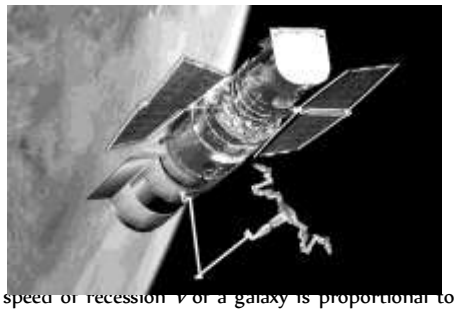
(4) **Steady state theory :** As the farthest galaxies speed away from each other, new galaxies are born to take their places. The total number of galaxies in the universe remains constant.

It is certain that : (i) The age of the universe is about 20 to 30 billion years. (ii) The most distant galaxy is situated at a distance of two billion light years away from the Earth. (iii) This galaxy is receding away from the Earth with a velocity 0.3 times that of light. (iv) The universe will live for about 100 million years more. Thus, the universe is quite young at present.

Hubble's law



(1) The speed of recession v of a galaxy is proportional to it's distance r from us *i.e.* $v \propto r \Rightarrow v = Hr$ this relation is called Hubble's law.

(2) Here H = An experimental quantity, called Hubble's constant. It's value is 19.3 *mm/sec* for each light year.

(3) Determining H has been a key goal of the Hubble's space telescope.

(4) The quantity $\frac{1}{H}$ has the dimensions of time.

(5) This time is called Hubble's times, which is an estimate of the order of magnitude of time that has elapsed since the Big Bange, and thus of the age of universe.

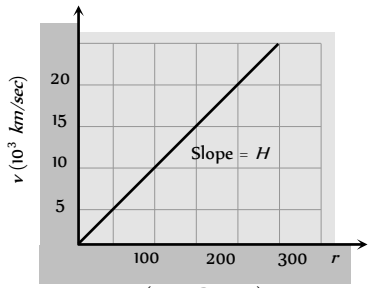


Fig. 31.7

Tips & Tricks

✍ The name black hole is given because it's gravity is so high that it prevents even light to radiate into space.

✍ Visible light is restricted from entering a telescope by dust particles in universe. Therefore range of a telescope is limited. Observation made in visible range are referred to as optical astronomy. Whereas observations made in radio range is called Radio-Astronomy.

✍ **Albedo :** The presence of atmosphere, clouds, *etc.* is acknowledged by a parameter known as albedo. It is the ratio of energy reflected by a planet to that incident on it. Clouds being good reflectors of light, they considerably increase the reflecting power of the planet and hence it's albedo is large. Venus has an albedo of 85% (highest).

✍ Mercury, Pluto and Venus do not have any satellites.

✍ On a clear night 5000 stars can be observed with naked eye.

✍ Closet star is alpha centuri (after the Sun) which is 4.3 light years away.

✍ Astronomy is branch of science which deals with the study of universe.

✍ Study of heavenly bodies is based upon visible light (λ ranging from 4000 Å to 8000 Å) and radio waves (λ ranging from 1 *mm* to 20 *m*).

✍ Hipparchus, a Greek astronomer, divided naked eye stars into six magnitude classes, on the basis of their brightness. The brightest stars were placed in the first magnitude class. Faintest visible stars were put in the sixth magnitude class.

✍ A comet does not have any tail when it is far from the Sun.

✍ **Mercury**

(i) Smallest planet (ii) Closest to the Sun

(iii) Fastest (iv) No atmosphere.

✍ Cygnus is a group of five stars. Which forms a cross like a swan.

✍ The clouds of dusty gas are called nebulae.

Ordinary Thinking

Objective Questions

Universe

1. A study of binary stars is most helpful in **[CBSE PMT 1993]**

(a) Finding their distances

(b) Finding their temperature

(c) Finding their masses

(d) Verifying Newton's force law of gravitation

2. A group of bright and faint stars is called **[AFMC 1994]**

(a) Galaxy (b) Comet

(c) Black hole (d) Constellation

3. According to modern astronomers into how many constellations, the whole sky is divided **[BHU 1994]**

(a) 10 (b) 88

(c) 880 (d) 5000

4. Which of the following theories is the most satisfactory about the origin of the universe **[CBSE PMT 1994]**

(a) Big Bang theory (b) Pulsating theory

(c) Steady state theory (d) None of these

5. Which of the planet is brightest **[BHU 1999]**

(a) Mercury (b) Venus

(c) Mars (d) Jupiter

6. A star which appears blue will be **[CPMT 1998]**

(a) As hot as the sun (b) Cooler than the sun

(c) Very cold indeed (d) Much hotter than the sun

7. Hubble showed that the universe as a whole is expanding and the distant stars are receding from us. The spectral line from a star, when compared with the corresponding line from an source will then show **[Haryana CEE 1996]**

(a) A shift in frequency towards the red end

(b) A shift in frequency towards the violet end

(c) No shift in frequency at all

(d) A shift in frequency towards the violet end as well as a decrease in intensity

8. The solar constant on the surface of the earth is *S*. What will be its value on the surface of another planet which is about 5.3 *A.U.* away from sun **[AMU 1996, 97]**

(a) $\frac{S}{5.3}$ (b) $\frac{S}{(5.3)^2}$

(c) $5.3\ S$ (d) $(5.3)\ S$

9. CO gas is found in which of the following pairs of the planet **[AFMC 1994]**

(a) Earth and Mercury (b) Mercury and Saturn

(c) Venus and Saturn (d) Venus and Mars

10. The wavelength of maximum energy, released during an atomic explosion, was $2.93 \times 10^{-}$ *m*. Given that the Wien's constant is $2.93 \times 10^{}$ *m K*, the maximum temperature attained must be of the order of **[Haryana CEE 1996]**

(a) $10^{}$ *K* (b) 10 *K*

(c) $10^{}$ *K* (d) 5.86×10 *K*

11. Black hole is a **[BHU 1995; MH CET 2003]**

(a) Hole in the ozone layer of atmosphere

(b) Hole in earth's centre

(c) Highly dense matter available in the atmosphere

(d) Hole in troposphere

12. A planet of mass M has a satellite of mass m, revolving around the planet in a circular orbit of radius r and time period T. The mass (M) of the planet is **[AMU 2000]**

(a) $\frac{4\pi^2 r^3}{GT^2}$ (b) $\frac{4\pi^2 r^2}{GT^3}$

(c) $\frac{GT^2}{4\pi r^3}$ (d) $\frac{r^3 G}{4\pi T^2}$

13. The age of universe is believed to be **[NTSE 1995]**

(a) 1 billion years (b) 10 billion years

(c) 10-20 billion years (d) 1000 billion years

14. A planet which is born sister of earth is **[AFMC 2000]**

(a) Mercury (b) Venus

(c) Mars (d) Jupiter

15. Source of Sun's energy is **[CBSE PMT 1992; KCET 1994; AFMC 1998; BHU 2000; DCE 2001]**

(a) Burning of hydrogen

(b) Fission reactions involving hydrogen

(c) Fusion reactions involving hydrogen

(d) Some other source

16. Asteroids are **[DPMT 2000]**

(a) Small planets

(b) Shooting stars

(c) Found in a belt between Earth ad Venus

(d) None of these

17. Sun radiates continuously and maintains its brightness because **[MP PMT 1990; JIPMER 1997]**

(a) Helium is converted into iron in its core

(b) Of fusion of hydrogen nuclei into helium

(c) Fusion of helium in hydrogen

(d) Burning of carbon, in its core

18. Venus appears brighter than other stars because **[MP PMT 1990]**

(a) It is heavier than other planets

(b) Its density is more than other planets

(c) It is nearer to earth in comparison to other planets

(d) Nuclear fusion takes place at its surface

19. There is no atmosphere on moon because **[MP PMT 1990]**

(a) There is no vegetation

(b) The escape velocity at its surface is very low

(c) Diffusion constant of gases is high

(d) There is vacuum in space

20. Which of the following planets have rings around it **[MP PMT 1991]**

(a) Uranus (b) Mars

(c) Jupiter (d) Saturn

21. Milky way is **[MP PMT 1991; Kerala PMT 2001]**

(a) A planet of our system

(b) A sun

(c) One of the solar system

(d) One of the enormous galaxies of universe

22. Hubble's law states that the velocity with which the 'milky way' is moving away from the earth is proportional to **[MP PMT 1991; Kerala PMT 2004]**

(a) Square of the distance of the milky way from the earth

(b) Distance of milky way from the earth

(c) Mass of the milky way

(d) Product of the mass of the milky way and its distance from the earth

23. The hottest planet of solar system is **[CBSE PMT 1992]**

(a) Mars (b) Mercury

(c) Venus (d) Pluto

24. Towards the centre of sun **[MP PMT 1992]**

(a) Density decreases

(b) Pressure decreases

(c) Temperature decreases

(d) Density and pressure increases

25. Period of revolution increases in the order of **[MP PMT 1992]**

(a) Saturn, Uranus, Venus (b) Mars, Saturn, Pluto

(c) Mercury, Neptune, Mars (d) Mars, Jupiter, Venus

26. The length of Milky way is **[MP PMT 1992]**

(a) 100,000 light years (b) 10,000 light years

(c) 1000 light years (d) 100 light years

27. Which of the nine planets is nearest to sun **[CBSE PMT 1992]**

(a) Venus (b) Mercury

(c) Mars (d) Jupiter

28. An extremely hot star would appear to be **[AMU 1996, 97]**

(a) Red (b) Blue

(c) Yellow (d) Orange

29. The sun emits a light with maximum wavelength 510 mm while another star X emits a light with maximum wavelength of 350 nm. What is the ratio of surface temperature of sun and the star X

(a) 2.1 (b) 0.68

(c) 0.46 (d) 1.45

30. A double star is a system of two stars rotating about their centre of mass only under their mutual gravitational attraction. Let the star have mass m and $2m$ and their separation be l. Their time period of rotation about their centre of mass will be proportional to **[JIPMER 2000]**

(a) $l^{2/3}$ (b) l

(c) $m^{1/2}$ (d) $m^{-1/2}$

31. Hubble's law is related with **[AIIMS 2002; Pb. PET 2002]**

(a) Comet (b) Speed of galaxy

(c) Black hole (d) Planetary motion

32. 'Albedo' is **[Pb. PET 2001; BHU 2001; Kerala PET 2002; AFMC 2002]**

(a) Reflecting power of a heavenly body

(b) Transmitive power of a heavenly body

(c) Absorptive power of a heavenly body

(d) Refracting power of a heavenly body

33. According to the pulsating theory the expansion and contraction of the universe repeats after every **[TNPCEE 2002]**

(a) 11 years (b) 8 billion years
(c) 8 million years (d) 80 billion years

34. Meteors are **[TNPCEE 2002]**
(a) Small stars
(b) Burnt pieces of comets that fall on earth
(c) Comets without tails
(d) None of these

35. Which of the following helps us in the determination of the temperature of sun **[CBSE PMT 2001]**
(a) Kirchhoff's law (b) Maxwell Boltzmann law
(c) Planck's law (d) Stefan's law

36. How does the red shift confirms that the universe is expanding **[Pb. PMT 1997; AIIMS 2001]**
(a) Due to Wien's law (b) Due to Stefan's law
(c) Due to Kirchhoff's law (d) Due to Doppler's effect

37. Two stars P and Q are observed at night. Star P appears reddish while, star Q is white. From this we conclude **[Roorkee 1992]**
(a) Temperature of Q is higher than that of P
(b) Temperature of Q is lower than that of P
(c) Star Q is at the same distance at that of star P
(d) Star P is farther than star Q

38. Albedo is maximum for **[Pb. PET 2000]**
(a) Pluto (b) Venus
(c) Earth (d) Mercury

39. When original mass of star is greater than 5 M (M = mass of the sun). The death of this star will give rise to **[Pb. PET 2000]**
(a) White dwarf (b) Black hole
(c) Quasars (d) Nebula

40. The tail of the comet is due to **[Pb. PET 2002]**
(a) Vaporisation of water on the comet
(b) Sublimation of vapour in the comet
(c) Cooling of water in the comet
(d) Vaporisation of heat in the comet

41. In our solar system, there is one sun and **[BHU 2004]**
(a) Seven planets
(b) Nine planets
(c) Eleven planets
(d) Indefinite number of planets

42. Which one of the following planet has the longest day **[AFMC 2003]**
(a) Venus (b) Mars
(c) Mercury (d) Earth

43. Which one of the following is known as Saptarishi **[AFMC 2003]**
(a) Orion (b) Ursa major
(c) Ursa minor (d) Scorpion

44. Smaller pieces of heavy stones and metals which on entering earth's atmosphere burns out are **[AFMC 2003]**
(a) Comets (b) Meteorites
(c) Asteroids (d) All of these

45. In determining the temperature of a distant star, one makes use of **[DCE 2003]**
(a) Kirchhoff's law (b) Stefan's law
(c) Wien's displacement law (d) None of these

46. The motion of planets in the solar system is an example of conservation of **[DCE 2001, 03]**
(a) Mass (b) Momentum
(c) Angular momentum (d) Kinetic energy

47. Mass of earth has been determined through **[Kerala (Engg.) 2002]**
(a) Use of Kepler's T/R constancy law
(b) Sampling the density of earth's crust and using R
(c) Cavendish's determination of G and using R and 'g' at the surface
(d) Use of periods of satellites at different heights above earth's surface

48. The galaxies are moving away from each other. It is explained by
(a) White dwarf star (b) Red shift
(c) Neutron star (d) None of these

49. Speed of recession of galaxy is proportional to it's distance **[DCE 1999]**
(a) Directly (b) Inversely
(c) Exponentially (d) None of these

50. Great bear is a **[DCE 1998]**
(a) Star (b) Galaxy
(c) Constellation (d) Planet

51. Surface temperature of the sun is of the order of **[DCE 1996]**
(a) 5000 K (b) 7000 K
(c) 6000 K (d) 12000 K

52. The colour of a star is an indication of its **[BCECE 2005]**
(a) Weight (b) Distance
(c) Surface temperature (d) Size

53. Which of the following is coldest planet **[BCECE 2005]**
(a) Mercury (b) Pluto
(c) Earth (d) Venus

54. According to Hubble's law, the redshift (Z) of a receding galaxy and its distance r from earth are related as **[AIIMS 2005]**
(a) $Z \propto r$ (b) $Z \propto 1/r$
(c) $Z \propto 1/r^2$ (d) $Z \propto r^{3/2}$

55. The condition for a uniform spherical mass m of radius r to be a black hole is [G = gravitational constant and g = acceleration due to gravity] **[AIIMS 2005]**
(a) $(2Gm/r)^{1/2} \le c$ (b) $(2Gm/r)^{1/2} = c$
(c) $(2Gm/r)^{1/2} \ge c$ (d) $(gm/r)^{1/2} \ge c$

56. Fraunhofer lines of the solar system is an example of **[AIIMS 2001]**
(a) Emission spectrum
(b) Emission band spectrum
(c) Continuous emission spectrum
(d) Line absorption spectrum

57. The difference in the lengths of a mean solar day and a sidereal day is about **[AIIMS 2003]**
(a) 1 min (b) 4 min

(c) 15 min (d) 56 min

Critical Thinking

Objective Questions

1. A bright star is indicated to have a brightness magnitude of – 5 compared to a star of brightness zero magnitude. It means that this star compared to the reference star of zero brightness is

(a) 100 times less bright (b) 5 times more bright

(c) 5 times less bright (d) 100 times more bright

2. The sun revolves around the galaxy with a speed of 250 *km/sec* and it's radius is $3 \times 10^{\cdot}$ light year. The mass of the milky way is

(a) $3 \times 10^{\cdot}$ *kg* (b) $3 \times 10^{\cdot}$ *kg*

(c) $5 \times 10^{\cdot}$ *kg* (d) $6 \times 10^{\cdot}$ *kg*

3. There are certain types of stars called visible stars which undergo periodic change in their light output. If such a star quadruple it's light output, how much does it's magnitude change

(a) – 1.25 (b) – 1.5

(c) – 1.75 (d) – 2

4. A particular emission line, detected in the light from a galaxy, has a wavelength $\lambda' = 1.1\lambda$, where λ is the proper wavelength of the line. The galaxy distance from us

(a) $1.6 \times 10^9 ly$ (b) $0.97 \times 10^9 ly$

(c) $2.4 \times 10^9 ly$ (d) $1.62 \times 10^{11} ly$

5. Assuming that the dimmest visible star to the naked eye has a magnitude of about 6. Brightness of planet Venus (magnitude = – 4) *w.r.t.* this star is

(a) 10,000 times brighter (b) 2000 times brighter

(c) 15000 times brighter (d) 4000 times brighter

6. A galaxy is observed to be moving with a velocity of 8600 *km-sec*. If it is at a distance of 430 million light year from us, Hubble constant and corresponding age of the universe are respectively

(a) $2 \times 10^{-5} \frac{kms^{-1}}{ly}, 1.49 \times 10^{10}\ year$

(b) $2 \times 10^{-6} \frac{kms^{-1}}{ly}, 1.58 \times 10^{3} year$

(c) $10^{6} \frac{kms^{-1}}{ly}, 1.49 \times 10^{10} year$

(d) None of these

7. Consider a binary star system consisting of two stars of masses M_1 and M_2 separated by a distance of 30 AU with a period of revolution equal to 30 years. If one of the two stars is 5 times farther from the centre of mass than the other. The masses of the two stars in terms of solar masses are

(a) 5, 15 (b) 25, 5

(c) 25, 10 (d) 7, 25

8. A planet of mass m moves in an ellipse around the sun of mass M_S so that its maximum and minimum distances are r_1 and r_2 respectively. The angular momentum of the planet relative to the centre of the sun is

(a) $\sqrt{\frac{2GM_S r_1}{(r_1 + r_2)}}$ (b) $\sqrt{\frac{2GM_S m^2 r_1 r_2}{(r_1 + r_2)}}$

(c) $\sqrt{\frac{GM_S r_1 r_2}{(r_1 + r_2)}}$ (d) $\sqrt{\frac{2GM_S}{r_1 r_2 (r_1 + r_2)}}$

9. The percentage of Sun's total energy which reaches the earth's surface is

(a) $10^{\cdot}$ % [Kerala PMT 2003] (b) $10^{\cdot}$ %

(c) $10^{\cdot}$ % (d) $10^{\cdot}$ %

10. Suppose a planet goes around Sun with a linear speed twice as fast that of earth. What will be it's orbit size as compared to that of earth ? (Radius of earth = R)

[BHU 1993]

(a) $R / 4$ (b) $R / 2$

(c) R (d) $2R$

Assertion & Reason

For AIIMS Aspirants

Read the assertion and reason carefully to mark the correct option out of the options given below:

(a) If both assertion and reason are true and the reason is the correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of the assertion.
(c) If assertion is true but reason is false.
(d) If the assertion and reason both are false.
(e) If assertion is false but reason is true.

1. Assertion : The stars twinkle while the planets do not.

Reason : The stars are much bigger in size than the planets. [AIIMS 2003]

2. Assertion : A pulsor is a source of radio waves which change in terms of intensity at regular interval of time

Reason : A pulsor is a rotating neutron star

[AIIMS 1998, 2002]

3. Assertion : The comet do not obey Kepler's laws of planetary motion

Reason : The comet do not have elliptical orbit

[AIIMS 1995]

4. Assertion : A star which appears blue will be much hotter than the sun

Reason : It is based on Wien's law

5. Assertion : There is no atmosphere on moon

Reason : Escape velocity at the surface of moon is low.

6. Assertion : Red shift confirms that the universe is expanding

Reason : Wavelength of red light is maximum in the visible region

7. Assertion : Sun is at the galactic centre C of the milky way

Reason : All planets of solar system revolve around the sun.

8. Assertion : Moon is seen as it partly reflects the sun light falling on it

Reason : Moon is a satellite of earth. It does not emit light of its own

9. Assertion : The value of Hubble's constant is 16 km/s