Astrophysics Yr 2 Class test 2: 2010 **NAME:**_____

1) What type of spectral line broadening is caused by the Heisenberg Uncertainty Principle?

***Answer**:* *Natural line broadening.*

(3 marks)

2) Calculate the energy in joules resulting from an individual fusion reaction which converts hydrogen to helium.

Mass of hydrogen atom $M_H = 1.67 \times 1o^{-27} kg$

Mass of helium atom $M_{He} = 6.645 \times 10^{-27} kg$

Speed of light $c = 3 \times 10^8 ms^{-1}$.

Solution: $4M_H \rightarrow 1He$

Mass difference $= 4 \times 1.67 \times 10^{-27} - 6.645 \times 10^{-27} = 3.5 \times 10^{-29} kg.$

$E = mc^2 = 3.5 \times 10^{-29} \times 9 \times 10^{16} = 3.15 \times 10^{-12}$ *joules.*

(3 marks)

3) Explain very briefly why the initial collapse of a molecular cloud core is isothermal.

Answer: *Low density → low optical depth → (infra red) photons produced as result of collapse readily escape carrying (heat) energy away. Hence initial collapse is isothermal.*

(3 marks)

4) At a physical depth of 350km, the optical depth of the Sun's photosphere is 5. Calculate the fraction of radiation which reaches the surface from this depth.

Solution:

$f = f_0 e^{-\tau} = f_0 e^{-5} = f_0 \times 0.0067$

Hence: $\frac{f}{f_0} = 0.0067$

(3 marks)

5) Aside from irregular galaxies, give the names of the three main types of galaxy as classified by Hubble.

Answer:

Elliptical; spiral & barred spiral.

(3 marks)

6) The Jeans mass M_j is given by the expression:

$$M_J = \left\{\frac{3}{4\pi}\right\}^{1/2} \left\{\frac{k}{\mu G}\right\}^{3/2} T^{3/2} \rho^{-1/2}$$

Calculate M_j for a cloud of molecular hydrogen whose temperature T = 10K and the density $\rho = 10^{-16}kgm^{-3}$.

Boltzmann constant $k = 1.38 \times 10^{-23}$ joules per degree.

Gravitational constant $G = 6.672 \times 10^{-11}$ newton metre^2 per kg^2.

$\mu = 3.34 \times 10^{-27}$ kg.

Solution:

$$M_J = \left\{\frac{3}{4\pi}\right\}^{1/2} \left\{\frac{1.38 \times 10^{-23}}{3.34 \times 10^{-27} \times 6.672 \times 10^{-11}}\right\}^{3/2} 10^{3/2}\left(10^{-16}\right)^{-1/2}$$

$M_J = 7.53 \times 10^{29}$kg; i.e. 0.38 solar masses.

(5 marks)