Register Number:
DATE:

ST. JOSEPH'S COLLEGE (AUTONOMOUS), BANGALORE-27

M.Sc. PHYSICS - IV SEMESTER

SEMESTER EXAMINATION: APRIL 2022
(Examination conducted in July 2022)

PHDE 0420/0418 - ASTROPHYSICS

Time- 2 1/2 hrs. **Max Marks-70**

This question paper has 4 printed pages and 2 parts

PART A

Answer any FIVE full questions. **(5x10=50)**

1.
   (a) Explain the various stages of star formation.
   (b) What, in this model, creates the planets? [5+5]

2.
   (a) What are the various stages of Stellar Evolution?
   (b) What are Red Giants? Which stage of Stellar Evolution do they form? [6+4]

3. In Fig.1 is displayed a black and white image of the object M 91.

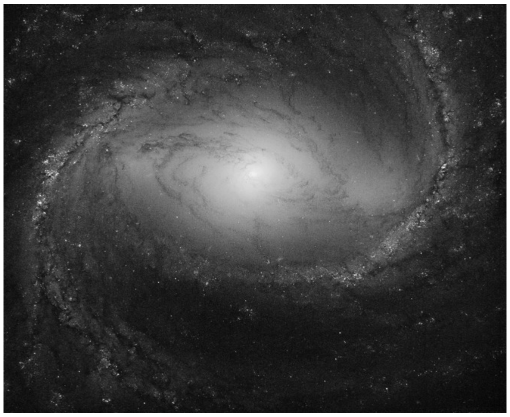


Fig.1: M91

(a) What does the letter “M” in M91 stand for?

(b) What is the object shown in the image and what type (classification) is the object classified as?

(c) If this image was to be seen in color, the wispy, stretching part at the outer ends of the image is made of blue colored dots. While the center of the object has some dark veins and is pink in color.

i. Why is the outer end blue? Explain in brief.

ii. Why is the central color pink? Explain in brief.

iii. What are the veins seen in the central portion of the image? [1+2+2+2+3]

4.

(a) What is the “Hubble Deep Field”?

(b) How many images of the “Hubble Deep Field” did we discuss in the class?

(c) What were the objects seen in those images?

(d) What do all the “Hubble Deep Field” put together mean about the universe? [2+1+1+6]

5. Write a short note on Gamma-Ray Bursts explaining:

(a) what they are,

(b) where they are located (what are the various observations and subsequent inferences – at least two – that indicate that they are far away?),

(c) there are two populations,

(d) how they manifest in various wavelengths and what that means. [1+4+2+3]

6.

(a) Derive an expression for the Keplerian velocity (tangential velocity v) of an object of mass m that is revolving around a gravitating object of mass M in a circular orbit of radius r.

(b)

i. What are color-magnitude diagrams?

ii. How can they indicate stellar evolution?

iii. What role do they play in determining the age of Globular Clusters? [5+1+2+2]

7. Brightness of an object is defined as the amount of energy passing through unit area normal to the direction of radiation per unit time per unit solid angle. Consider an extended object having brightness B_1 with a surface area σ_1 at a distance d_1 from an optical system of collecting area A. Assuming that the object is imaged at a distance d_2 with an image area of σ_2 show that the brightness of the image is equal to the brightness of the object.

PART B

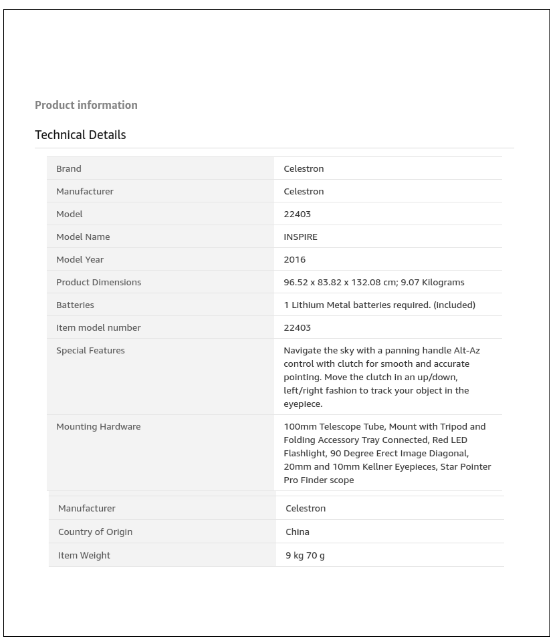
Answer any __FOUR__ full questions. (**__4x5=20__**)

[Constants: h=6.6x10^{-34} J s (Planck's constant), 1eV = 1.6x10^{-19} J (electron volt to Joules), c=2.99x10^{8} m/s (speed of light), 1Å = 1x10^{-10}m (Angstrom to meters), e = 1.6x10^{-19} C (electronic charge), m_{proton}=1.673x10^{-27}kg (mass of proton), $m_{electron}$=9.109x10^{-31}kg (mass of electron), G=6.674x$10^{-11}$$m^3kg^{-1}s^{-2}$ (Gravitational constant), $M_\odot$=1.9891x10^{30} kg (Solar mass), $R_\odot$=6.9x10^{8} m, σ = 5.67x10^{-8} W m^{-2} K^{-4} (Stefan-Boltzmann constant), M_{Earth}=5.97x10^{27}kg (Mass of Earth), $D_{earth\text{-}sun}$=1.49x10^{11}m (Earth-Sun distance), 1 inch = 2.54 cm, 1AU = 1.496x10^{11} m, 1 ly= 9.461x10^{15} m, 1 pc= 3.086x10^{16}m]

8.
(a) What is the angular diameter of Venus? [Radius of Venus: $6051.8\ \mathrm{km}$, Earth-Venus Distance: $205.22\times10^{9}\ \mathrm{m}$]
(b) How many Venuses would it take to cover the angular diameter subtended by the Sun as viewed from Earth? [3+2]

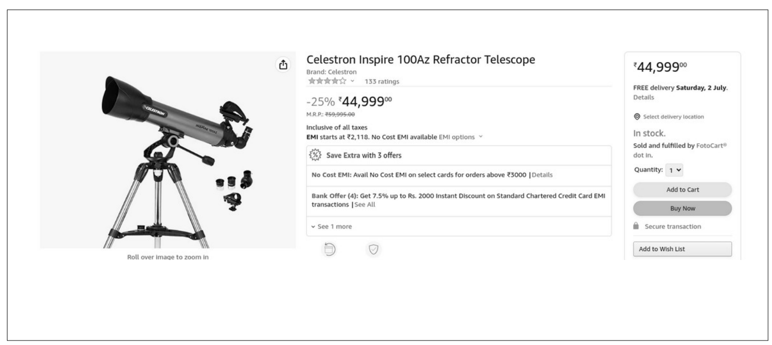
9. The Burst and Transient Sources Experiment (BATSE) on the Compton Gamma Ray Observatory (CGRO) has its second energy channel centered at $75\ \mathrm{keV}$. If we have a gamma ray telescope operating at $75\ \mathrm{keV}$ and want a resolution of $1''$ (1 arcsecond), what would be the aperture for such a telescope?

10. A telescope listed on Amazon has the following details (it comes with a CCD and an optical zoom for the CCD).


Product information

Technical Details

Brand	Celestron
Manufacturer	Celestron
Model	22403
Model Name	INSPIRE
Model Year	2016
Product Dimensions	96.52 x 83.82 x 132.08 cm; 9.07 Kilograms
Batteries	1 Lithium Metal batteries required. (included)
Item model number	22403
Special Features	Navigate the sky with a panning handle Alt-Az control with clutch for smooth and accurate pointing. Move the clutch in an up/down, left/right fashion to track your object in the eyepiece.
Mounting Hardware	100mm Telescope Tube, Mount with Tripod and Folding Accessory Tray Connected, Red LED Flashlight, 90 Degree Erect Image Diagonal, 20mm and 10mm Kellner Eyepieces, Star Pointer Pro Finder scope
Manufacturer	Celestron
Country of Origin	China
Item Weight	9 kg 70 g



(a) For a person who wants to be an avid astronomy enthusiast and staying in the city would you recommend this telescope? Explain why.
(b) Do the specifications look okay (Is the magnification fine? Are the eyepieces appropriate?
(c) Uranus and Neptune have apparent magnitudes of 5.68 and 7.78 respectively – would these planets be observable through this telescope?)?

11. One of the first high pressure Mercury Vapor Lamp (Philips Philora HP300) had a specification of 75 W. It was observed to have four lines at 5790, 5460, 4358 and 4046 Å respectively. Assuming the lamp to be a sphere of radius 1 inch, and that it radiates all its supplied power into radiation in such a manner that the 5460 Å has an arbitrary power of L_0. Lines 4046, 4358 and 5790 Å respectively have powers of $0.4 \; L_0$, $0.75 \; L_0$ and $0.5 \; L_0$. Compute the specific intensity I_λ defined as the energy per unit time per unit steradians, per unit area, per unit wavelength about 4046 Å hitting a detector kept at a distance of 5 m.

12. The following is data obtained from SDSS. The table contains the magnitude of stars in the various bands that SDSS has. Analyze the data and determine the color of the stars (explain your decision):

Name	**u**	**g**	**r**	**i**	**z**
Star 1	19.35777	20.15456,	24.80203,	17.77139,	18.46624
Star 2	16.93403	15.38486	14.69913	14.44319	14.33092
Star 3	19.81038	19.81346,	19.51732	19.45395,	19.50075

13. The spectrum of a galaxy from SDSS shows $H\alpha$ having a lab wavelength of 6562.817 Å to be located at 6875.433 Å while Na D2 is seen to be at 6170.209 Å (this line has a lab wavelength of 5895.923 Å). Obtain the redshift of the object (check for consistency in your results).