If this bumper sticker is blue,

you're driving too fast!

Grading by a committee of your peers…!

An astronomer tries to get out of a ticket for running a red light by claiming that the Doppler shift made the light appear green to her. Does her story hold water?

(Please grade the following answer using the scale in the lower-right of the screen.)

If she were driving toward the traffic signal, then there would be a blue shift occuring, so that story holds water. I think she still gets a ticket though, unless she started crying like most girls do to get out of it

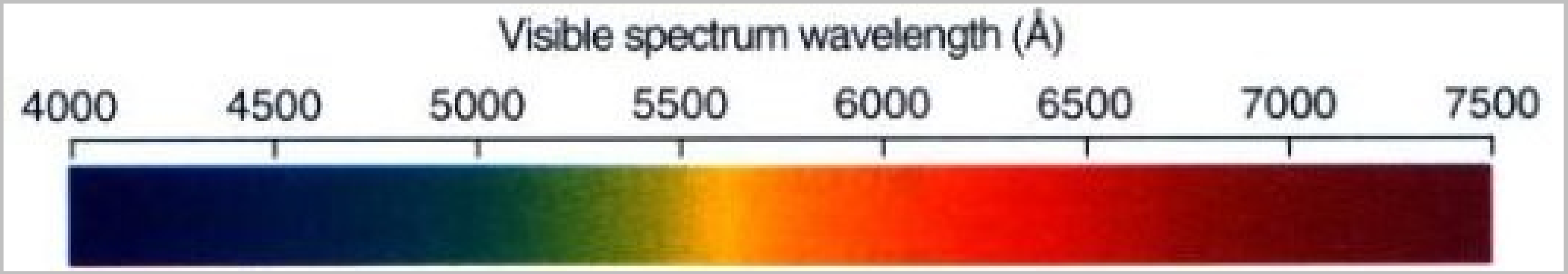
A 0
B 1
C 2
D 3
E Shock Therapy

In theory, if we approach a light-emitting source, blueshift ocurrs because the wavelengths are squished together, making the frequency higher and the wavelenghts shorter. Despite this, he argument does not hold water because in order to see a blueshift in light waves, the astronomer needs a prism, which I assume she was not driving with.

Color is color! If you're approaching a monochromatic red light-source at 1/6 the speed of light, it *will* look blue-green to you!

(Note : For the traffic light itself : you'd need to know the infrared spectrum to really figure out the color.... It is a continuous spectrum.)

How fast?



Red light : 6,000 Å
Green light : 5,000 Å

$$z = \frac{\Delta\lambda}{\lambda} = \frac{\lambda_{\text{obs}} - \lambda_{\text{orig}}}{\lambda_{\text{orig}}}$$

$$z = \frac{-1000\ \text{Å}}{6000\ \text{Å}} = -\frac{1}{6}$$

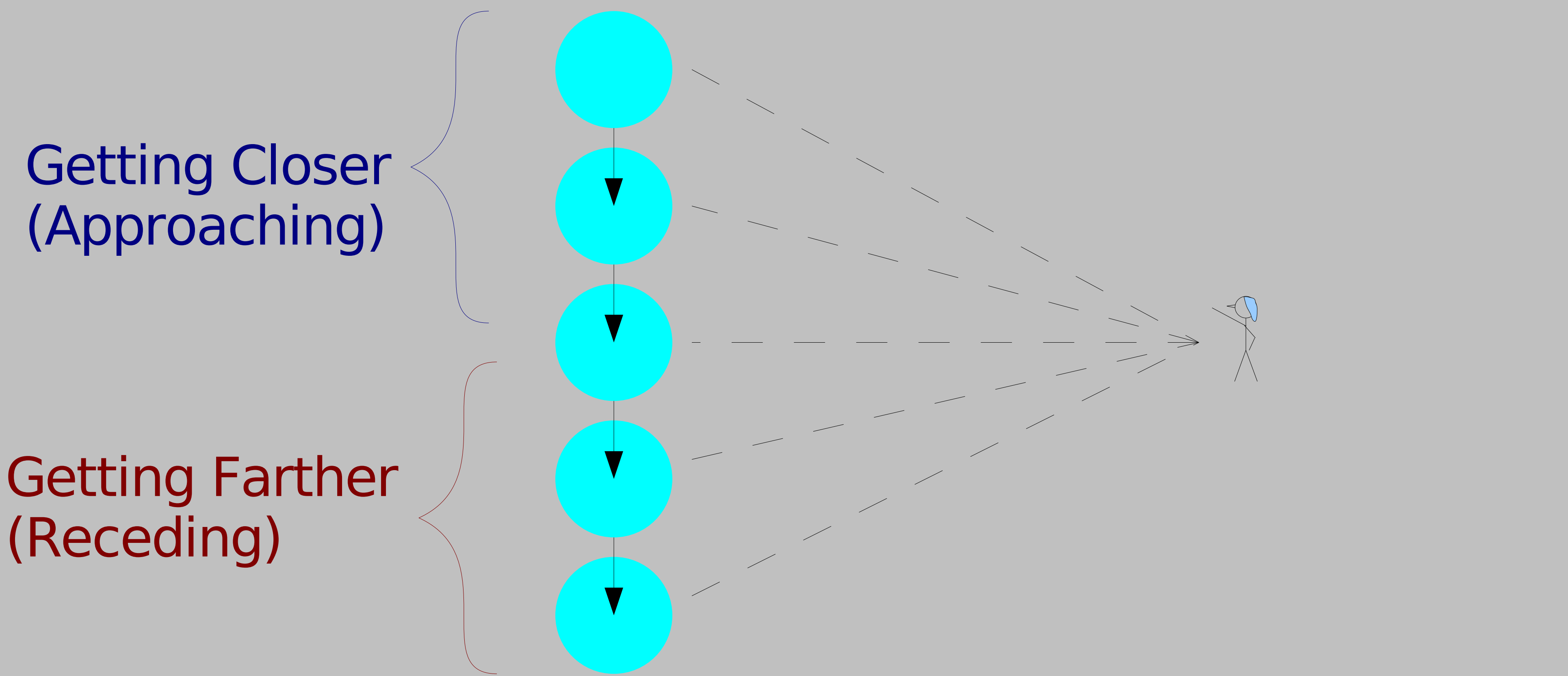
$$\frac{v}{c} = -\frac{1}{6} \qquad v = -\frac{1}{6}c$$

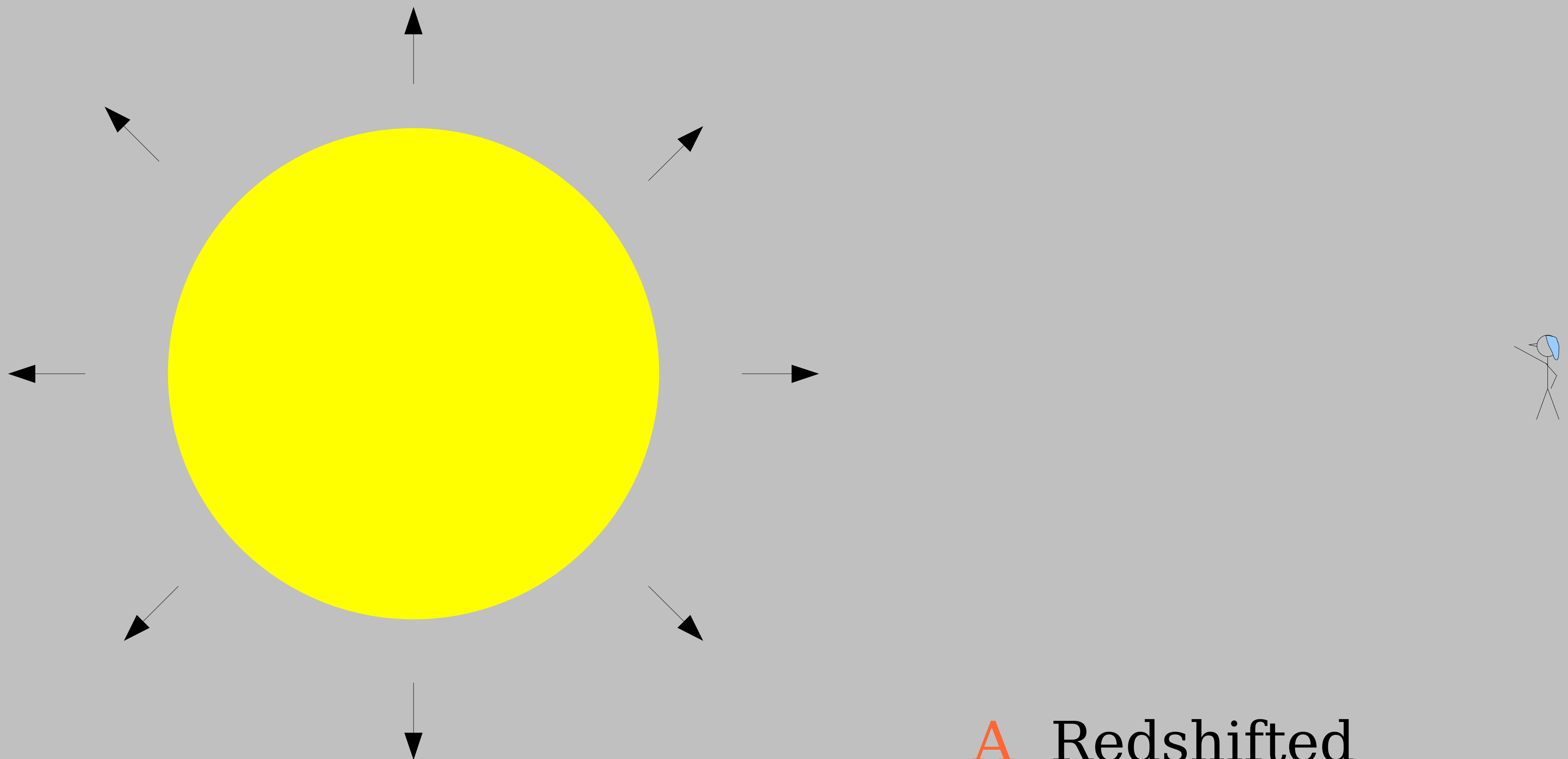
Redshift or Blueshift?

A Redshift
B Neither
C Blueshift
D Not Enough Info

What will you see?

B





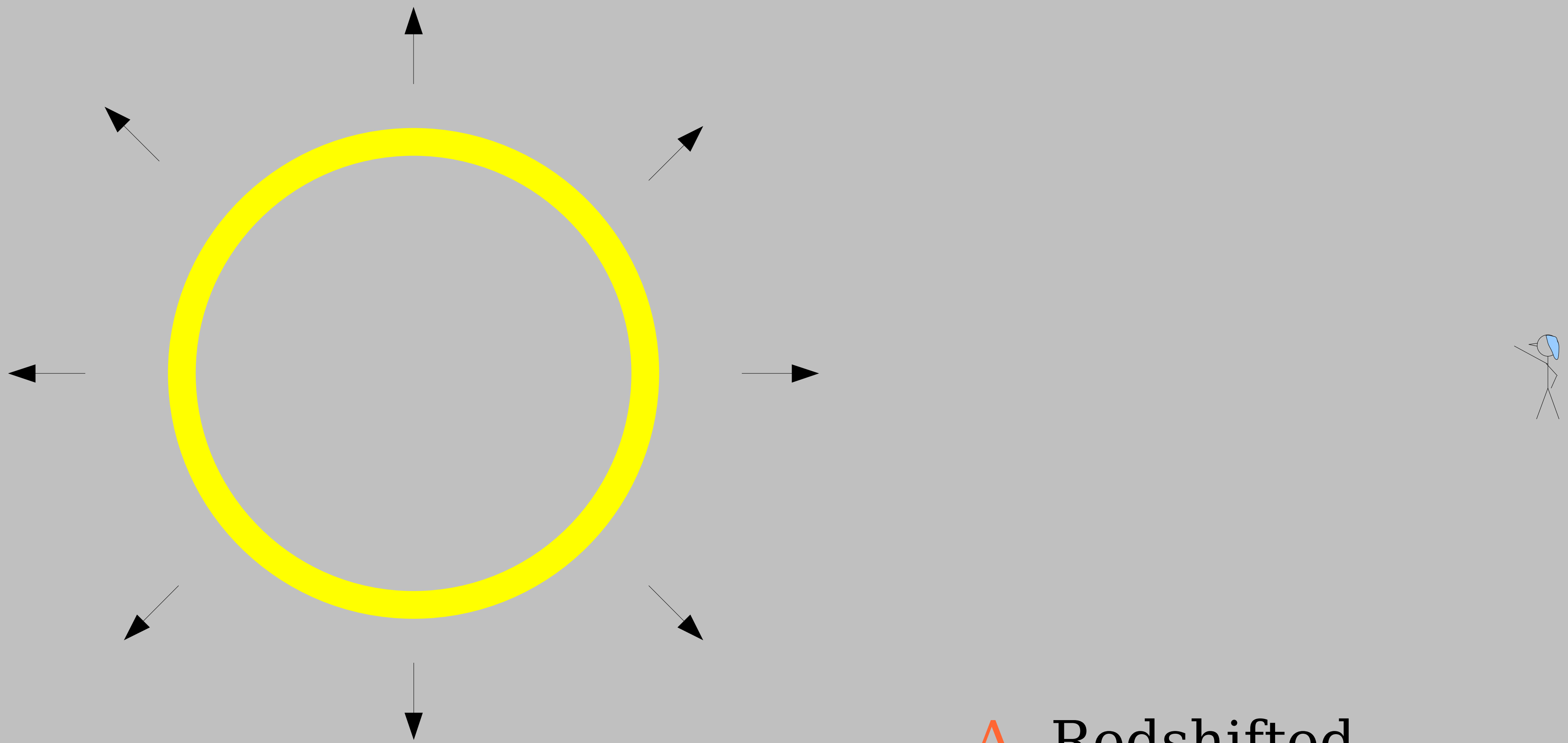
You observe an opaque cloud of gas which is currently expanding. You observe the lines in the spectrum (as compared to the same cloud at a constant size) to be:

A Redshifted

B Blueshifted

C Unchanged

D Broadened (spread out)



You observe a *transparent* cloud of gas which is currently expanding. You observe the lines in the spectrum (as compared to the same cloud at a constant size) to be:

A Redshifted

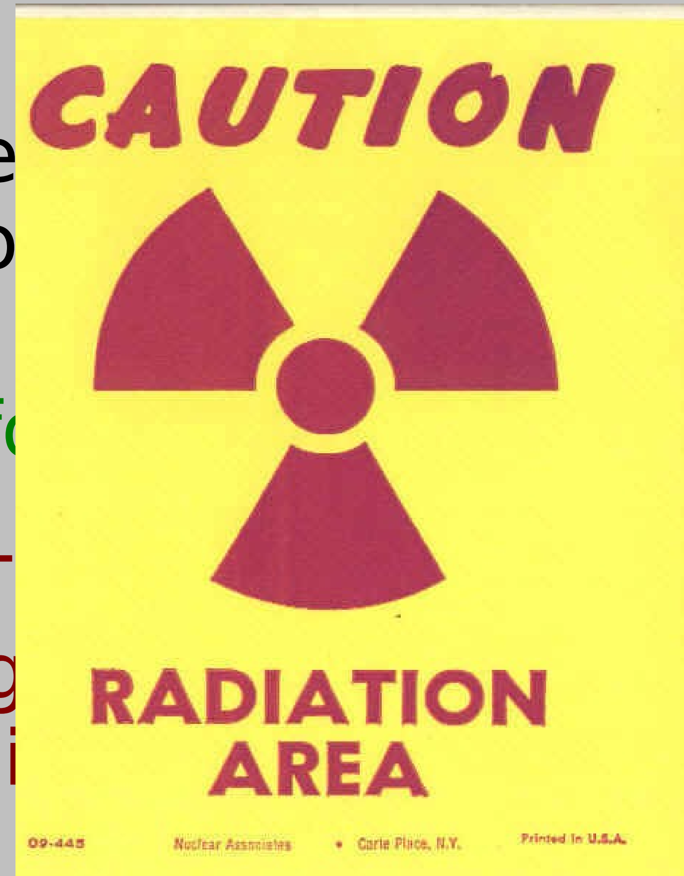
B Blueshifted

C Unchanged

D Broadened (spread out)

RADIATION

RADIATION : the [sign covers text] ergy in the fo[sign covers text] rticles.



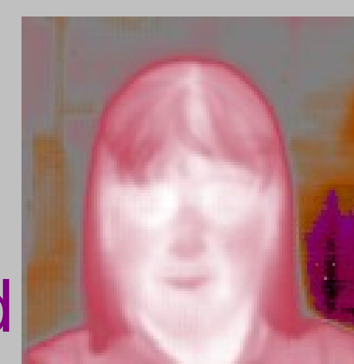
Light is a fo

BLACKBODY RADIAT[sign covers text] ristic spectrum of lig[sign covers text] "thermally emi[sign covers text] omething that's glowing [sign covers text].

You are radiating!

Astronomer
Alycia Weinberger

...in the infrared



RADIATION : the act of emitting energy in the form of waves or particles.

Light is a form of radiation!

BLACKBODY RADIATION : the characteristic spectrum of light given off by a “thermally emitting” body, i.e. something that's glowing because it's warm.

You are radiating!

Astronomer
Alycia Weinberger

...in the infrared

Blackbody (Thermal) Radiation : the spectrum of light emitted by a body that radiates just because it is warm.

$$L = A\,\sigma\,T^4$$

L Luminosity (in Watts) – energy output per second

A Surface area (in m^2)

T Temperature (in Kelvin)

σ Steffan-Boltzmann constant = 5.67×10^{-8} W m^{-2} K^{-4}

For a sphere (e.g. a star):

$$L = (4\pi R^2)\,\sigma\,T^4$$

R Radius of the star (in m)

Example : Luminosity of the Sun

$T_\odot$ = 5,780 K
$R_\odot$ = 695,500 km
σ = 5.67×10^{-8} W m^{-2} K^{-4}

$$L = (4\,\pi\,R^2)\,\sigma\,T^4$$

$$L = 4\,\pi\,(695{,}500\ \mathrm{km})^2\,(5.67\times10^{-8}\ \mathrm{W\ m^{-2}\ K^{-4}})\,(5780\,K)^4$$

$$L = 4\,\pi\,(695{,}500\ \mathrm{km})^2\,(5.67\times10^{-8}\ \mathrm{W\ m^{-2}\ K^{-4}})\,(5780\,K)^4\left(\frac{1{,}000\,\mathrm{m}}{\mathrm{km}}\right)^2$$

$$L_\odot = 3.85\times10^{26}\ \mathrm{W}$$

Consider two glowing panels. Panel 2 has half the area of panel 1, and is at twice the temperature of Panel1:

$$A_2 = 0.5\,A_1$$

$$T_2 = 2\,T_1$$

How does the energy put out per second by these two panels compare?

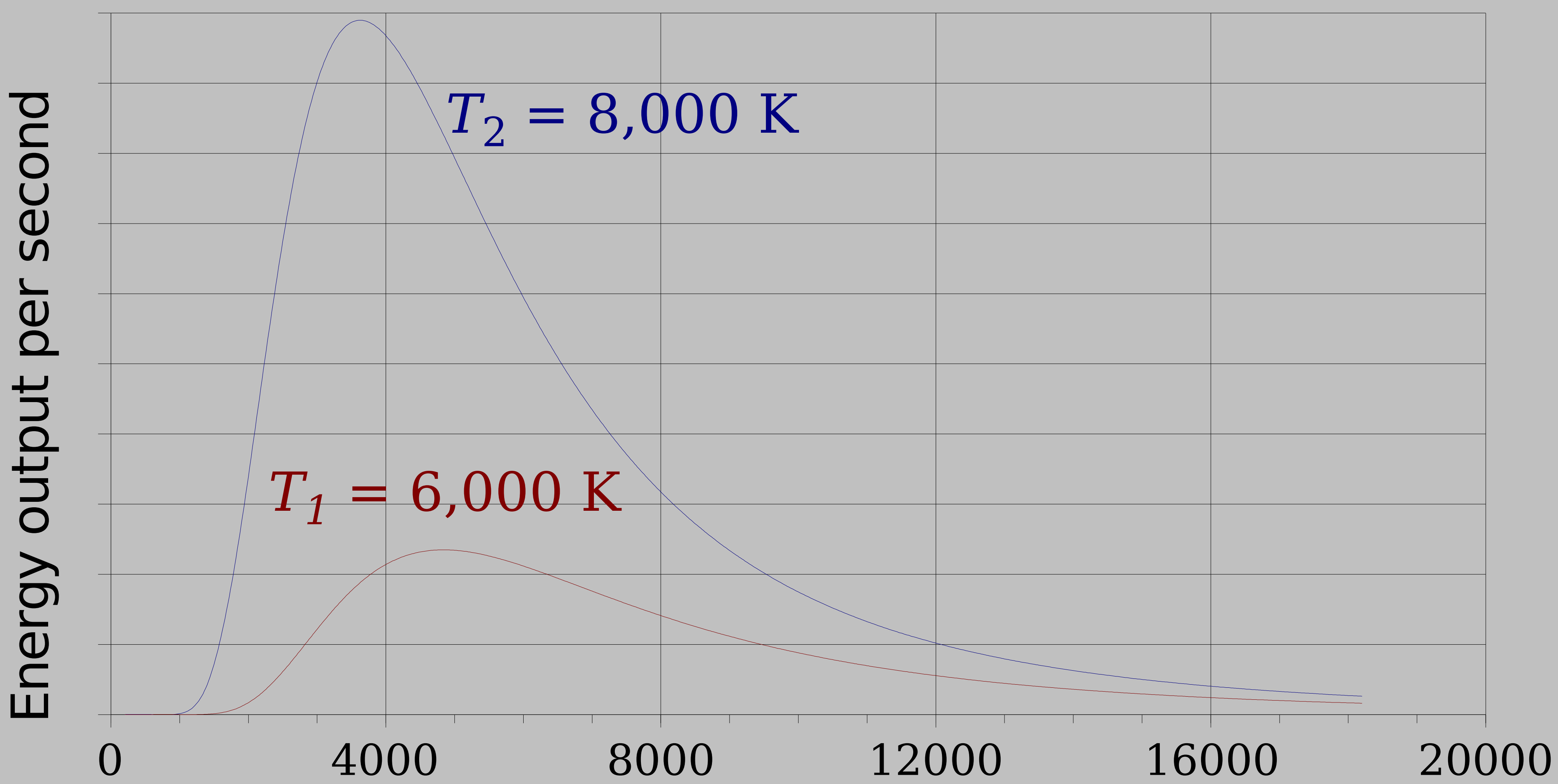
A Panel 1 puts out more energy per second.

B Panel 2 puts out more energy per second

C They put out the same amount of energy per second

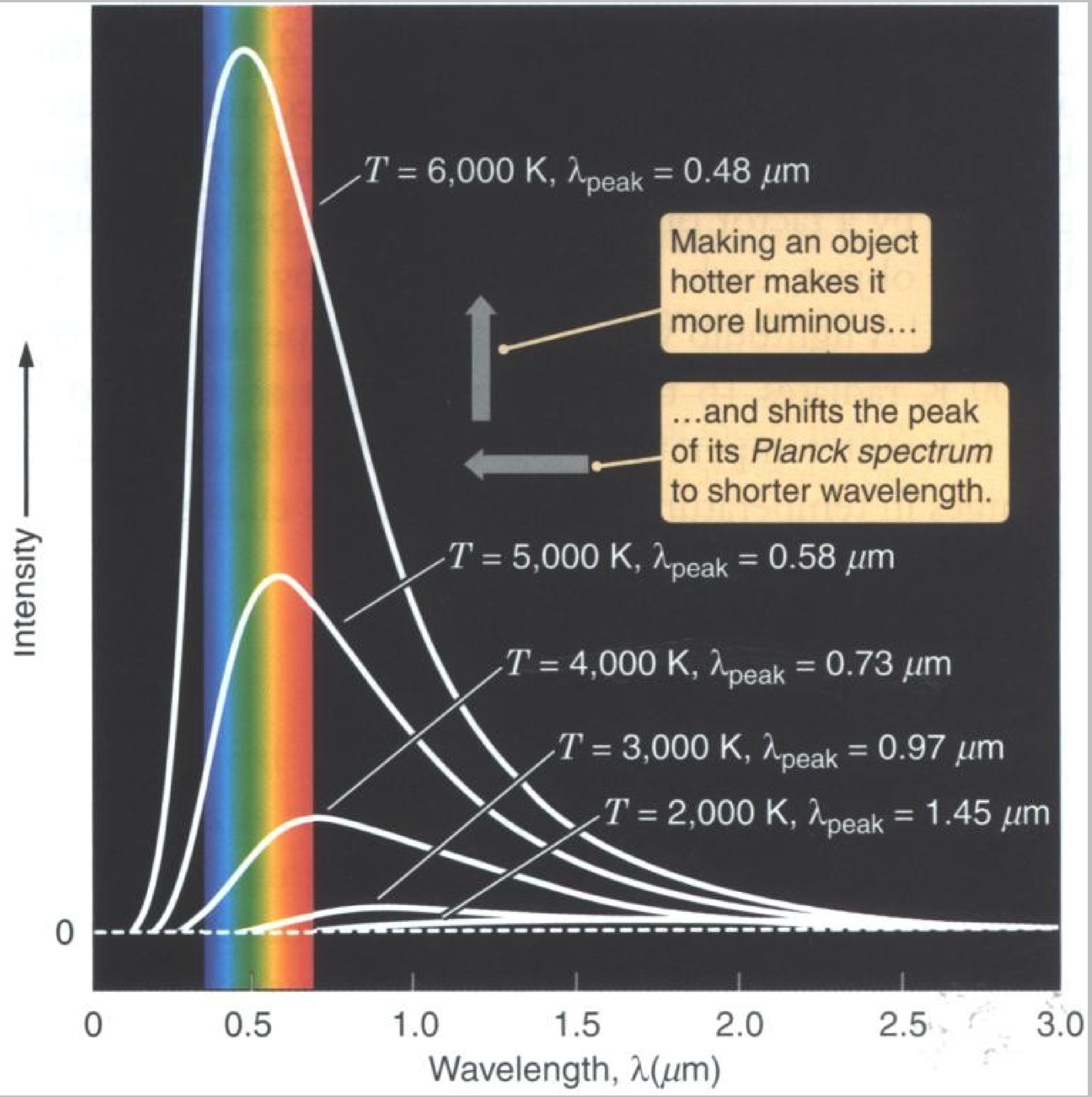
D There is not enough information to answer the question.

Blackbody (Thermal) Radiation



Higher Temperature: More Energy/sec (*for objects of same size*)

Higher T: Peak at higher frequency = lower wavelength = bluer



T = 6,000 K, λpeak = 0.48 μm
Making an object hotter makes it more luminous…
…and shifts the peak of its Planck spectrum to shorter wavelength.
T = 5,000 K, λpeak = 0.58 μm
T = 4,000 K, λpeak = 0.73 μm
T = 3,000 K, λpeak = 0.97 μm
T = 2,000 K, λpeak = 1.45 μm
Intensity
0
0
0.5
1.0
1.5
2.0
2.5
3.0
Wavelength, λ(μm)