



End Semester Examination 2023
SC 302: Physics II

Total Time: 3 hours

Total Marks: 90

Note: Assume suitable data, if necessary. Answer all parts of a question at one place.

[25x1=25]

I. Fill in the blanks: (Write only answers)

1. When the fuel-supply of a very massive star has finished, we can see a _____ in the sky.
2. 1 Light year = _____ $\times 60 \times 60 \times 24 \times 365$ m.
3. In Astronomy, parsec is the unit used for measurement of _____.
4. ${}^{238}\text{U}$ is not suitable as fuel in nuclear reactors because _____.
5. Two stars A and B are having apparent brightness +10 and -25 respectively. In the night sky, star B is twinkling _____ than star A.
6. In Orion constellation, the surface temperature of red Betelgeuse is _____ than blue-white Rigel.
7. Star X with a smaller B - V color index appears _____ than a star Y with a larger value of B - V.
8. Star Rigel (B type) is _____ than the Sun (G type).
9. From Harvard classification, the strength of Balmer lines diminishes at about 10,000K due to _____ of hydrogen.
10. _____ are the particles exchanged between nucleons.
11. _____ principle allows the exchange of particles between nucleons, without violating conservation of energy.
12. The surface energy contribution for the binding energy is _____ for ${}^7_3\text{Li}$ than ${}^{209}_{83}\text{Bi}$.
13. The stability of ${}^7_3\text{Li}$ nucleus is _____ as compared to that of ${}^{16}_8\text{O}$.
14. The odd-odd nuclei yield _____ total angular momenta.
15. The intensity of radioactive rays emitted by _____ element is stronger than that of Uranium.
16. If the magnetic field is pointing towards you, α - rays will be deviated towards your _____.
17. _____ Uranium isotope is the best suitable element as fuel in nuclear fission reactor.
18. The _____ star has the largest proper motion.
19. A celestial object which produces streaks of light when it crosses Earth's atmosphere is _____.
20. Right ascension $\alpha = 75^\circ$ is equal to _____ hours in time units.
21. _____ constellation is called the "Great Bear".
22. The shell model of nucleus predicts _____.
23. Only _____ component of the velocity of a star can be determined by Doppler shift.
24. In the HR diagram, a branch of stars with low luminosity but very hot temperatures are called _____.
25. Along the main sequence, the mass of a B type star is _____ than that of the K type star.

[10 x 2 = 20]

II. Fill in the blanks: (Write only answers)

- I. According to Bohr's theory of nuclear reactions, a _____ nucleus is formed at first stage which has _____ memory of how it was formed.

- Star 1 has an apparent magnitude = 7.5 and Star 2 has an apparent magnitude = 5.5. The brightness of Star 1 is _____ than star 2 by _____ times?
- The Harvard spectral classification has been established on the basis of _____ and _____ equations.
- The spectral class of two stars having the same surface temperature is G2. One star is in supergiant phase while other is in main sequence phase. Their luminosity classes are _____ and _____ respectively.
- Consider stars A and B from spectral type F. If B is n-times more luminous than A, then it is _____ times larger than A.
- The luminosity class of G2 bright giant star is _____ and its surface temperature is _____ that of the Sun.
- Virgo galaxy is far away from Earth as compared to Andromeda. Using _____ law we can conclude that _____ galaxy is moving faster.
- If ${}^{24}_{12}\text{Mg}$ is formed in the core of a star, then its mass is _____ the solar mass and it is formed by _____ cycle of nuclear fusion.
- _____ and _____ are the most common elements in the stellar atmospheres.
- If the Sun is viewed from one-third of Earth's distance, its brightness would _____ by a factor of _____.

III. Diagram based questions.

[5x2=10]

Q1. Draw a neat and labelled diagram of a celestial sphere. On that show:

- (i) The Earth (ii) Stars (iii) Zenith (iv) Nadir (v) Celestial equator.

Q2. Draw a Hertzsprung-Russell diagram systemically and then on that show:

- (i) Main sequence stars (ii) Red giant stars (iii) Red supergiant stars (iv) White dwarfs (v) The Sun.

[5x2=10]

IV. Answer the following:

- At radioactive equilibrium, the atomic ratio between radioisotopes X and Y in a mineral sample is found to be $5 \times 10^8 : 1$. Find $T_{1/2}$ (Y). (Given: $T_{1/2}$ (X) = 3×10^{10} years)
- If a star is 2.5 pc away from the Earth, then it is how many times the distance to the Sun.
- Suppose Vega star is overhead at 12 noon on your 20th birthday. Let n_p and n_s be the number of sidereal and solar days. When your age increases by 9 months, find n_p in units of n_s .
- A wood is thought to have been cut about 10 years ago. It contains the following radioisotopes: X ($T_{1/2} = 100$ s), Y ($T_{1/2} = 6$ yrs) and Z ($T_{1/2} = 500$ yrs). Which of the three isotopes will you use to determine the age of the wood accurately? Explain why you chose that.
- What is the limitation on the fuel that can be used in a reactor whose moderator is light water? Why is the situation different if the moderator is heavy water?

[25 marks]

V. Answer the following:

I. For the following reaction:



- (i) Find the Q value. (ii) What is the threshold energy if ${}^4\text{He}$ nuclei are incident on protons at rest? ($m({}^1\text{H}) = 1.007825$ u, $m({}^4\text{He}) = 4.002602$ u, $m({}^2\text{H}) = 2.014102$ u, $m({}^3\text{He}) = 3.016029$ u) [4]

2. A piece of wood from a recently cut tree shows 12.4 decays per minute. A sample of the same size from a tree cut thousands of years ago shows 3.5 decays per minute. What is the age of this sample? ($T_{1/2}({}^{14}\text{C}) = 5730 \text{ years}$) [4]
3. The apparent magnitude of a star X is 2.4 and its distance is $4.5 \times 10^{-6} \text{ pc}$. Calculate its absolute magnitude and distance modulus. [4]
4. A galaxy in the constellation Gemini is receding from the earth at 15,000 km/s. If one of the characteristic wavelengths of the light the galaxy emits is 550 nm, what is the corresponding wavelength measured by astronomers on the earth? [4]
5. The luminosity of the Sirius is $25.4L_{\odot}$ ($L_{\odot} = 3.839 \times 10^{26} \text{ W}$), radius $1.77R_{\odot}$ ($R_{\odot} = 6.95508 \times 10^8 \text{ m}$) Find (i) the effective temperature (ii) the radiant flux received by Earth above its absorbing atmosphere, at a distance of 10 pc? (iii) peak wavelength. [5]
6. Define Hubble's law with diagram.
A galaxy is receding from us with a velocity of 1440 km/s. How far away is the galaxy according to Hubble's Law? The Hubble parameter is 72 km/s/Mpc. [4]