrt{2Rg}$, Where Ve= Escape velocity, R=Radius of earth and g=acceleration due to gravity.

66. Calculate the escape velocity for earth given (Radius of earth is 6.37×10^6m and acceleration due to gravity is $9.8 ms^{-2}$)

67. What happens when a stone is thrown upwards with a velocity of more than 11.2km/s?

The stone would escape the earth's gravitational field.

68. Write the relation between orbital velocity and escape velocity.

Orbital velocity = $V_o = \sqrt{Rg}$

Escape velocity = $V_e = \sqrt{2Rg}$

Substituting (2) in (1)

$V_e = \sqrt{2Rg}$

$V_e = \sqrt{2} \times \sqrt{Rg}$

$V_e = \sqrt{2}\, V_o$

69. Is the escape velocity of moon greater than that on earth? Why?

No, escape velocity of moon is less than that of the earth as mass of moon is less when compared to earth.

70. What is a geostationary satellite?

An artificial satellite having a period of revolution same as that of the period of rotation of the earth is called geostationary satellite.

71. What is the main objective of launching geostationary satellites?

Establishment of communication link.

72. Why is the period of revolution of geostationary satellite more or less than 24 hours?

The period of revolution of satellite has to be the same as that of period of rotation of earth which is 24 hours.

73. How many geostationary satellites are required to cover every part of the earth?

Three geostationary satellites are required.

74. At what height should a satellite be placed to make a satellite geostationary?

Geostationary satellites must be placed 36,000km above the surface of the earth.

75. Mention the orbital period and distance from the surface of the earth of geostationary satellites.

Orbital period must be 24 hours.

Distance from the surface of the earth must be greater than 36,000km.

76. Mention the uses or applications of satellites.

Artificial satellites are used for communication, weather forecast, surveying and exploration of space.

77. Mention the achievements of Indian space programme.

India has made many achievements.

a) Indian space scientists have successfully built many types of satellites. They include communication satellites, meteorological satellites, remote sensing satellites and scientific satellites.

b) Many of these satellites have been launched from India itself using rockets like PSLV, GSLV.

c) PSLV has been used to launch many satellites of other countries.

d) India has successfully sent an unmanned spacecraft to explore the moon.
e) ISRO launched a spacecraft to explore planet Mars.

78. Expand the following.

ISRO – Indian Space Research Organisation
PSLV – Polar Satellite Launch Vehicle
GSLV – Geosynchronous Satellite Launch Vehicle

79. Name the following.

a) The place from which the first indigenous sounding rocket was launched – Thumba
b) India's first artificial satellite – Aryabhata
c) India's first experimental remote sensing satellite – Bhaskara I
d) First satellite to be launched from Indian soil – Rohini
e) India's first experimental communication satellite – APPLE
f) India's first operational remote sensing satellite – IRS 1A
g) India's first indigenously built multipurpose satellite – INSAT
h) India's first unmanned spacecraft to moon – Chandrayaan 1

Fill in the blanks:

1. The stage of star where a gaseous cloud of hydrogen is formed at the centre is **protostar**.
2. The raw material for the formation of protostar is **hydrogen**.
3. Sun is in **steady stage**.
4. The stage of the star where the outer envelope gets detached and thrown out into space is called **planetary nebula**.
5. The value of Chandrashekar's limit **1.4 times the mass of the sun**.
6. The heaviest element formed in the stellar evolution before supernova explosion is **iron**.
7. The last stage in the stellar evolution of stars which are 5 times the mass of sun is **supernova**.
8. The stage of star formed by the remnants of supernova is **neutron star**.
9. A star which is composed of tightly packed neutrons is **neutrons star**.
10. A spinning neutron star emitting radiowaves is called **pulsar**.
11. The galaxies which are brighter than ordinary galaxies are called **Quasars**.
12. The short from of 'Quasi-stellar sources' is **Quasar**.
13. The end stage of a star whose mass is 30 times the mass of the sun is **black hole**.
14. A small region having intense gravitational field is called **black hole**.
15. The properties that can be recognized in a black hole are **density** and **gravity**.
16. If the **radius** of the sun is reduced to **3km** it can become a black hole.
17. The name of our galaxy is **Milky Way**.
18. Milky Way is an example of **spiral** galaxy.
19. The unit used to measure stellar distances is **light year**.
20. The diameter of Milky Way galaxy is **one lakh light years**.
21. The central thickness of Milky Way galaxy is **6000** light years.
22. In the Milky Way galaxy, sun is located about **28,000** light years from the centre.

23. The matter in the universe was compressed into a very small fiery region called **primordial fire ball**.
24. Big Bang Theory was proposed by **Edwin Hubble**.
25. The **velocity of recession** is proportional to its **distance** from us is **Hubble's Law**.
26. The mixture of oxidizer and fuel is called **propellant**.
27. An example of solid propellant is **Polybutadiene** and **aluminium perchlorate**.
28. An example of liquid propellant is **liquid hydrogen and liquid oxygen**.
29. Rocket propulsion is based on the principle of **conservation of momentum**.
30. The scientific instruments placed in the front portion of rocket is called **payload**.
31. The product of rate of fuel consumption and exhaust velocity is called **Thrust**.
32. The ratio of payload mass to the fuel mass is called **payload ratio**.
33. The velocity of the body moving along a circular path is called **orbital velocity**.
34. The formula for orbital velocity of a satellite at a height 'h' is $V_o = \sqrt{\frac{GM}{R+h}}$.
35. Several rockets joined one on top of another is called **multistage rocket**.
36. The minimum velocity with which a rocket must be projected to get away from earth's gravitational field is called **escape velocity**.
37. The value of escape velocity for earth is **11.2 kms^{-1}**.
38. The relation between orbital velocity and escape velocity is $V_e = \sqrt{2}\, V_o$.
39. The value of escape velocity is $\sqrt{2}$ times the orbital velocity.
40. Satellites which have an orbital period of 24 hours are called **geostationary satellites**.
41. Geostationary satellites are also called **communication satellites**.
42. The number of geostationary satellites required to cover every part of globe is **three**.
43. A geostationary satellite must be placed at a height of **36,000km** from the surface of the earth.
44. The first Indian to fly into space is **Rakesh Sharma**.
45. The unmanned spacecraft sent by India to explore the moon was **Chandrayaan – 1**.
46. The first Indian built rocket was launched from **Thumba**.
47. The first Indian artificial satellite was **Aryabhatta**.
48. The first Indian remote sensing satellite was **Bhaskara 1**.
49. India's first experimental communication satellite was **APPLE**.
50. India's first indigenously built multipurpose satellite series is **INSAT**.

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