Formative assessment: cosmology

Name:

Table 1: List of constants

Wien's law constant		2.9×10^{-3} m K
Stephan-Boltzman constant	σ	5.67×10^{-8} W m^{-2} K^{-4}
Luminosity of the Sun	$L_\odot$	3.8×10^{26} W
1 Astronomical unit	Au	1.50×10^{11} m
1 Parsec	Pc	3.1×10^{16} m
1 lightyear	ly	9.46×10^{15} m
Speed of light	c	3.00×10^{8} m s^{-1}
Planck's constant	*h*	6.63×10^{-34} J s
Hubble's constant	H_0	70 km s^{-1} MPc^{-1} 70,000 m s^{-1} MPc^{-1}

Table 2: List of prefixes

Prefix	**Abbreviation**	**Value**
Mega	M	10^6
Kilo	K	10^3
milli	m	10^{-3}
micro	$\boldsymbol{\mu}$	10^{-6}
nano	n	10^{-9}

Equations:

$E=hf$

$c=\lambda f$

$L=\sigma AT^4$

$V = H_o d$

$$\lambda_{max} T = 2.9 \times 10^{-3}$$

$$z = \frac{\Delta\lambda}{\lambda} \simeq \frac{v}{c}$$

$$b = \frac{L}{4\pi d^2}$$

Description questions

1. What is cosmological redshift, and how does it relate to the expansion of the universe? Provide a brief explanation in your own words.

2. Explain how astronomers use the concept of cosmological redshift to study distant galaxies. What information does the redshift of light from a galaxy provide about its motion and distance?

3. The formula for cosmological redshift (z) is given by

$$z = \frac{\lambda_{observed} - \lambda_{emitted}}{\lambda_{emitted}}$$

What do each of these variables represent, and how does this formula help us calculate redshift? How is the formula abve the same as the formula given on the first page?

4. Describe Hubble's Law and its significance in our understanding of the expanding universe. How does the redshift of distant galaxies contribute to the evidence supporting Hubble's Law?

5. If we could see individual stars in a distant galaxy would they all have the same measured redshift? Justify your answer.

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Mathematical questions

1. Given the observed wavelength of light from a distant galaxy is 650 nm, and the emitted wavelength is 500 nm, calculate the redshift, **z**.

2. If the redshift of light from a quasar is measured to be **z** = 0.08, and the emitted wavelength is 400 nm, find the observed wavelength.

3. Suppose a galaxy is observed with a redshift of **z** = 0.03. If the emitted wavelength is 700 nm, calculate the observed wavelength and determine the approximate distance to the galaxy using the speed of light, $c = 3 \times 10^8$ m s^{-1} and $H_0 = 70000$ m s^{-1} MPc^{-1}.

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4. Two galaxies, A and B, have redshifts of $\mathbf{z}_A = 0.05$ and $\mathbf{z_B} = 0.10$ respectively.
   a) If both galaxies emit light with a wavelength of 600 nm, compare the observed wavelengths of light from galaxies A and B.
   b) What can you infer about the motion and distance of these galaxies based on their redshift values?

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