GLOBAL ASTRONOMY & ASTROPHYSICS CHALLENGE

SAMPLE QUESTIONS

A Preview of the Question System

40 Multiple-Choice Questions with Full Solutions

TOPICS COVERED

Observational Astronomy · Astrophysics · Planetology

Cosmology · Orbital Mechanics · Space Missions

2026

Sample Questions

Q1

A star exhibits parallax angle $p = 0.1$ arcseconds. Its distance is:

(A) 10 pc

(B) 100 pc

(C) 1 pc

(D) 10 ly

Answer: (A) **Difficulty:** Easy

Solution:

$$d = \frac{1}{p} = \frac{1}{0.1} = 10 \text{ pc} \tag{1}$$

Q2

Hubble Space Telescope ($\lambda = 500$ nm, $D = 2.4$ m) angular resolution:

(A) 0.05 arcsec

(B) 0.5 arcsec

(C) 5 arcsec

(D) 50 arcsec

Answer: (A) **Difficulty:** Medium

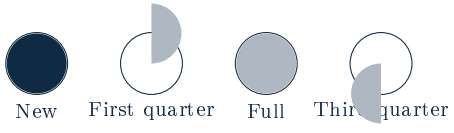
Solution:

$$\theta = 1.22\frac{\lambda}{D} = 1.22\frac{500 \times 10^{-9}}{2.4} \tag{2}$$

$$\theta = 2.5 \times 10^{-7} \text{ rad} = 0.05 \text{ arcsec} \tag{3}$$

Q3

A student arranges the principal lunar phases in the sequence shown below. Which phase comes immediately after the new moon?



(A) First quarter

(B) Full moon

(C) Third quarter

(D) New moon

Answer: (A) **Difficulty:** Medium

Solution: The principal sequence begins new moon, first quarter, full moon, then third quarter.

Q4

10-meter telescope vs. 1-meter telescope light collection ratio:

(A) 10 times

(B) Depends on wavelength

(C) 1000 times

(D) 100 times

Answer: (D) **Difficulty:** Easy

Solution:

$$\text{Ratio} = \left(\frac{D_{\text{large}}}{D_{\text{small}}}\right)^2 = \left(\frac{10}{1}\right)^2 = 100 \tag{4}$$

Q5

G5 star: $m = 10$, $M = 5$ (from spectral type). Distance:

(A) 10 pc

(B) 100 pc

(C) 1000 pc

(D) 1 Mpc

Answer: (B) **Difficulty:** Medium

Solution:

$$m - M = 5\log_{10}(d) - 5 \tag{5}$$

$$10 - 5 = 5\log_{10}(d) - 5 \tag{6}$$

$$\log_{10}(d) = 2 \Rightarrow d = 100 \text{ pc} \tag{7}$$

Q6

Hana measures $m = 11$ and uses $M = 6$ for a star. What distance follows from $m - M = 5\log_{10} d - 5$?

(A) 10 pc

(B) 100 pc

(C) 1000 pc

(D) 10,000 pc

Answer: (B) **Difficulty:** Medium

Solution: $5 = 5\log_{10} d - 5$, giving $\log_{10} d = 2$ and $d = 100$ pc.

Q7

A survey camera records a source at magnitude 14, then magnitude 12 during an outburst. How did its apparent brightness change?

(A) It stayed constant

(B) It became fainter

(C) It became brighter

(D) It disappeared

Answer: (C) **Difficulty:** Medium

Solution: Smaller apparent magnitude means greater observed brightness.

Q8

Hydrogen fusion in Sun's core via:

(A) Equal rates

(B) CNO cycle

(C) Proton-proton chain

(D) Triple-alpha process

Answer: (C) **Difficulty:** Medium

Solution: pp-chain dominates Sun ($M < 1.3M_{\odot}$). CNO cycle dominates massive stars.

Q9

Jonas designs a probe that must leave the Sun from its visible surface. He uses $M = 1.99 \times 10^{30}$ kg and $R = 6.96 \times 10^{8}$ m to estimate the minimum launch speed.

(A) 62 km/s

(B) 220 km/s

(C) 618 km/s

(D) 1240 km/s

Answer: (C) **Difficulty:** Medium

Solution: $v_e = \sqrt{2GM/R} = 618$ km/s.

Q10

What is the approximate Chandrasekhar limit?

(A) $20M_\odot$

(B) $0.1M_\odot$

(C) $5M_\odot$

(D) $1.4M_\odot$

Answer: (D) **Difficulty:** Medium

Solution: A nonrotating white dwarf is limited to about $1.4M_\odot$.

Q11

Ravi studies a star with twice the Sun's mass and sixteen times its luminosity. He estimates how long it can remain on the main sequence.

(A) 0.625 Gyr

(B) 1.25 Gyr

(C) 5 Gyr

(D) 80 Gyr

Answer: (B) **Difficulty:** Medium

Solution: $t \approx 10\ \text{Gyr}(M/L) = 10(2/16) = 1.25$ Gyr.

Q12

Isaac studies radiation from a compact object with five solar masses. He calculates the luminosity at which radiation pressure can balance gravity.

(A) 2.6×10^{30} W

(B) 1.3×10^{31} W

(C) 6.5×10^{31} W

(D) 2.6×10^{32} W

Answer: (C) **Difficulty:** Medium

Solution: $L_E = 1.3 \times 10^{31}(M/M_\odot) = 6.5 \times 10^{31}$ W.

Q13

Pavel notices that a 600 nm line shifts by 0.020 nm in a stellar spectrum. He calculates the star's radial speed.

(A) 1 km/s

(B) 10 km/s

(C) 100 km/s

(D) 1000 km/s

Answer: (B) **Difficulty:** Medium

Solution: $v = c\Delta\lambda/\lambda = 10$ km/s.

Q14

Which supernova type is commonly used as a standardizable candle?

(A) Type Ia

(B) Type II only

(C) Type Ib only

(D) Type Ic only

Answer: (A) **Difficulty:** Medium

Solution: Type Ia supernovae have calibratable peak luminosities.

Q15

Eddington limit is maximum luminosity before:

(A) Supernova explosion

(B) Radiative pressure exceeds weight

(C) Collapse to white dwarf

(D) Significant cooling

Answer: (B) **Difficulty:** Hard

Solution:

$$L_{\text{Edd}} = \frac{4\pi GMm_p c}{\kappa} \propto M \tag{8}$$

Massive stars lose mass via radiation-driven winds near Eddington limit.

Q16

Isaac's model converts 0.005 kg of mass into energy. Using $E = mc^2$, how much energy is released?

(A) 4.5×10^{12} J

(B) 4.5×10^{18} J

(C) 4.5×10^{16} J

(D) 4.5×10^{14} J

Answer: (D) **Difficulty:** Medium

Solution: $E = 0.005(3.0 \times 10^8)^2 = 4.5 \times 10^{14}$ J.

Q17

Nia observes two identical supernovae. One is three times farther away. What fraction of the flux does the farther one provide?

(A) 1/3

(B) 1/6

(C) 1/9

(D) 1/27

Answer: (C) **Difficulty:** Medium

Solution: Flux follows the inverse-square law, so the ratio is $1/3^2 = 1/9$.

Q18

Pavel studies a probe signal emitted closer and closer to a black hole's event horizon. How does a distant observer see the signal?

(A) Instantly brighter

(B) Increasingly blueshifted

(C) Unchanged

(D) Increasingly redshifted

Answer: (D) **Difficulty:** Medium

Solution: Strong gravitational redshift lowers the observed photon frequency.

Q19

Star torn apart near black hole by:

(A) Black hole gravity too strong

(B) Tidal force exceeds star's self-gravity

(C) Always destroys stars

(D) Direct collision

Answer: (B) **Difficulty:** Hard

Solution:

$$\text{Roche limit}: \quad d \approx 2.46 R_{\text{BH}} \left(\frac{M_{\text{BH}}}{M_\star} \right)^{1/3} \tag{9}$$

Tidal force $>$ self-gravity $\Rightarrow$ disruption.

Q20

A stellar model has a surface twice as hot and the same radius as another star. How does its luminosity compare?

(A) Sixteen times larger

(B) Four times larger

(C) Twice as large

(D) The same

Answer: (A) **Difficulty:** Medium

Solution: $L \propto T^4$, so doubling temperature increases luminosity by $2^4 = 16$.

Q21

Strange matter hypothetically:

(A) Matter viewed strangely

(B) Dark matter only

(C) Contains strange quarks at ultra-high density

(D) Defies physics

Answer: (C) **Difficulty:** Medium

Solution: At NS density+: quark matter (u, d, s) may be more stable than neutron matter. "Strange stars" theoretically possible.

Q22

Sam's simulation packs more than a solar mass into a sphere about 20 km across. What object is he modeling?

(A) A neutron star

(B) A red giant

(C) A molecular cloud

(D) A main-sequence star

Answer: (A) **Difficulty:** Medium

Solution: Neutron stars contain stellar-scale masses within city-scale diameters.

Q23

In X-ray binary, material from Roche lobe forms:

(A) Direct impact on compact object

(B) Accretion disk via Coriolis effect deflection

(C) Single stream from L1

(D) Polar cap accretion only

Answer: (B) **Difficulty:** Hard

Solution: Material streams from L1 with high angular momentum. Coriolis deflects into disk orbit around compact object.

Q24

On a newly discovered world, Amina studies a planet with twice Earth's mass and one and a half times Earth's radius. She estimates how its surface gravity compares with Earth's.

(A) 0.44

(B) 2.25

(C) 1.33

(D) 0.89

Answer: (D) **Difficulty:** Medium

Solution: $g/g_\oplus = (M/M_\oplus)/(R/R_\oplus)^2 = 2/(1.5)^2 = 0.89$.

Q25

Which planet is known as the Red Planet?

(A) Mars

(B) Venus

(C) Mercury

(D) Uranus

Answer: (A) **Difficulty:** Medium

Solution: Iron oxides give Mars its reddish appearance.

Q26

What is the main visible material in Saturn's rings?

(A) Basalt dust only

(B) Liquid iron

(C) Methane gas

(D) Water ice

Answer: (D) **Difficulty:** Medium

Solution: Saturn's rings are dominated by water-ice particles.

Q27

Eric models a star moving around the system's center of mass in a circle of radius 10^7 m every ten days. He calculates its orbital speed.

(A) 7.3 m/s

(B) 73 m/s

(C) 730 m/s

(D) 7300 m/s

Answer: (B) **Difficulty:** Medium

Solution: $v = 2\pi r/P = 72.7$ m/s.

Q28

Adel measures a galaxy 100 Mpc away and adopts a Hubble constant of 70 km/s/Mpc. He estimates the galaxy's recession speed.

(A) 700 km/s

(B) 3500 km/s

(C) 7000 km/s

(D) 14,000 km/s

Answer: (C) **Difficulty:** Medium

Solution: $v = H_0 d = 70(100) = 7000$ km/s.

Q29

Redshift z relation to scale factor:

(A) $z = 1 + a(t)$

(B) $1 + z = a_0/a_{\text{emission}}$

(C) $z = v/c$ only

(D) Independent of expansion

Answer: (B) **Difficulty:** Hard

Solution:

$$\lambda_{\text{obs}} = \lambda_{\text{em}} \frac{a_0}{a_{\text{em}}} \Rightarrow 1 + z = \frac{a_0}{a_{\text{em}}} \tag{10}$$

Cosmological redshift: expansion stretches wavelengths.

Q30

What is associated with accelerated cosmic expansion?

(A) Dark energy

(B) Ordinary dust

(C) Planetary rings

(D) Solar wind

Answer: (A) **Difficulty:** Medium

Solution: Dark energy is the name given to the component driving accelerated expansion.

Q31

Circular orbit at radius r has velocity:

(A) $v = \sqrt{2GM/r}$

(B) $v = c$ always

(C) $v = GM/r^2$

(D) $v = \sqrt{GM/r}$

Answer: (D) **Difficulty:** Easy

Solution:

$$\text{Centripetal: } \frac{v^2}{r} = \frac{GM}{r^2} \tag{11}$$

$$v = \sqrt{\frac{GM}{r}} \tag{12}$$

Q32

Adel monitors a satellite moving in a circular orbit 7000 km from Earth's center. Using Earth's gravitational parameter 398600 km^3/s^2, he calculates how long one complete orbit takes.

(A) 48.6 min

(B) 5828 min

(C) 194 min

(D) 97.1 min

Answer: (D) **Difficulty:** Medium

Solution: $P = 2\pi\sqrt{r^3/\mu} = 5828$ s $= 97.1$ min.

Q33

Ravi tracks a spacecraft 8000 km from Earth's center on an orbit with semimajor axis 10000 km. With $\mu = 398600$ km^3/s^2, he calculates its speed at that moment.

(A) 5.47 km/s

(B) 7.73 km/s

(C) 9.98 km/s

(D) 12.2 km/s

Answer: (B) **Difficulty:** Medium

Solution: $v = \sqrt{\mu(2/r - 1/a)} = 7.73$ km/s.

Q34

Kepler wants a spacecraft to orbit Earth at $r = 8000$ km. Using $v = \sqrt{\mu/r}$ with $\mu = 398600$ km^3/s^2, what speed is required?

(A) 5.06 km/s

(B) 11.2 km/s

(C) 8.94 km/s

(D) 7.06 km/s

Answer: (D) **Difficulty:** Medium

Solution: $v = \sqrt{398600/8000} = 7.06$ km/s.

Q35

Eccentricity e:

(A) No relationship to orbit shape

(B) $e = 1$ circle

(C) $e = 0$ circle, $e = 1$ parabola, $e > 1$ hyperbola

(D) Always between 0 and 1

Answer: (C) **Difficulty:** Medium

Solution:

$$e = 0 \text{ (circle)}, \quad 0 < e < 1 \text{ (ellipse)}, \quad e = 1 \text{ (parabola/escape)}, \quad e > 1 \text{ (hyperbola)} \tag{13}$$

Q36

An engineer doubles a circular orbit's radius around the same planet. What happens to the orbital speed?

(A) It decreases

(B) It doubles

(C) It stays fixed

(D) It becomes zero

Answer: (A) **Difficulty:** Medium

Solution: Circular speed varies as $1/\sqrt{r}$.

Q37

On planet Mars, Samy starts a rover communication test while Earth is 2.25×10^8 km away. The mission team calculates the one-way delay before a command can arrive.

(A) 1.25 min

(B) 7.50 min

(C) 12.5 min

(D) 25.0 min

Answer: (C) **Difficulty:** Medium

Solution: $t = d/c = 750$ s $= 12.5$ min.

Q38

Which mission visited Jupiter, Saturn, Uranus, and Neptune?

(A) Viking 1

(B) Apollo 8

(C) Voyager 2

(D) Mariner 2

Answer: (C) **Difficulty:** Medium

Solution: Voyager 2 flew past all four giant planets.

Q39

Near which point does JWST operate?

(A) Earth's surface

(B) Earth-Moon L1

(C) Mars-Sun L1

(D) Sun-Earth L2

Answer: (D) **Difficulty:** Medium

Solution: JWST follows a halo orbit near Sun-Earth L2.

Q40

Where does the International Space Station orbit?

(A) Low Earth orbit

(B) Lunar orbit

(C) Sun-Earth L2

(D) Mars orbit

Answer: (A) **Difficulty:** Medium

Solution: The ISS travels in low Earth orbit.