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Class 12

Physics

Chapter 23

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CLASS 12 PHYSICS — FBISE

Astrophysics & Universe (Chapter: Stars & Cosmology)
Important MCQs & Short Questions
By Fairy (Misbah)

PART A — MULTIPLE CHOICE QUESTIONS (MCQs)

Q1. Luminosity of a star is defined as:
A) The brightness observed from Earth
B) The total power of radiation emitted by a star
C) The surface temperature of a star
D) The intensity of radiation at Earth's surface

✓ ***Answer: B) The total power of radiation emitted by a star***

Q2. The SI unit of luminosity is:
A) W/m^2
B) Candela
C) Watt (W)
D) Lux

✓ ***Answer: C) Watt (W)***

Q3. The inverse square law for radiant flux intensity states that F is proportional to:
A) d
B) d^2
C) 1/d
D) $1/d^2$

✓ ***Answer: D) $1/d^2$ [$F = L / 4\pi d^2$]***

Q4. In the formula $F = L / 4\pi d^2$, 'L' represents:
A) Distance from the source
B) Radiant flux intensity
C) Luminosity of the source
D) Surface area

✓ ***Answer: C) Luminosity of the source***

Q5. Standard candles are used in astronomy to determine:
A) Surface temperature of stars
B) Distances to galaxies
C) Chemical composition of stars
D) Speed of stars

✓ ***Answer: B) Distances to galaxies***

Q6. Which of the following is an example of a standard candle?
A) White dwarf
B) Neutron star
C) Type Ia Supernova
D) Red giant

✓ ***Answer: C) Type Ia Supernova***

Q7. Wien's displacement law relates the peak wavelength (λ_{max}) to:
A) Luminosity
B) Distance
C) Absolute temperature T
D) Mass

✓ Answer: C) Absolute temperature T [λ_max T = constant]

Q8. If a star has a higher surface temperature, its peak emission wavelength will:

A) Increase
B) Decrease
C) Remain the same
D) Become zero

✓ Answer: B) Decrease (shift toward shorter wavelengths)

Q9. The Stefan–Boltzmann law is expressed as:

A) $L = 4\pi r^2 \sigma T^{\blacksquare}$
B) $L = \sigma T^2$
C) $L = 4\pi r^2 T$
D) $L = \sigma T^{\blacksquare}/r^2$

✓ Answer: A) $L = 4\pi r^2 \sigma T^{\blacksquare}$

Q10. The Stefan–Boltzmann constant σ has the value approximately:

A) $5.67 \times 10^{\blacksquare\blacksquare}$ W $m^{\blacksquare 2}$ $K^{\blacksquare\blacksquare}$
B) $6.63 \times 10^{\blacksquare 3 \blacksquare}$ J·s
C) $3.0 \times 10^{\blacksquare}$ m/s
D) $1.38 \times 10^{\blacksquare 23}$ J/K

✓ Answer: A) $5.67 \times 10^{\blacksquare\blacksquare}$ W $m^{\blacksquare 2}$ $K^{\blacksquare\blacksquare}$

Q11. According to the Stefan–Boltzmann law, if the radius of a star doubles (temperature constant), its luminosity:

A) Doubles
B) Quadruples
C) Increases by factor of 8
D) Increases by factor of 16

✓ Answer: B) Quadruples ($L \propto r^2$)

Q12. To estimate the radius of a star, we combine:

A) Wien's law and Newton's law
B) Wien's displacement law and Stefan–Boltzmann law
C) Inverse square law and Wien's law
D) Hubble's law and Wien's law

✓ Answer: B) Wien's displacement law and Stefan–Boltzmann law

Q13. The emission spectrum of a distant star shows absorption lines shifted toward longer wavelengths. This is called:

A) Blueshift
B) Redshift
C) Photoelectric effect
D) Blackbody radiation

✓ Answer: B) Redshift

Q14. Redshift of spectral lines from distant galaxies indicates that the Universe is:

A) Contracting
B) Stationary
C) Expanding
D) Rotating

✓ Answer: C) Expanding

Q15. The formula for redshift (z) is given by:

A) $z = \Delta\lambda/\lambda \approx \Delta f/f \approx v/c$
B) $z = \lambda/\Delta\lambda$
C) $z = c/v$
D) $z = f/\Delta f$

✓ Answer: A) $z = \Delta\lambda/\lambda \approx \Delta f/f \approx v/c$

Q16. A blackbody is an object that:

A) Reflects all radiation
B) Absorbs all incident radiation and re-emits it
C) Transmits all radiation
D) Only emits radiation, does not absorb

✓ ***Answer: B) Absorbs all incident radiation and re-emits it***

Q17. The peak wavelength of the Sun (T ≈ 5800 K) using Wien's constant (b = 2.9 × 10■^{3} m·K) is approximately:

A) 200 nm
B) 500 nm
C) 1000 nm
D) 2000 nm

✓ ***Answer: B) 500 nm [λ = 2.9×10■^{3}/5800 ≈ 500 nm]***

Q18. Absorption lines in a stellar spectrum are produced when:

A) Light passes through the hot core of a star
B) Cooler outer gases absorb specific wavelengths from the continuous spectrum
C) Electrons emit photons
D) The star rotates rapidly

✓ ***Answer: B) Cooler outer gases absorb specific wavelengths***

Q19. Hubble's law states that the recession velocity of a galaxy is:

A) Inversely proportional to its distance
B) Directly proportional to its distance
C) Constant for all galaxies
D) Proportional to the square of its distance

✓ ***Answer: B) Directly proportional to its distance [v = H■d]***

Q20. The Doppler formula Δλ/λ = v/c applies when:

A) v >> c
B) v << c
C) v = c
D) v > c

✓ ***Answer: B) v << c (non-relativistic Doppler effect)***

Q21. If a star emits radiation with peak wavelength in the infrared region, its surface temperature compared to the Sun is:

A) Higher
B) Lower
C) The same
D) Cannot be determined

✓ ***Answer: B) Lower***

Q22. The luminosity of a star depends on:

A) Its mass only
B) Its distance from Earth
C) Its surface temperature and radius
D) Its chemical composition only

✓ ***Answer: C) Its surface temperature and radius***

Q23. Emission lines in a stellar spectrum appear as:

A) Dark lines on a bright background
B) Bright lines on a dark background
C) A continuous rainbow
D) Broad bands of colour

✓ ***Answer: B) Bright lines on a dark background***

Q24. According to Wien's law, a star appearing blue has a surface temperature that is:

A) Lower than a red star
B) Higher than a red star
C) Equal to a red star
D) Unrelated to colour

✓ ***Answer: B) Higher than a red star***

Q25. The redshift formula $z = v/c$ is valid for electromagnetic radiation from a source:

A) Moving toward the observer
B) Moving away from the observer
C) Stationary relative to observer
D) Moving perpendicular to observer

✓ ***Answer: B) Moving away from the observer***

PART B — SHORT QUESTIONS

Q1. Define luminosity of a star.

Luminosity (L) is the total power (energy per unit time) radiated by a star in all directions. Its SI unit is Watt (W). It represents the intrinsic brightness of a star, independent of its distance from Earth.

Q2. State the inverse square law for radiant flux intensity.

The radiant flux intensity F (power received per unit area) at a distance d from a source of luminosity L is given by:

$F = L / (4\pi d^2)$

This shows F decreases with the square of the distance from the source.

Q3. What are standard candles? Why are they important?

Standard candles are astronomical objects whose absolute luminosity is known (e.g., Cepheid variable stars, Type Ia supernovae). By comparing their known luminosity with observed radiant flux, astronomers can calculate their distance, allowing us to measure distances to far-away galaxies.

Q4. State Wien's displacement law and write its mathematical form.

Wien's displacement law states that the peak wavelength (λ_max) of blackbody radiation is inversely proportional to its absolute temperature T:

λ_max × T = b (b = 2.898 × 10■³ m·K)

Hotter stars emit at shorter (bluer) wavelengths; cooler stars emit at longer (redder) wavelengths.

Q5. What is blackbody radiation?

Blackbody radiation is the electromagnetic radiation emitted by an ideal blackbody (a perfect absorber and emitter). The spectrum of this radiation depends only on temperature. Stars approximate blackbodies, and their surface temperatures can be estimated from their spectral peak wavelength.

Q6. State the Stefan–Boltzmann law with its formula.

The Stefan–Boltzmann law states that the luminosity (L) of a star is proportional to its surface area and the fourth power of its absolute temperature T:

L = 4πr²σT■

where σ = 5.67 × 10■■ W m■² K■■ is the Stefan–Boltzmann constant and r is the radius of the star.

Q7. How can we estimate the radius of a star?

By combining Wien's displacement law (to find T from peak wavelength) and the Stefan–Boltzmann law (L = 4πr²σT■), the radius of a star can be found:

$r = \sqrt{(L / (4\pi\sigma T■))}$

This requires knowledge of both the star's luminosity and surface temperature.

Q8. What is redshift, and what does it indicate?

Redshift occurs when spectral lines from a distant object are shifted toward longer (red) wavelengths compared to their rest wavelengths. It indicates the source is moving away from the observer. The observation of redshift in distant galaxies is evidence that the Universe is expanding.

Q9. Write the Doppler redshift formula and explain each term.

The Doppler redshift formula is:

$z = \Delta\lambda/\lambda \approx \Delta f/f \approx v/c$

where $\Delta\lambda$ = change in wavelength, λ = rest wavelength, Δf = change in frequency, f = original frequency, v = recession velocity of the source, and c = speed of light. Valid for $v << c$.

Q10. Differentiate between emission and absorption spectra.

Emission spectrum: Produced when excited gas emits light at specific wavelengths — appears as bright coloured lines on a dark background. Each element has a unique emission spectrum.

Absorption spectrum: Produced when cool gas absorbs specific wavelengths from a continuous spectrum — appears as dark lines on a bright background. Used to identify elements in stellar atmospheres.

Q11. Why do lines in the spectra of distant galaxies show a redshift?

Distant galaxies are moving away from us due to the expansion of the Universe. As a result, the wavelengths of their emitted light are stretched (Doppler effect), shifting spectral lines toward the red (longer wavelength) end of the spectrum. Greater distance generally means greater redshift (Hubble's law).

Q12. How does Wien's law help determine a star's surface temperature?

By measuring the peak wavelength (λ_max) of the star's spectrum, the surface temperature can be calculated using:

$T = b / \lambda\_max$ (where $b = 2.898 \times 10$■^{3} m·K)

For example, if λ_max = 500 nm, then $T = 2.898\times10$■^{3} / 500×10■■ $\approx$ 5800 K.

Q13. What is the significance of Wien's constant?

Wien's constant $b = 2.898 \times 10$■^{3} m·K is used in Wien's displacement law ($\lambda\_max\, T = b$). It establishes the relationship between the peak emission wavelength of a blackbody and its temperature, enabling astronomers to determine stellar surface temperatures from spectral analysis.

Q14. If a star's luminosity is L and it is at distance d, write the formula for its radiant flux F. What happens to F if distance doubles?

$F = L / (4\pi d^2)$

If d doubles ($d \rightarrow 2d$):

$F' = L / (4\pi(2d)^2) = L / (16\pi d^2) = F/4$

Therefore, radiant flux becomes one-fourth when distance doubles — this confirms the inverse square law.

Q15. How does the Stefan–Boltzmann law explain why giant stars are more luminous than dwarf stars of the same temperature?

From $L = 4\pi r^2\sigma T$■, luminosity is proportional to r^2 (radius squared) at constant temperature. Giant stars have a much larger radius than dwarf stars. Therefore, even at the same surface temperature, giant stars radiate far more total energy (higher luminosity) than dwarf stars.

■ *These questions are based on FBISE Class 12 Physics SLOs (P-12-F-43 to P-12-F-49) covering Luminosity, Inverse Square Law, Standard Candles, Blackbody Radiation, Wien's Displacement Law, Stefan–Boltzmann Law, and Redshift.*

***By Fairy (Misbah)* — Best of luck!** ■

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