Name_____Example_____

Funniest Moment in Class_____

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1. A star has a Luminosity of 4.5 x 10²⁶ W, and a peak black body radiation of 520 nm. What is its radius? (8.08 x 10⁸ m)

$$T = \frac{2.90 E\text{-}3}{\lambda}$$

$$T = \frac{2.90 E\text{-}3}{520 E\text{-}9} = 5576.92 \text{ K}$$

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

$$4.5E26 = (5.67E\text{-}8)(4\pi) r^2 (5576.92)^4$$

$$r = 8.08017 \ E8 \ m$$

2. A star has an apparent brightness of 2.35x10⁻¹⁴ W/m². If it has an absolute magnitude of 2.3, how many parsecs are we from it? (3590 -> 3600 pc)

$$m = 2.5 \log\left(\frac{2.52E\text{-}8}{2.35 E\text{-}14}\right) = 15.0759$$

$$m - M = 5 \log\left(\frac{d}{10}\right)$$

$$15.0758 - 2.3 = 5 \log\left(\frac{d}{10}\right)$$

$$10\left(10^{\left(\frac{m-M}{5}\right)}\right) = 3590.59 \ Pc$$

3. A galaxy is 23 Mpc from us. At what wavelength would we see the 486 nm spectral line or Murrayium from that galaxy. (Use H = 50 km/s/Mpc) (487.863 -> 488 nm)

$$v = Hd$$

$$v = \left(50 \frac{Km}{s \cdot Mpc}\right)(23 \ mpc) = 1150 \frac{Km}{s}$$

$$\frac{\Delta V}{C} = \frac{\Delta \lambda}{\lambda}$$

$$\frac{1150 \frac{Km}{s}}{3E5 \frac{Km}{s}} = \frac{\Delta \lambda}{486}$$

$$\Delta \lambda = 1.863$$
so
$$\lambda' = 486 + 1.863$$
$$487.863 \ nm$$

4. A very strong concertmaster is on top of a 148 m tall tower near a black hole where the gravitational field strength is 5.53x10¹² m/s/s. If another player is making a frequency of 440.0 Hz at the bottom, what frequency does the concertmaster hear at the top? What beat frequency do they hear? (436. Hz, and 4.00 beats per second)

$$\frac{g \Delta h}{c^2} = \frac{\Delta f}{f}$$

$$\frac{(5.53E12)(148)}{(3E8)^2} = \frac{\Delta f}{440}$$

$$\Delta f = 4.00 \ Hz$$

Low clocks run slow so the concert master hears 440 - 4 = 436.0 Hz

and this beats f = |440 - 436| = 4.00 $\frac{beats}{Sec}$

5. A black hole has a mass of 21 solar masses. (The mass of the sun is 1.99x10³⁰ kg.) *Calculate the radius of the event horizon, *Calculate the time it would take a clock 160 km beyond the event horizon to register 60. seconds of elapsed time as we observe it from a great distance. (62 km, 71 s)

$$R_s = \frac{2GM}{c^2} = \frac{2(6.67E\text{-}11)(21)(1.99E30)}{(3E8)^2} = 61942.1 \ m$$

$$\Delta t = \frac{\Delta t_0}{\sqrt{1 - \frac{R_s}{r}}} = \frac{60s}{\sqrt{1 - \frac{61942.1}{(160,000 + 61942.1)}}} = 70.666 \ s$$