

# National Testing Agency

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## Astronomy and Astrophysics

**Group Number :** 1  
**Group Id :** 90958244  
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## Astronomy and Astrophysics

**Section Id :** 90958244  
**Section Number :** 1  
**Section type :** Online  
**Mandatory or Optional:** Mandatory  
**Number of Questions:** 70  
**Number of Questions to be attempted:** 70  
**Section Marks:** 100  
**Display Number Panel:** Yes  
**Group All Questions:** No

**Sub-Section Number:** 1  
**Sub-Section Id:** 90958246  
**Question Shuffling Allowed :** Yes

**Question Number : 1 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical**

**Correct Marks : 1 Wrong Marks : 0**

Which type of galaxy has very little dust and gas and consists mostly of old stars?

- A. Elliptical
- B. Spiral
- C. Barred Spiral
- D. Irregular

**Options :**

1. A
2. B
3. C
4. D

**Question Number : 2 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical**

**Correct Marks : 1 Wrong Marks : 0**

The mass of the central supermassive black hole in a spiral galaxy strongly correlates with

- A. the luminosity of the disk of the galaxy
- B. the colour of the bulge of the galaxy
- C. the colour of the disk of the galaxy
- D. the luminosity of the bulge of the galaxy

**Options :**

1. A
2. B
3. C
4. D

**Question Number : 3 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical**

**Correct Marks : 1 Wrong Marks : 0**

The atmosphere is equivalent to how much mass in units of  $\text{gm cm}^{-2}$  at Mumbai?

- A. 1.0
- B. 1033
- C. 13.6
- D. 800

**Options :**

1. A
2. B
3. C
4. D

**Question Number : 4 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical**

**Correct Marks : 1 Wrong Marks : 0**

Granulation patterns in the Sun can be seen as flows in

- A. Doppler grams
- B. Magneto grams
- C. EUV Imaging
- D. X-ray imaging

Options :

- 1. A
- 2. B
- 3. C
- 4. D

Question Number : 5 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

In the Sun the regions of strong magnetic field appear brighter in EUV images. This shows

- A. changing of characteristic plasma from absorption to emission
- B. action of neutrinos
- C. coupling of the solar layers
- D. coronal mass ejection

Options :

- 1. A
- 2. B
- 3. C
- 4. D

Question Number : 6 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

Which of these features is associated with highest magnetic fields in Sun?

- A. apex of coronal loops
- B. coronal holes
- C. solar winds
- D. the poles of the Sun

Options :

- 1. A
- 2. B
- 3. C
- 4. D

Question Number : 7 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

As per the general theory of relativity, gravitational waves are generated by time-varying

- A. monopole
- B. dipole
- C. quadrupole
- D. octupole

Options :

- 1. A
- 2. B
- 3. C
- 4. D

Question Number : 8 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

The gravitational wave travels at the speed of

- A. sound
- B. neutrinos
- C. electron
- D. light

Options :

- 1. A
- 2. B
- 3. C
- 4. D

Question Number : 9 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

If a gravitation wave passes through a set of test particles, the distance between the particles changes then the displacement strain is

- A. proportional to the amplitude of the radiation
- B. proportional to the square of the amplitude of the radiation
- C. does not depend on the incoming wave at all
- D. zero

Options :

- 1. A

2. B
3. C
4. D

**Question Number : 10 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical**

**Correct Marks : 1 Wrong Marks : 0**

As per general theory of relativity, gravitational waves have

- A. one state of polarisation
- B. six states of polarisation
- C. no polarisation
- D. two states of polarisation

**Options :**

1. A
2. B
3. C
4. D

**Question Number : 11 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical**

**Correct Marks : 1 Wrong Marks : 0**

As per general theory of relativity, gravitational waves are

- A. electromagnetic waves
- B. longitudinal waves
- C. transverse waves
- D. not related to the direction of propagation

**Options :**

1. A
2. B
3. C
4. D

**Question Number : 12 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical**

**Correct Marks : 1 Wrong Marks : 0**

To determine the passing gravitational wave through the space-time, one needs to

- A. monitor the position of a single test particle as a function of time
- B. measure the proper distance between at least two test particles as a function of time
- C. measure the proper distance between at least four test particles as a function of time
- D. measure the distance to the source emitting radiation

Options :

- 1. A
- 2. B
- 3. C
- 4. D

Question Number : 13 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

CCD detectors are better than photographic plates for astronomical imaging because

- A. they have a larger field of view
- B. they have a linear response to the amount of light incident
- C. they do not require cooling
- D. they are inexpensive

Options :

- 1. A
- 2. B
- 3. C
- 4. D

Question Number : 14 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

Vizier is

- A. a repository of astronomical catalogues
- B. a tool for displaying images
- C. a tool for plotting data in catalogues
- D. a Python library for image analysis

Options :

- 1. A
- 2. B
- 3. C

4. D

Question Number : 15 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

In astronomy, what is FITS?

- A. A multivariate analysis tool
- B. A library for optimised fitting to pulsar data
- C. A software for displaying astronomical images
- D. A standardised format for exchanging astronomical data

Options :

- 1. A
- 2. B
- 3. C
- 4. D

Question Number : 16 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

The Sloan Digital Sky Survey has obtained spectra for about

- A. 10,000 quasars
- B. 100,000 quasars
- C. 1 million quasars
- D. 10 million quasars

Options :

- 1. A
- 2. B
- 3. C
- 4. D

Question Number : 17 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

The synchrotron emission from a relativistic electron

- A. is equal in all directions
- B. spread over  $2\pi$  Ste radian in the forward hemisphere
- C. concentrated in a narrow cone along the direction of motion
- D. is along the magnetic field

Options :

- 1. A
- 2. B

3. C

4. D

Question Number : 18 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

Which of the following discoveries of Galileo help proved that the heliocentric theory of planetary motion is correct?

- A. Dark spots on the surface of the Sun
- B. Stars in the Milky Way
- C. The rings of Saturn
- D. The phases of the planet Venus

Options :

1. A

2. B

3. C

4. D

Question Number : 19 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

If we need to obtain a resolution of 1 milliarcsecond at 1.4 GHz using an interferometer, then we need

- A. antennas all across the world
- B. antennas all over India
- C. antennas in space orbiting the earth
- D. antennas on earth and the moon

Options :

1. A

2. B

3. C

4. D

Question Number : 20 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

Nuclear Fusion inside a massive star ( $> 10$  solar mass) stops after producing

- A. Iron peak elements
- B. Helium
- C. Carbon, Oxygen and Magnesium
- D. Rare Earth elements



**Options :**

1. A
2. B
3. C
4. D

**Question Number : 21 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical**

**Correct Marks : 1 Wrong Marks : 0**

In the interior of a neutron star, mixture of free protons and free neutrons are found

- A. in the entire volume
- B. in the core, above nuclear density
- C. in the inner crust and the core
- D. in the inner core, at densities above  $10^{18} \text{ kg m}^{-3}$

**Options :**

1. A
2. B
3. C
4. D

**Question Number : 22 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical**

**Correct Marks : 1 Wrong Marks : 0**

For images with dense distributions of stars or star clusters, the brightness of stars are estimated using

- A. timing analysis
- B. aperture photometry
- C. PSF photometry
- D. spectroscopy

**Options :**

1. A
2. B
3. C
4. D

**Question Number : 23 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical**

**Correct Marks : 1 Wrong Marks : 0**

In the dust reverberation technique of timing analysis,

- A. light from accretion disk and dusty torus are compared
- B. light from accretion disk and broad line regions are compared
- C. light from black-hole and dusty torus are compared
- D. light from narrow line and broad line regions are compared

Options :

- 1. A
- 2. B
- 3. C
- 4. D

Question Number : 24 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

Which of these is true for an adaptive optics system on a telescope?

- A. A narrower peak of the PSF is important for detecting a distant normal galaxy
- B. A larger Strehl ratio is important for imaging the centre of a star cluster
- C. A narrower peak of the PSF is important for detecting a planet that is far away from its parent star
- D. A larger Strehl ratio is important for detecting a distant normal galaxy

Options :

- 1. A
- 2. B
- 3. C
- 4. D

Question Number : 25 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

If the Fried parameter at 500 nm is 100 cm, then what is the best resolution obtainable with a large telescope without adaptive optics?

- A. 10 arc second
- B. 1 arc second
- C. 0.1 arc second
- D. 0.01 arc second

Options :

- 1. A
- 2. B
- 3. C

4. D

Question Number : 26 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

The typical density in space is 0.1 particles per cc and in the Earth's atmosphere is  $1 \times 10^{19}$  particles per cc. For a cylinder of cross section  $1\text{cm}^2$ , how long must the cylinder be in space to have the same number of particles as 1 cc of Earth's atmosphere?

- A. 0.00106 light years
- B. 1.06 light years
- C. 10600 light years
- D. 106 light years

Options :

- 1. A
- 2. B
- 3. C
- 4. D

Question Number : 27 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

To compute the standard deviation the statistical average that is used is

- A. mean
- B. mode
- C. median
- D. both mode and median

Options :

- 1. A
- 2. B
- 3. C
- 4. D

Question Number : 28 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

In the Friedman-Le Maître-Robertson-Walker (FLRW) cosmology, the space-time geometry is described by the following line-element,

$ds^2 = c^2 dt^2 - a^2(t) \left[ \frac{dr^2}{1-kr^2} + r^2(d\theta^2 + \sin^2\theta d\varphi^2) \right]$ , where  $a(t)$  is the scale-factor. It is given that  $\frac{\dot{a}}{a} > 0$ . Therefore, according to the FLRW model,

- A. all cosmic objects and structures in the universe must expand in size
- B. unbound structures having size bigger than about 200-300 Mpc expand
- C. structures and cosmic objects having size smaller than about 200 Mpc expand
- D. structures and cosmic objects having size smaller than about 200 Mpc contract

Options :

- 1. A
- 2. B
- 3. C
- 4. D

Question Number : 29 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

For the AGN unification scheme to work,

- A. the torus should be transparent to optical photons
- B. the torus should absorb the photons from the narrow-line emitting clouds
- C. the torus should absorb the photons from the broad-line emitting clouds
- D. the torus should be opaque from radio up to gamma rays

Options :

- 1. A
- 2. B
- 3. C
- 4. D

Question Number : 30 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

Among the following ISRO missions, the observatory meant for multiwavelength astronomy is

- A. Chandrayaan-1
- B. Astrosat
- C. Mars Orbiter Mission
- D. Chandrayaan-2

Options :

1. A
2. B
3. C
4. D

**Question Number : 31 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical**

**Correct Marks : 1 Wrong Marks : 0**

With reference to the electromagnetic spectrum, which one of the following statements is true?

- A. Decreasing frequency is correlated to decreasing energy
- B. An object emitting predominantly in the ultra-violet is cooler than red hot iron
- C. Increasing temperature is correlated to increasing wavelength
- D. Ultra-violet emitters are at higher temperature than gamma-ray emitters

**Options :**

1. A
2. B
3. C
4. D

**Question Number : 32 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical**

**Correct Marks : 1 Wrong Marks : 0**

A spectrum provides the properties of a photon as a function of

- A. position
- B. time
- C. polarisation
- D. energy

**Options :**

1. A
2. B
3. C
4. D

**Question Number : 33 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical**

**Correct Marks : 1 Wrong Marks : 0**

The matched filter  $q(t)$  is proportional to the signal  $h(t)$  (that is  $q(t) = Ah(t)$ , where  $A$  is a constant) in

- A. stationary noise
- B. coloured noise
- C. white noise
- D. this is never the case

Options :

- 1. A
- 2. B
- 3. C
- 4. D

Question Number : 34 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

In Astrosat, the X-ray detector covering a large field of view for regular monitoring of the X-ray sky and discovering X-ray transients is

- A. SSM
- B. UVIT
- C. SXT
- D. LAXPC

Options :

- 1. A
- 2. B
- 3. C
- 4. D

Question Number : 35 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

With reference to our solar system, choose the correct statement

- A. Sedna is the only trans-Neptunian object
- B. Mercury and Ceres are dwarf planets
- C. Uranus does not have any satellite
- D. Pluto is a trans-Neptunian object

Options :

- 1. A
- 2. B
- 3. C
- 4. D

Question Number : 36 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

Dark patches are seen in the plane of the Milky Way galaxy. These are most likely to be produced by

- A. blank parts of the galaxy where there are no stars
- B. clouds of interstellar material that contain dust particles
- C. supernova explosions that have pushed away nearby stars
- D. black holes that bend light away from our line of sight

Options :

- 1. A
- 2. B
- 3. C
- 4. D

Question Number : 37 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

The physical process that efficiently stops star formation of a galaxy moving swiftly in the core of a galaxy cluster is known as

- A. galaxy harassment
- B. strangulation
- C. downsizing
- D. ram-pressure stripping

Options :

- 1. A
- 2. B
- 3. C
- 4. D

Question Number : 38 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

Till what radial distance from the centre of the Sun, does the Sun rotate as a solid body? ( $R_{Sun} = 6.95 \times 10^5 \text{ km}$ )

- A.  $\sim 2 \times 10^5 \text{ km}$
- B.  $\sim 10 \times 10^5 \text{ km}$
- C.  $\sim 4.8 \times 10^5 \text{ km}$
- D.  $\sim 6.95 \times 10^5 \text{ km}$

**Options :**

1. A
2. B
3. C
4. D

**Question Number : 39 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical**

**Correct Marks : 1 Wrong Marks : 0**

The slope of the radio spectrum of a dead radio galaxy no longer powered by the central black hole steepens with time since

- A. the rate of energy loss is higher for higher frequencies
- B. the rate of energy loss is lower for higher frequencies
- C. the loss due to Hubble expansion of the radio galaxy is higher for higher frequencies
- D. the loss due to Hubble expansion of the radio galaxy is lower for higher frequencies

**Options :**

1. A
2. B
3. C
4. D

**Question Number : 40 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical**

**Correct Marks : 1 Wrong Marks : 0**

The suitable place for a habitable planet in our Galaxy is

- A. near the central bulge
- B. inside the spiral arms
- C. at the edge of the Galaxy
- D. within the gap between two spiral arms

**Options :**

1. A
2. B
3. C
4. D

<b>Sub-Section Number:</b>	2
<b>Sub-Section Id:</b>	90958247
<b>Question Shuffling Allowed :</b>	Yes



Question Number : 41 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

A scalar field is expected to vanish on the infinite plane  $x = 0$  in  $(3 + 1)$ -dimensional Minkowski spacetime. In such a case, the modes of the scalar field will depend on the  $x$ -coordinate as

- A.  $\cos(k_x x)$
- B.  $\sin(k_x x)$
- C.  $\exp - (i k_x x)$
- D.  $\exp (i k_x x)$

Options :

- 1. A
- 2. B
- 3. C
- 4. D

Question Number : 42 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Consider a solar mass star orbiting the  $4 \times 10^6$  solar mass black hole at the centre of our Galaxy in a circular face-on orbit, once every 4 years. The radius of the orbit is

- A.  $4 \times 10^{-6} pc$
- B.  $0.002 pc$
- C.  $0.006 pc$
- D.  $2 pc$

Options :

- 1. A
- 2. B
- 3. C
- 4. D

Question Number : 43 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

The star in the previous question is observed by a telescope here regularly. The Sun is 8 kpc from the galactic centre. Which of these telescopes can distinguish the positions of the star 2 years apart?

- A. 10 m telescope with perfect adaptive optics at 400 nm
- B. 5 m telescope with perfect adaptive optics at 2 micron
- C. 1 m telescope in space at 2 micron
- D. 30 m telescope without adaptive optics at 200 nm

**Options :**

- 1. A
- 2. B
- 3. C
- 4. D

**Question Number : 44 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical**

**Correct Marks : 2 Wrong Marks : 0**

The distance of the galaxy M87 from the Earth is 16 Mpc and its apparent diameter on the sky is 7.2 arcmin. What is the diameter of the galaxy in kpc?

- A. 3.5 kpc
- B. 10.5 kpc
- C. 35 kpc
- D. 105 kpc

**Options :**

- 1. A
- 2. B
- 3. C
- 4. D

**Question Number : 45 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical**

**Correct Marks : 2 Wrong Marks : 0**

In the Bullet cluster, the dark matter and the hot intergalactic gas seem to be displaced from each other due to

- A. intergalactic winds from the active galactic nucleus of the central galaxy
- B. a recent collision between two clusters of galaxies
- C. supernova explosions in the galaxies of the cluster
- D. galaxies moving in the intergalactic gas with high velocities

**Options :**

- 1. A

2. B
3. C
4. D

**Question Number : 46 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical**

**Correct Marks : 2 Wrong Marks : 0**

If the variability time scale at the nucleus of a galaxy, say at X-ray wavelengths, is of the order of  $10^4$  seconds. Then the corresponding length scale of the variable component is approximately of the order of

- A. 100 pc
- B. 1 pc
- C. 0.01 pc
- D.  $10^{-4}$  pc

**Options :**

1. A
2. B
3. C
4. D

**Question Number : 47 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical**

**Correct Marks : 2 Wrong Marks : 0**

Which of these statements about the unification scheme of AGNs is true?

- A. radio loud and radio quiet populations differ in the viewing angle due to relativistic boosting of synchrotron emission
- B. radio loud quasars and radio galaxies differ in the viewing angle
- C. a Seyfert 1 seen exactly along the jet will look like a BL Lac object
- D. the unification scheme does not critically depend on the presence of a dusty torus

**Options :**

1. A
2. B
3. C
4. D

**Question Number : 48 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical**

**Correct Marks : 2 Wrong Marks : 0**

The thermal nature of Hawking radiation from collapsing black holes can be completely attributed to

- A. the properties of matter prior to collapse
- B. the structure and shape of matter prior to collapse
- C. initial conditions imposed on the quantum field at early times
- D. the exponential redshifting of the modes near the horizon

Options :

- 1. A
- 2. B
- 3. C
- 4. D

Question Number : 49 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

A purely background electric field

- A. only polarizes the vacuum
- B. only creates particles
- C. polarizes the vacuum and creates particles
- D. neither polarizes the vacuum nor creates particles

Options :

- 1. A
- 2. B
- 3. C
- 4. D

Question Number : 50 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

The mean lifetime of a hydrogen atom in the higher hyperfine level is 11 million years.

What is its spontaneous decay rate?

- A.  $18.2 \times 10^{-8} \text{ s}^{-1}$
- B.  $5.8 \times 10^{-15} \text{ s}^{-1}$
- C.  $9.1 \times 10^{-8} \text{ s}^{-1}$
- D.  $2.9 \times 10^{-15} \text{ s}^{-1}$

Options :

- 1. A
- 2. B
- 3. C
- 4. D

Question Number : 51 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Which of these statements about the method of calculation of masses of galaxy clusters is true?

- A. Virial theorem, hydrostatic equilibrium and gravitational lensing are all sensitive to the baryonic matter
- B. Virial theorem, hydrostatic equilibrium and gravitational lensing are all sensitive to the total matter
- C. Virial theorem and gravitational lensing are sensitive to the total matter and hydrostatic equilibrium is sensitive to baryonic matter
- D. Gravitational lensing is sensitive to the total matter and virial theorem and hydrostatic equilibrium is sensitive to baryonic matter

Options :

- 1. A
- 2. B
- 3. C
- 4. D

Question Number : 52 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Which of these statements is true?

- A. The speed of the Sun around the Galactic centre can be used to determine the mass within the volume enclosed by the Sun's orbit even though the Galactic mass is not concentrated at the centre
- B. The mean free path for galaxies is much larger than the mean free path for stars
- C. When our galaxy collides with the Andromeda galaxy, the stars won't collide and hence the galaxy shapes will not change
- D. The radial dependence of the speed of stars around a galaxy is independent of the radial dependence of the stellar density of the galaxy

Options :

- 1. A
- 2. B
- 3. C
- 4. D

Question Number : 53 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Our atmosphere restricts the resolution to about 1 arc second. If the Thirty Meter Telescope is built without adaptive optics, by what factor will its resolution be degraded, compared to a perfect adaptive optics system, at 500 nm?

- A. no worse
- B. 290
- C. 30
- D. 4300

Options :

- 1. A
- 2. B
- 3. C
- 4. D

Question Number : 54 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

What is the range of terminal velocities of coronal mass ejections (CMEs), having  $E_{\text{total}}$  in the range of  $10^{19} - 10^{26} J$ , with respective mass range of  $m_{\text{CME}} 10^8 - 10^{13} \text{ kg}$ . Assume that the highest energy is associated with the largest mass CME.

- A. typically range of  $V_{\text{CME}} \sim 45 - 450 \text{ km s}^{-1}$
- B. typically range of  $V_{\text{CME}} \sim 225 - 2250 \text{ km s}^{-1}$
- C. typically range of  $V_{\text{CME}} \sim 450 - 4500 \text{ km s}^{-1}$
- D. typically range of  $V_{\text{CME}} \sim 900 - 9000 \text{ km s}^{-1}$

Options :

- 1. A
- 2. B
- 3. C
- 4. D

Question Number : 55 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

A radio pulsar has a spin period of 1 sec and a spin-down age of  $10^6$  years. What is its estimated surface dipole magnetic field strength?

- A.  $3 \times 10^{10}$  G
- B.  $4 \times 10^{12}$  G
- C.  $8 \times 10^{14}$  G
- D.  $2 \times 10^{13}$  G

Options :

- 1. A
- 2. B
- 3. C
- 4. D

Question Number : 56 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

What is the approximate mass density of white dwarf material at which the equation of state makes the transition to the relativistic regime?

- A.  $7 \times 10^9 \text{ kg m}^{-3}$
- B.  $3 \times 10^6 \text{ kg m}^{-3}$
- C.  $6 \times 10^{10} \text{ kg m}^{-3}$
- D.  $5 \times 10^7 \text{ kg m}^{-3}$

Options :

- 1. A
- 2. B
- 3. C
- 4. D

Question Number : 57 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Approximately how much is the Fermi Energy of electrons at a n-p-e matter density of  $10^{15} \text{ g cm}^{-3}$ , assuming a proton fraction of 10%?

- A. 20 MeV
- B. 1 GeV
- C. 150 MeV
- D. 511 keV

Options :

- 1. A
- 2. B
- 3. C

4. D

Question Number : 58 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

In the absence of nuclear strong interaction, the maximum mass of a neutron star would have been

- A. 5.6 solar mass
- B. 2.8 solar mass
- C. 1.4 solar mass
- D. 0.7 solar mass

Options :

- 1. A
- 2. B
- 3. C
- 4. D

Question Number : 59 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

A slowly rotating neutron star with a surface dipole magnetic field strength of  $10^9$  G is accreting matter steadily at a rate of  $10^{-8}$  solar masses per year. Approximately how long will it take for the star to be spun up to a period of 10 milliseconds?

- A.  $10^6$  years
- B.  $10^4$  years
- C.  $10^{10}$  years
- D.  $10^8$  years

Options :

- 1. A
- 2. B
- 3. C
- 4. D

Question Number : 60 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0



The first quasar to be reliably identified was 3C273 at a redshift of 0.1584, which corresponds to a luminosity distance of about 760 Mpc. If its flux density is about 50 Jy at 8 GHz, what would be its luminosity at this frequency?

- A.  $3.5 \times 10^{27} \text{ W Hz}^{-1}$
- B.  $2.1 \times 10^{25} \text{ W Hz}^{-1}$
- C.  $4.3 \times 10^{29} \text{ W Hz}^{-1}$
- D.  $3.3 \times 10^{31} \text{ W Hz}^{-1}$

Options :

- 1. A
- 2. B
- 3. C
- 4. D

Question Number : 61 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

The Fried parameter is  $r_0 = 15 \text{ cm}$  at a wavelength of  $500 \text{ nm}$ , at the site of a telescope of  $4 \text{ m}$  aperture diameter. What is the value of  $r_0$  at  $2.2 \mu\text{m}$ , and what is the wavelength at which the Fried parameter becomes equal to the telescope diameter?

- A. 88 cm,  $7.7 \mu\text{m}$
- B. 45 cm,  $3.85 \mu\text{m}$
- C. 107.6 cm,  $7.17 \mu\text{m}$
- D. 20.5 cm,  $1.5 \mu\text{m}$

Options :

- 1. A
- 2. B
- 3. C
- 4. D

Question Number : 62 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

The relativistic electrons in the intra-cluster medium experience energy losses due to synchrotron emission ( $\propto B^2$ ) and due to Inverse-Compton scattering of the Cosmic Microwave Background (IC-CMB) photons. The IC-CMB losses can be expressed in terms of an equivalent magnetic field  $B_{eq}$ . The lifetime of relativistic electrons experiencing these energy losses,  $t_{life}$  is found to be,

$$t_{life} = 1.59 \times 10^9 \frac{B^{1/2}}{B^2 + B_{eq}^2} [\nu_{GHz}(1+z)]^{-1/2} \text{ yr}$$

where  $B$  and  $B_{eq}$  are in  $\mu G$  and the frequency  $\nu$  is in GHz units and  $z$  is the redshift.

What is the relation between  $B$  and  $B_{eq}$  such that the lifetime is maximised?

(HINT: Set the derivative of the lifetime as a function of  $B$  to zero and get  $B$  in terms of  $B_{eq}$ .)

A.  $B = \frac{B_{eq}}{\sqrt{3}}$

B.  $B = B_{eq}$

C.  $B = B_{eq}^2$

D.  $B = \sqrt{B_{eq}}$

Options :

1. A
2. B
3. C
4. D

Question Number : 63 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

After imposing the harmonic (or, Lorentz) gauge, the metric perturbation  $h_{\mu\nu}$  satisfies the equation  $\eta^{\mu\nu} h_{\alpha\beta,\mu\nu} = 0$ . Suppose, we make an infinitesimal coordinate transformation  $x^\mu \rightarrow x'^\mu = x^\mu + \epsilon \xi^\mu$ , then the new metric perturbation  $h'_{\mu\nu}$  satisfies,

A.  $\eta^{\mu\nu} \frac{\partial^2 h'_{\alpha\beta}}{\partial x^\mu \partial x^\nu} = 0$  if  $\eta^{\alpha\beta} \frac{\partial^2 \xi^\mu}{\partial x^\alpha \partial x^\beta} = 0$

B.  $\eta^{\mu\nu} \frac{\partial^2 h'_{\alpha\beta}}{\partial x^\mu \partial x^\nu} = 0$

C.  $\frac{\partial (h'_{\alpha\beta} - \frac{1}{2} \eta_{\alpha\beta} h')}{\partial x^\beta} = 0$

D.  $\frac{\partial (h'^{\alpha\beta} - \frac{1}{2} \eta^{\alpha\beta} h')}{\partial x^\beta} = 0$

Options :

1. A
2. B
3. C
4. D

Question Number : 64 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

In the frame-work of linearized Einstein equation, when matter is present, the local conservation of energy and momentum of the matter takes the form,

$$\frac{\partial T^{\mu\nu}}{\partial x^\nu} = 0. \text{ This is ensured because,}$$

- A. in this case, the Christoffel symbols are identically zero
- B.  $h_{\mu\nu}$  satisfies the harmonic gauge (i.e. Lorentz gauge) condition
- C. energy and momentum of the matter are always conserved globally, in general relativity
- D. in this case,  $T_{\mu\nu}$  does not depend on space-time coordinates

Options :

1. A
2. B
3. C
4. D

Question Number : 65 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

A binary stellar system at a distance  $10^8$  m from the Earth, consists of two very evolved stars A and B. The average separation between them is  $3 \times 10^{14}$  m, as they go around their common centre of mass. At some point of time, B explodes as a supernova. Few mille-seconds later, A too undergoes supernova explosion. Gravitational waves (GWs) resulting from each explosion are detected on Earth are about 100 years later. But the time lag between the observed GWs from these two distinct explosions is  $10^6$  seconds. Then,

- A. GWs from A and B suffered differential delay due to intervening gaseous matter along the line of sight
- B. GWs from one of the explosions got reflected from another star not lying along the line of sight
- C. our line of sight to the binary system is perpendicular the plane of the binary orbit
- D. our line of sight to the binary system must lie along the plane of the binary orbit

Options :

- 1. A
- 2. B
- 3. C
- 4. D

Question Number : 66 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

In the weak field limit, the linearized Einstein equation in the presence of matter is given by,

A.   $h_{\mu\nu} = \frac{-8\pi G}{c^4} T_{\mu\nu}$

B.   $\left(h_{\mu\nu} - \frac{1}{2}\eta_{\mu\nu}h\right) = \frac{-16\pi G}{c^4} T_{\mu\nu}$

C.   $h_{\mu\nu} = \frac{-16\pi G}{c^4} T_{\mu\nu}$

D.   $\left(h_{\mu\nu} - \frac{1}{2}\eta_{\mu\nu}h\right) = \frac{-8\pi G}{c^4} T_{\mu\nu}$

Options :

- 1. A
- 2. B
- 3. C
- 4. D

Question Number : 67 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Assume a radiation-dominated,  $k = 0$ , FLRW model of the universe. If the universe has a temperature  $2 \times 10^{10} K$  when it is 1 second old, then after 99 seconds its temperature is

- A.  $2 \times 10^8 K$
- B.  $10^{10} K$
- C.  $2 \times 10^9 K$
- D.  $10^8 K$

Options :

- 1. A
- 2. B
- 3. C
- 4. D

Question Number : 68 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

A very distant quasar is detected at a cosmological redshift of  $z = 8$ . Assume that the scale factor (corresponding to an expanding Einstein-de Sitter universe) is given by  $a(t) \propto t^{2/3}$  when the universe was  $t$  years old. Then, the light we observe from this quasar was emitted when the universe was,

- A.  $1/27$  of the present age of the universe
- B.  $1/81$  of the present age of the universe
- C.  $1/3$  of the present age of the universe
- D.  $1/9$  of the present age of the universe

Options :

- 1. A
- 2. B
- 3. C
- 4. D

Question Number : 69 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

For an arbitrary second rank tensor  $W_{\mu\nu}$ ,

- A.  $W_{\nu}^{\mu} = W_{\nu}^{\mu}$
- B.  $\frac{\partial W_{\mu\nu}}{\partial x^{\nu}}$  is a vector
- C. it is always possible to express  $W_{\mu\nu}$  as a sum of a symmetric tensor and an anti-symmetric tensor
- D.  $W^{\mu\nu} = g^{\mu\beta} g^{\nu\alpha} W_{\alpha\beta}$

Options :

- 1. A
- 2. B
- 3. C
- 4. D

Question Number : 70 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Radio jets are often seen to be one-sided while the outer radio lobes which are supplied with energy by these jets appear reasonably symmetric. This is believed to be due to relativistic beaming of the approaching jets. For a jet moving at the velocity of light,  $c$ , at an angle  $20^\circ$  to the line of sight, the flux density ratio of the approaching to the receding jet (assuming the parameter  $n=1$  and spectral index=1) is about

- A.  $3 \times 10$
- B.  $3 \times 100$
- C.  $3 \times 1000$
- D.  $3 \times 10000$

Options :

- 1. A
- 2. B
- 3. C
- 4. D