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PHH 552

IV Semester M.Sc. Degree Examination, September/October 2022

PHYSICS

Astrophysics and Relativity

Time : 3 Hours

Max. Marks : 70

Note : Answer **any four** questions choosing **one** from **each** of the Parts – I to IV and **two** questions in Part – V.

PART – I

1. a) Explain the trigonometric parallax method of measuring stellar distances.
b) Derive an expression for the distance to a star in terms of its distance modulus.
c) What is the distance to a star whose parallax is 0.1 arc sec ?
Given : $1 \text{ pc} = 2.06 \times 10^5 \text{ AU}$ (or $3.09 \times 10^{13} \text{ km}$, or 3.26 light years). A star is at a distance of 100 pc, and its apparent magnitude is 5. What is its absolute magnitude ? **(6+4+5)**
2. a) What is a variable star ? What are the different types of variable stars ?
Explain the cepheid group of variables.
b) What are Pulsars and Black holes ? Explain. **(7+8)**

PART – II

3. a) Explain with supportive evidences the big-bang model of the origin of universe.
b) What is an H-R diagram ? Explain its features and uses in astronomy. **(8+7)**
4. a) Describe the process of energy generation in stars.
b) What is white dwarf ? Explain. Describe the structure and properties of a typical white dwarf star. **(7+8)**

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PART – III

5. a) Derive Lorentz transformation equations and show that speed of light is a universal constant.
- b) Two rockets are leaving their space station along perpendicular paths, as measured by an observer on the space station. Rocket 1 moves at $0.60c$ and rocket 2 moves at $0.80c$, both measured relative to the space station. What is the velocity of rocket 2 as observed from rocket 1 ? **(10+5)**
6. a) Explain Relativistic Doppler Effect. Obtain expressions for the apparent change in frequencies in the case of Longitudinal and transverse Doppler effect.
- b) A neutral K meson (mass $497.7 \text{ MeV}/c^2$) is moving with a kinetic energy of 77.0 MeV . It decays into a pi meson (mass $139.6 \text{ MeV}/c^2$) and another particle of unknown mass. The pi meson is moving in the direction of the original K meson with a momentum of $381.6 \text{ MeV}/c$.
- i) Find the momentum and total relativistic energy of the unknown particle.
- ii) Find the mass of the unknown particle. **(8+7)**

PART – IV

7. a) Obtain Maxwell's equations in covariant form.
- b) Discuss the covariant differentiation of tensors and obtain equation of geodesic. **(8+7)**
8. a) What are Christoffel's symbols ? Obtain their transformation rules for first and second kind.
- b) Discuss the Schwarzschild solution of Einstein's equations and derive an expression for Schwarzschild line element. **(7+8)**

PART – V

9. Answer **any two** of the following. **(2×5=10)**
- a) Find the velocity and momentum of an electron ($E_0 = 0.511 \text{ MeV}$) with a kinetic energy of 10.0 MeV .
- b) The average lifetime of a pi meson in its own frame of reference is $2.6 \times 10^{-8} \text{ s}$. If the meson moves with a speed of $0.95c$, What is (a) its mean lifetime as measured by an observer on Earth and (b) the average distance it travels before decaying, as measured by an observer on Earth ?
- c) Explain the experiment of Rebka and Pound.
- d) Write a short note on Neutron stars.
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