GENERAL

astronomy through practical investigations no 26 answers

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Astronomy Through Practical Investigations: No. /26 Answers Explained

For students and amateur astronomers alike, the best way to grasp the mysteries of the night sky is by turning theory into hands on experiments. “Astronomy through practical investigations” is a series of guided questions that challenge learners to observe, measure, and analyze celestial phenomena. In this article we tackle the 26th set of questions, offering detailed, step by step answers that illuminate the science behind each task.

Why Practical Investigations Matter in Astronomy

Astronomy is often seen as a field dominated by giant telescopes and space probes, but the fundamental principles—gravity, light, motion—can be explored with simple tools. Practical investigations:

- Build intuition about how celestial bodies behave.
- Develop data collection and analytical skills.
- Encourage curiosity and problem solving.
- Make distant concepts tangible for learners.

Below we combine hands on methods with the theoretical background needed to answer each question in the 26th set.

Question 1: What is the apparent magnitude of a star and how do you measure it?

Answer: Apparent magnitude is a logarithmic measure of a star’s brightness as seen from Earth. The scale is inverted: lower numbers mean brighter objects. To measure it, you need a small photometer or a calibrated photometric filter set. Steps:

1. Point the telescope or binoculars at the target star.
2. Record the star’s brightness relative to a known standard star with a catalogued magnitude.
3. Use the Pogson formula: m = m € + 2.5 /log • €(F €/F), where m is the target magnitude, m € the standard magnitude, and F and F € the measured fluxes.
4. Account for atmospheric extinction by observing at different airmasses.

With a smartphone camera and an app like SkyView, you can even estimate magnitudes by comparing pixel intensities, though professional results require calibrated equipment.

Question 2: How does the Doppler effect help determine the radial velocity of a star?

Answer: The Doppler effect causes spectral lines to shift toward the blue (approaching) or red (receding) when a star moves relative to us. To calculate radial velocity:

1. Obtain a high resolution spectrum of the star.
2. Identify a known absorption line (e.g., H; B cSbã#, öæÒ’à
3. Measure the observed wavelength ;µöö'2 æB 6ö× &R —B Fò F†R Æ &÷ atory wavelength ;² à

4. Compute the shift: 9C» = ;µöö'2 b » €.
5. Apply the formula: v_r = c /(9C»/;² ’Â v†W&R 2 —2 F†R 7 VVB öb Æ–v‡Bà

Typical radial velocities of nearby stars range from a few to several hundred km s {¹. The method is the backbone of exoplanet detection via the radial velocity technique.

Question 3: How can you use a simple telescope to measure the angular diameter of the Moon?

Answer: Angular diameter is the apparent size of an object. With a small refractor:

1. Set the telescope’s reticle (crosshairs) to a known scale (e.g., 1 /arcminute per division).
2. Align the reticle over the Moon’s disc.
3. Count the number of divisions the Moon spans.
4. Multiply divisions by the scale to get the angular diameter.

For the Moon, the average angular diameter is about 0.5°, or 30 arcminutes. A quick comparison with the Sun during a total solar eclipse reveals that the Sun’s angular diameter is similar, explaining why a total eclipse is possible.

Question 4: What is the significance of the light curve of a variable star, and how do you construct one?

Answer:A light curve plots brightness versus time, revealing periodicity and amplitude of variability. Construction steps:

1. Select a variable star (e.g., Mira or Cepheid).
2. Observe nightly, recording apparent magnitude or instrumental counts.
3. Plot the data on a graph with time on the x axis and brightness on the y axis.
4. Fit a sine wave or other periodic model to determine period.

For Cepheid variables, the period–luminosity relation allows distance estimation. The light curve’s shape also distinguishes between pulsation modes.

Question 5: How does the parallax method determine stellar distances?

Answer: Parallax measures the apparent shift of a star against background stars due to Earth’s orbit. Procedure:

1. Observe the target star at two epochs separated by six months.
2. Measure the angular shift p (in arcseconds).
3. Compute distance: d = 1/p (parsecs).

For example, a parallax of 0.1 3 corresponds to 10 pc. Modern missions like Gaia extend this method to millions of stars with micro arcsecond precision.

Question 6: What role does the spectral classification (OBAFGKM) play in understanding stellar properties?

Answer: Spectral classification categorizes stars based on temperature and spectral features. Each class corresponds to a temperature range and characteristic absorption lines:

- O: >30,000 /K, strong ionized helium lines.

- B: 10,000–30,000 /K, neutral helium and hydrogen.
- A: 7,500–10,000 /K, strong hydrogen lines.
- F: 6,000–7,500 /K, weak hydrogen, strong metallic lines.
- G: 5,200–6,000 /K, solar type.
- K: 3,700–5,200 /K, orange stars.
- M:

Knowing a star's spectral type informs its mass, luminosity, radius, and evolutionary stage. Practical investigations involve recording spectra and matching them to standard templates.

Question 7: How can you estimate the mass of a binary star system using Kepler's Third Law?

Answer: For a binary system, the orbital period and semi major axis yield the combined mass. Steps:

1. Measure the orbital period P (years) from long term observations.
2. Determine the semi major axis a (AU) via astrometry.
3. Apply Kepler's Third Law: M •+M , = a^3/P^2 (solar masses).

Example: If a binary has *a* /= /1 /AU and P=d 1 yr, the total mass equals 1 M& . By resolving individual masses through radial velocity curves, you can test stellar evolution models.

Question 8: What is the significance of the Hertzsprung–Russell (H–R) diagram, and how can you plot one with your data?

Answer: The H–R diagram displays luminosity versus temperature, revealing stellar evolution tracks. To plot it:

1. Collect data: apparent magnitude, distance (parallax), spectral type.
2. Convert apparent magnitude to absolute magnitude using distance modulus.
3. Translate absolute magnitude to luminosity (L /" /10 { p. tM).
4. Assign effective temperature from spectral type.
5. Plot log /L on the y axis vs. log /T on the x axis (decreasing to the right).

Clusters often form a tight main sequence; deviations indicate evolved stars. Plotting your own dataset provides insight into stellar populations in your region of the sky.

Question 9: How can you determine the composition of a planet's atmosphere from transit spectroscopy?

Answer: When a planet transits its host star, starlight filters through its atmosphere. By comparing spectra in and out of transit:

1. Obtain high resolution spectra of the star during transit.
2. Subtract the out of transit baseline to isolate absorption features.
3. Identify molecular signatures (e.g., H ,O, CO, CH „).
4. Model the depth of absorption lines to infer atmospheric composition and pressure.

Even small telescopes can contribute to this field by monitoring bright transits and recording photometric light curves. The resulting data help classify exoplanet atmospheres as "hot Jupiters," "super Earths," etc.

Question 10: What is a light echo, and how can you observe one during a

nova event?

Answer: A light echo is reflected starlight from interstellar dust that arrives later than the direct light. To observe it:

1. Detect a nova or supernova in a nearby galaxy.
2. Use a wide field telescope to image the surrounding dust.
3. Take images over weeks or months; look for expanding rings of increased brightness.
4. Measure the angular expansion rate; combine with distance to estimate dust distribution.

Light echoes provide a three dimensional map of dust and can reveal past activity of the host star. They also serve as a natural laboratory for studying scattering properties.

Question 11: How does the Tully–Fisher relation help estimate distances to spiral galaxies?

Answer: The Tully–Fisher relation links a galaxy's rotational velocity to its luminosity. Steps:

1. Measure the 21 cm hydrogen line width to determine rotational velocity V_rot.
2. Compute absolute magnitude M using the calibrated relation: M = a /log(V_rot) + b.
3. Use observed apparent magnitude m to find distance modulus: m – M = 5 /log(d) – 5.
4. Solve for distance d (Mpc).

This method is vital for building the cosmic distance ladder, especially for galaxies beyond the reach of Cepheid variables.

Question 12: What is the difference between a protoplanetary disc and a debris disc?

Answer: Both are circumstellar structures but at different evolutionary stages:

- Protoplanetary disc:\\n\\nAge
- Gas rich; supports planet formation.
- Shows strong infrared excess due to warm dust.
- Often observed with ALMA or the VLT.

- Age >10 /Myr.
- Gas poor; composed of dust from colliding planetesimals.
- Infrared excess weaker; often seen with Spitzer or Herschel.

Practical investigation: measure the spectral energy distribution (SED) of a target star and fit a blackbody to determine disc temperature and mass.

Question 13: How can you use a spectrograph to detect exoplanet atmospheres via the Rossiter–McLaughlin effect?

Answer: The Rossiter–McLaughlin effect manifests as a distortion in the stellar radial velocity curve during transit due to the planet blocking part of the rotating stellar surface. Procedure:

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