Physics 90 Exam for Unit 1

February 28, 2020

Standard prefixes:

k = kilo = 10^3
M = mega = 10^6
G = giga = 10^9
T = tera = 10^{12}
c = centi = 10^{-2} (but do not confuse it this with the speed of light which is also *c*)
m = milli = 10^{-3}
μ = micro = 10^{-6}
n = nano = 10^{-9}
p = pico = 10^{-12}

Common unit abbreviations:

m is the usual abbreviation for meter (but also for milli!, so millimeter is mm)
s is the usual abbreviation for second
Hz is for Hertz which is $\frac{1}{\text{second}}$

Latitude and Longitude

1. Latitude

The latitude of the north pole is:

(A) +180°
(B) +90°
(C) 0°
(D)-90°

2. Longitude

The longitude of the Greenwich Royal Observatory in England is:

(A) +180°
(B) 0°
(C)-180°

Declination

3. Polaris

The declination of Polaris (The North Star) is about:

(A) +180°
(B) +90°
(C) 0°
(D)-90°

4. Looking Straight Up

If you are out at night in Pucon, Chile, which has latitude -39°, and you look straight up, you will see stars with declination:

(A) -61°
(B) -39°
(C) +39°
(D) +61°

Daily and Annual Motion of the Sun

5. Right Ascension

Right ascension is measured with a sidereal clock which:

(A) Is set to 0h when the constellation of Orion passes across the observing slit
(B) Needs to run a little slow, because the stars fall four minutes behind the Sun each day.
(C) Needs to run a little fast, because the stars get four minutes ahead of the Sun each day.

6. The “First Point of Aries”

The “First Point of Aries” has moved in the greater than 2000 years since Hipparchus set the system up. Today, the “First Point of Aries” is in

(A) Ursa Major
(B) Orion
(C) Pisces
(D) Sagittarius

7. Right Ascension

If you look through a slit in the roof and something with Right Ascension 13h goes across it, and you keep still and looking through the slit whatever comes into view after one hour has:

(A) Right Ascension of 12h
(B) Right Ascension of 13h
(C) Right Ascension of 14h
(D) Right Ascension of 15h

8. The Ecliptic and The Seasons

Some college students decide to meet each year after graduation on a day when the day and night are the same length. They could choose:

(A) The Fall Equinox, September 22
(B) The First Day of the Year, January 1
(C) The Summer Solstice, June 22
(D) The Winter Solstice, December 22

Apparent Magnitude (or just "Magnitude")

In the modern magnitude system, Vega has magnitude 0. If the brightness of star 1 is B_1 and the brightness of star 2 is B_2, and the magnitudes are m_1 and m_2, then

$$\frac{B_1}{B_2} = 100^{(m_2 - m_1)/5}$$

Also, since $100^{1/5}$ is about 2.5, we sometimes approximate and say each step (e.g., 1 → 2 or 15 → 16) is a factor of 2.5 dimmer.

9. Apparent Magnitude

In the modern magnitude system, three steps would be about:

(A) 6 times dimmer
(B) 7.5 times dimmer
(C) 16 times dimmer
(D) 100 times dimmer

10. Apparent Magnitude

Betelgeuse is sometimes magnitude 0 (the same as Vega). Today it has magnitude 1.5. This represents:

(A) a dimming by a factor of $100^{1.5}$ which is 1000.
(B) a dimming by a factor of $100^{1.5/5}$ which is about 4.
(C) a brightening by a factor of about 4.
(D) a brightening by a factor of 1000.

Frequency and Period

The definition for frequency in terms of period is

$f \equiv \frac{1}{P}$

11. Frequency and Period

The high pressure rotor on the world's most powerful turbofan jet engine turns at 9000 rpm. Convert that to Hertz:

(A) 540000 Hz
(B) 9000 Hz
(C) 150 Hz
(D) 100 Hz

12. Frequency and Period

What period corresponds to 100 Hz?

(A) 0.006 seconds
(B) 0.001 seconds
(C) 10^{-3} seconds
(D) 10 ms
(E) 0.1 seconds

Wave, Wave Speed, Period and Frequency

The main formula for waves of light is

$c = \frac{\lambda}{P}$ where the speed of light $c = 3 \times 10^8$ m/s

From this and the definition of frequency, you can also get $c = \lambda f$.

13. Frequency from Wavelength

Microwaves ovens have wavelength 12 cm. Their frequency is:

HINT, the very first thing you should do is convert cm to m so that you won't be off by 100.

(A) 2.5 MHz
(B) 2.5 GHz
(C) 2500 GHz
(D) 2,500,000,000,000 Hz

14. Wavelength from Frequency

X-rays have frequency ranging from 3×10^{16} Hz to 3×10^{19} Hz. Let's choose something from the middle of the range: $f = 3 \times 10^{17}$ Hz. What wavelength do these waves have?

(A) 1 nm
(B) 1 cm
(C) 1 Gm
(D) 1 Tm

Temperature Scales

The two main formulas for the various temperature scales, which you can rearrange to get lots of others are:

$T_{\text{Celsius}} = T_{\text{Kelvin}} - 273$

and

$T_{\text{Fahrenheit}} = \frac{9}{5} T_{\text{Celsius}} + 32$

15. The Celsius scale

The Celsius scale was chosen so that

(A) Water freezes at 0°C and boils at 100°C.
(B) Water freezes at 0°C and boils at 273°C.
(C) Water freezes at 273°C and boils at 546°C.

16. The Kelvin scale

On the Kelvin scale, the temperature at which all motion stops is:

(A) 0K
(B) 273K
(C) 373K
(D) 5777K

17. Temperature Scales

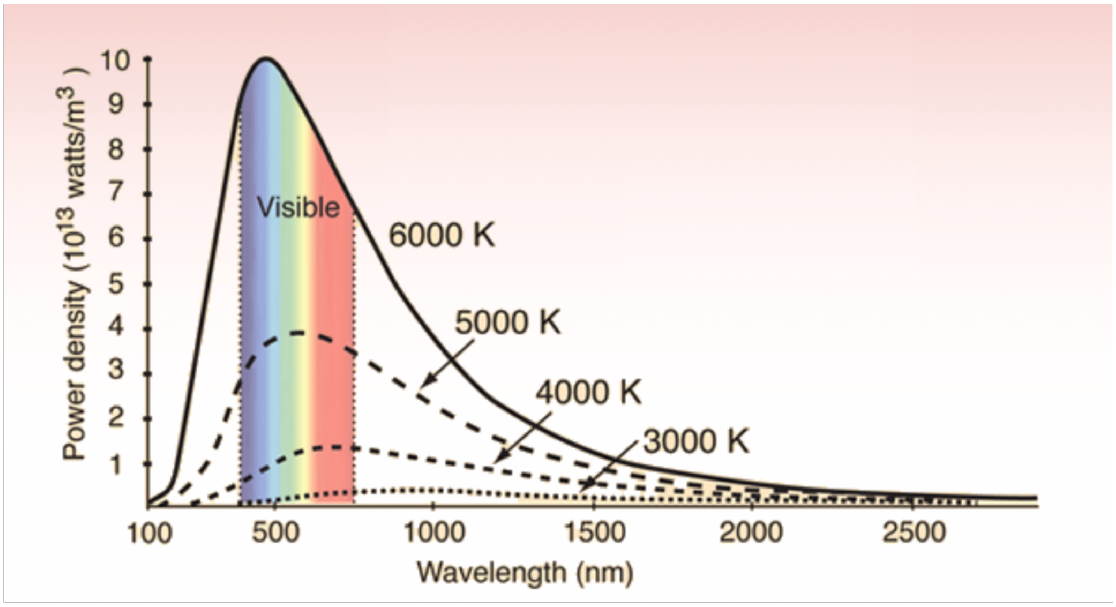
The temperature of Rigel is 11000 K. Convert to Celsius, and then convert to Fahrenheit. The temperature of Rigel in Fahrenheit is:

(A) 19832 °F
(B) 19341 °F
(C) 10938 °F
(D) 10727 °F

Temperature and Color

18. Temperature and Color

The graph below shows power output output as a function of wavelength for stars of various temperatures:



Study the dashed curve for the 4000K star. The peak wavelength for such a star is about:

(A) 100 nm
(B) 400 nm
(C) 700 nm
(D) 900 nm

Such a star looks reddish and an example is Betelgeuse which has temperature 3500K.

19. Temperature and Color

If a star produces about equal amounts of all three primary colors — blue, green and red — all three kinds of cones in your eye would be excited equally, and the star would appear:

(A) brown
(B) white
(C) black

Wien's Law for Blackbody Radiation

For an object that is radiating electromagnetic waves the radiated light has a peak in the spectrum, and the location for the peak is:

$$\lambda_{peak} = \frac{2.9\, x\, 10^6 \text{ nm Kelvin}}{T}$$

20. Wien's Law

There is a star in the Great Square of Pegasus that is just known as HR 8799. This star has temperature 7250 K. Use the formula above and your calculator to find the peak wavelength of this star:

(A) 700 nm, which is red
(B) 530 nm, which is green
(C) 470 nm, which is blue
(D) 400 nm, which is violet