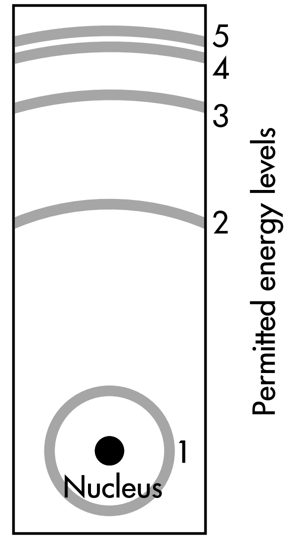


1. An electron in energy level $\begin{bmatrix} 1 \\ 2 \end{bmatrix}$ can:

(A) only emit a photon.
(B) only absorb a photon.
(C) either emit, or absorb a photon.
(D) neither emit, nor absorb a photon.
(E) (Unsure/guessing/lost/help!)

2. An electron moving between energy levels $\begin{bmatrix} 2 \rightarrow 4 \\ 4 \rightarrow 2 \end{bmatrix}$ must:

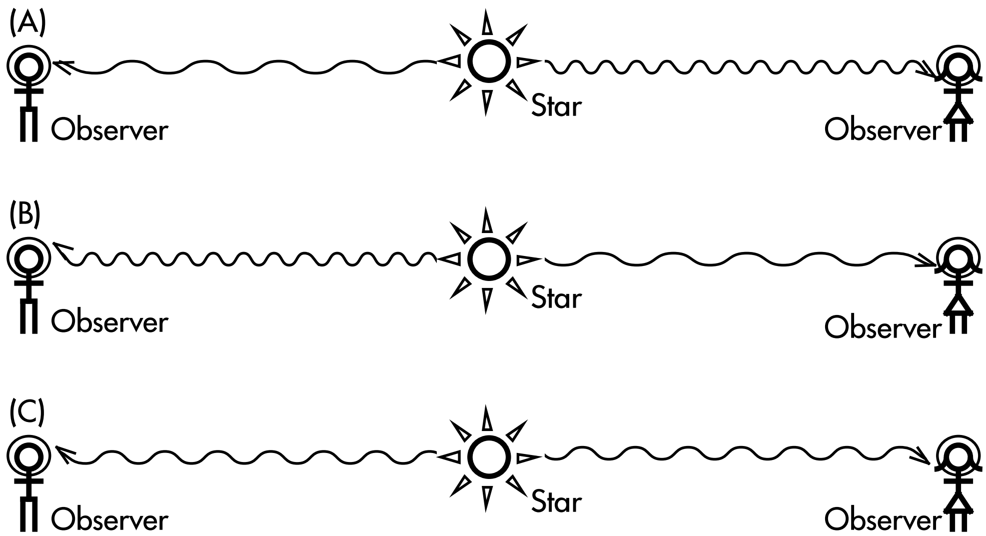
(A) emit a photon.
(B) absorb a photon.
(C) (Both of the above choices.)
(D) (Neither of the above choices.)
(E) (Unsure/guessing/lost/help!)

3. The energy of a photon emitted from moving between energy levels 2→1 is __________ the energy absorbed moving between energy levels 2→3.
(A) greater than.
(B) exactly equal to.
(C) less than.
(D) (Unsure/guessing/lost/help!)

4. The energy of a photon emitted from moving between energy levels 4→2 is __________ the energy absorbed moving between energy levels 2→4.
(A) greater than.
(B) exactly equal to.
(C) less than.
(D) (Unsure/guessing/lost/help!)

5. A photon with $\begin{bmatrix} \text{slightly more than the} \\ \text{the exact amount of} \\ \text{slightly less than the} \end{bmatrix}$ energy required for an electron to move between energy levels 1→2 would:
(A) be absorbed, causing the electron to move between energy levels 1→2.
(B) not be absorbed, such that the electron stays in energy level 1.
(C) (Unsure/guessing/lost/help!)

6. Which diagram below schematically shows a [star moving to the left / star moving to the right / stationary star]?



(D) (Unsure/guessing/lost/help!)

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7. In the cartoon shown at right[1], these astronomers are discussing a star that is:

(A) moving towards them.
(B) moving away from them.
(C) stationary.
(D) (Unsure/guessing/lost/help!)

"Oh, oh — looks like a blue shift."

[1] Sidney Harris, *Einstein Simplified: Cartoons on Science*, Rutgers University Press, 1989.

8. According to Kirchhoff's laws, __________ creates a(n) [continuous / absorption / emission] spectrum.

(A) a hot dense object.
(B) diffuse, hot gas atoms.
(C) the Doppler effect.
(D) blackbody radiation passing through diffuse, cool gas atoms.
(E) (Unsure/guessing/lost/help!)

9. [The sun′s photosphere / The sun′s chromosphere / A sunspot] gives off a(n) __________ spectrum.

(A) continuous.
(B) absorption.
(C) emission.
(D) (None of the above choices.)
(E) (Unsure/guessing/lost/help!)

10. [The sun′s photosphere / The sun′s chromosphere / A sunspot] gives off light from:

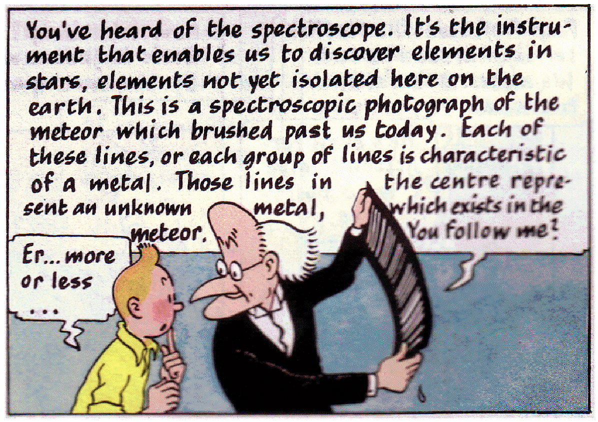
(A) electrons moving to lower energy orbitals.
(B) hot, agitated electrons and atoms.
(C) tangling and rearranging magnetic field loops.
(D) convection currents.
(E) (Unsure/guessing/lost/help!)

11. Which of these spectra will have the [least / most] absorption lines?

(A) The sun, observed from a spacecraft in orbit around Earth.
(B) The sun, observed from a telescope at sea level.
(C) Light from an incandescent light bulb, across the room.
(D) (Unsure/guessing/lost/help!)

12. In the cartoon shown at right[2], Professor Phostle is showing Tintin bright lines on a dark background, which could be an example of a(n) __________ spectrum.

(A) continuous.
(B) absorption.
(C) emission.
(D) (None of the above choices.)
(E) (Unsure/guessing/lost/help!)



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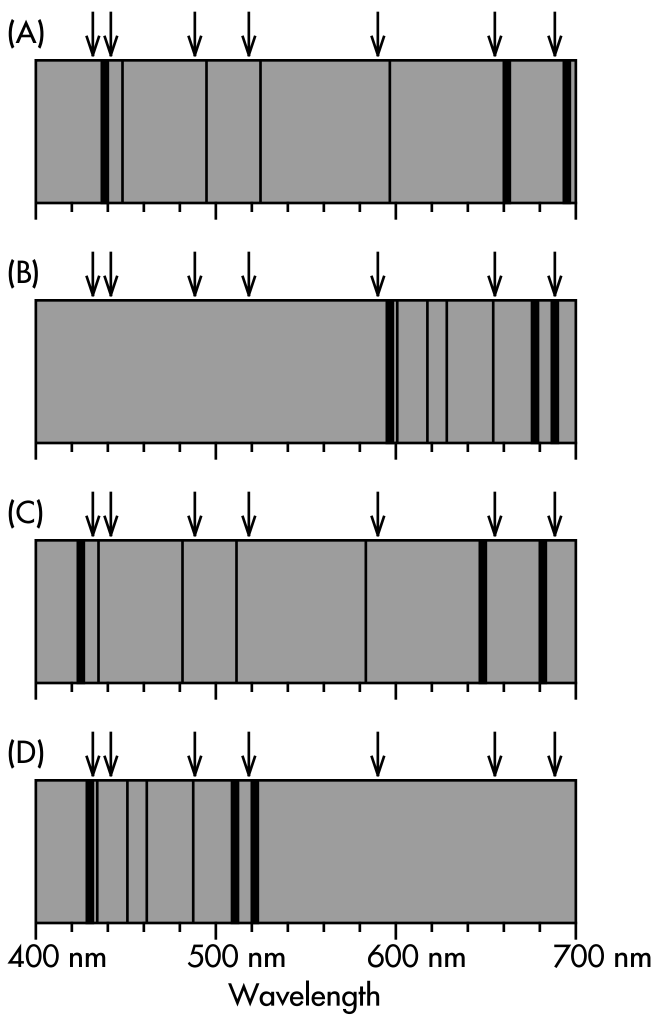
13. Which absorption spectrum corresponds to a star moving [towards / away from] Earth?

(The arrows indicate the expected wavelength values for a stationary star of the same type.)



(E) (More than one of these choices.)

(F) 

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[2] Hergé, *The Shooting Star*, Little, Brown Young Readers, 1978.

14. A star that is observed to have a parallax angle [smaller than / equal to / larger than] 1 arc second is located __________ 1 parsec away.

(A) closer than.
(B) exactly.
(C) farther than.
(D) (Unsure/guessing/lost/help!)

Apparent magnitude *m* is the measure of a star's brightness, as seen from Earth.

Absolute magnitude $\mathscr{M}$ is the measure of a star's brightness, if placed exactly 10 parsecs away from Earth.

	m apparent magnitude	$\mathscr{M}$ absolute magnitude
The sun	−27	+5
Canopus	−1	−3
Vega	0	+0.5
Kapteyn's star	+9	+11

15. Which star [seems brightest, as seen from Earth / seems dimmest, as seen from Earth / is brightest, if placed 10 parsecs from Earth / is dimmest, if placed 10 parsecs from Earth / is nearest to Earth / is farthest from Earth]?

(A) The sun.
(B) Canopus.
(C) Vega.
(D) Kapteyn's star.
(E) (Unsure/guessing/lost/help!)

	m apparent magnitude	$\mathscr{M}$ absolute magnitude
Rigel	+0.1	–7
Betelgeuse	+0.4	–6
Procyon A	+0.4	+3

16. Which star [seems brightest, as seen from Earth / seems dimmest, as seen from Earth / is brightest, if placed 10 parsecs from Earth / is dimmest, if placed 10 parsecs from Earth / is nearest to Earth / is farthest from Earth]?

(A) Rigel.
(B) Betelgeuse.
(C) Procyon A.
(D) (There is a tie.)
(E) (Unsure/guessing/lost/help!)

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	m apparent magnitude	$\mathscr{M}$ absolute magnitude
Antares	+0.9	–5
Pollux	+1.2	+1.1
Fomalhaut	+1.1	+1.9
Sirius A	–1.5	+1.4

17. How far is [Antares / Pollux / Fomalhaut / Sirius A] from Earth?

(A) Farther than 10 parsecs.
(B) Exactly 10 parsecs.
(C) Closer than 10 parsecs.
(D) (Not enough information is given.)
(E) (Unsure/guessing/lost/help!)

18. ___________ is [the hottest / the coolest / not a] blackbody color (of a hot, glowing dense object).

(A) Red.
(B) Orange.
(C) Yellow.
(D) Green.
(E) Blue.
(F) White.
(G) (Unsure/guessing/lost/help!)

19. A white dwarf is known to be smaller than a main-sequence star that has the same white-hot color because the white dwarf is:
(A) less luminous than the main-sequence star.
(B) cooler than the main-sequence star.
(C) (Both of the above choices.)
(D) (Unsure/guessing/lost/help!)

	Luminosity =	Size ×	Temp.^4
White dwarf			
White m.s.			

20. A main-sequence star will be ____________ compared to a giant that has the same luminosity.
(A) smaller and cooler.
(B) smaller and hotter.
(C) larger and cooler.
(D) larger and hotter.
(E) (Unsure/guessing/lost/help!)

	Luminosity =	Size ×	Temp.^4
M.s. star			
Giant			

21. A supergiant will be __________ compared to a giant that has the same size.
(A) dimmer and cooler.
(B) dimmer and hotter.
(C) brighter and cooler.
(D) brighter and hotter.
(E) (Unsure/guessing/lost/help!)

	Luminosity =	Size ×	Temp.^{4}
Supergiant			
Giant			

22. Which star is the [hottest / most luminous / largest / coolest / least luminous / smallest]?
(A) O5 main-sequence star.
(B) A0 main-sequence star.
(C) G0 supergiant.
(D) M5 main-sequence star.
(E) (Unsure/guessing/lost/help!)

23. Which stars are the [most / least] massive?
(A) Supergiants and giants.
(B) Upper-main-sequence stars.
(C) Lower-main-sequence stars (red dwarfs).
(D) White dwarfs.
(E) (Unsure/guessing/lost/help!)

24. Which stars obey a mass-luminosity relation (the more massive a star is, the more luminous it is)?
(A) Supergiants and giants.
(B) Main-sequence stars.
(C) White dwarfs.
(D) (Two of the above choices.)
(E) (All of the above choices.)
(F) (None of the above choices.)
(G) (Unsure/guessing/lost/help!)

25. Which stars are the $\begin{bmatrix}\text{most}\\ \text{least}\end{bmatrix}$ dense?
(A) Supergiants and giants.
(B) Upper-main-sequence stars.
(C) Lower-main-sequence stars (red dwarfs).
(D) White dwarfs.
(E) (Unsure/guessing/lost/help!)

26. Which stars are the most common, $\begin{bmatrix}\text{as seen from Earth with the naked eye}\\ \text{if you surveyed only the nearest stars}\end{bmatrix}$?
(A) Luminous stars, such as supergiants, giants, and upper-main-sequence stars.
(B) Faint stars, such as lower-main-sequence stars (red dwarfs), and white dwarfs.
(C) (There is a tie.)
(D) (Unsure/guessing/lost/help!)

27. $\begin{bmatrix}\text{Red dwarfs are not common}\\ \text{Giants and supergiants are very common}\end{bmatrix}$ in the night sky, as seen from Earth with the naked eye, because they:
(A) are visible from very far away.
(B) have long main-sequence lifetimes.
(C) are much closer than 10 parsecs.
(D) have low luminosities.
(E) (Unsure/guessing/lost/help!)

28. The [most / least] common stars in the night sky, visible to the naked eye on Earth, are located __________, and have _________ luminosities.

(A) nearby; bright.
(B) nearby; dim.
(C) far away; bright.
(D) far away; dim.

29. The [distances to / sizes of / masses of / densities of] stars are found from:

(A) absorption line widths.
(B) observing parallax.
(C) how they move in binary system orbits.
(D) colors and luminosities.
(E) (Unsure/guessing/lost/help!)