

ASTRONOMY (SL)

Examination Paper 2 May 2008

Marking Scheme

Marking Grid	
Section A	Marks
1	
2	
3	
4	
Section B	Marks
5	
6	
Total / 60	

Section A (40 marks)

Question 1. [10 marks]

- a)
1. core
 2. radiative zone/region/area
 3. convective zone/region/area
 4. photosphere
 5. Sunspot
 6. chromosphere
 7. corona

[2] : Award 2 marks if all are correct and 1 mark for a minimum of four correct.

b)

$$D = \frac{m}{V} \Rightarrow m = D \times \frac{4}{3} \pi r^3$$

$$D_{\text{Sun}} = \frac{M_{\odot}}{\frac{4}{3} \pi R_{\odot}^3}$$

$$M = \frac{M_{\odot}}{\frac{4}{3} \pi R_{\odot}^3} \times \frac{4}{3} \pi r^3 = \frac{r^3}{R_{\odot}^3} \times M_{\odot}$$

$$M = \left(\frac{r}{R_{\odot}} \right)^3 M_{\odot} = (0.3)^3 M_{\odot}$$

$$= 0.027 M_{\odot} = 5.4 \times 10^{28} \text{ kg}$$

$$= 2.7\% M_{\odot} \approx 3\% M_{\odot}$$

[1] : $M = (r/R_{\odot})^3 \cdot M_{\odot}$

[1] : correct answer = $0.027 M_{\odot}$ / $0.03 M_{\odot}$ / 2.7% of M_{\odot} / 3% of M_{\odot} / $5.4 \times 10^{28} \text{ kg}$

c)

[1] : Size – the outward pressure falls therefore the size decreases

[1] : Temperature – (the size falls therefore) the GPE falls therefore KE rises therefore the T rises.

Note(s) : In both cases the mark can only be given IF there is a change AND a valid reason.

d)

Reduction in outer temp :

$$PE \uparrow \therefore KE \downarrow \therefore T \downarrow$$

Rise in Luminosity :

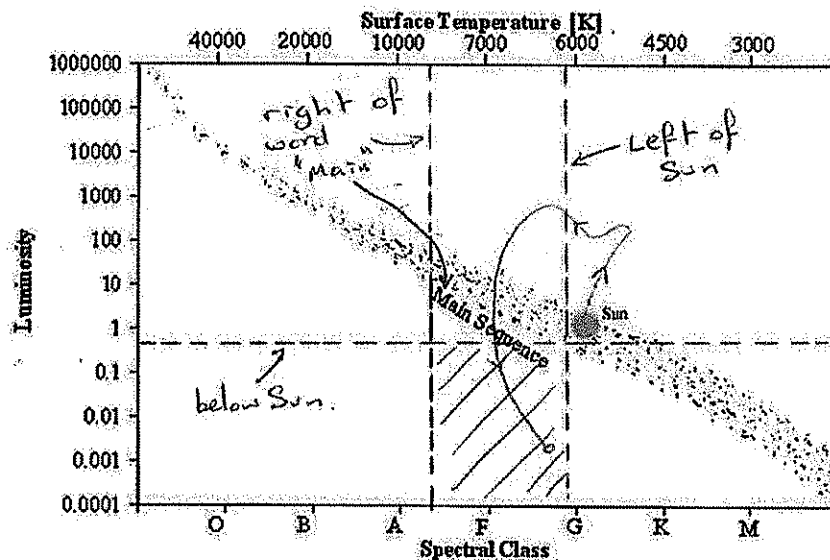
$$L = \sigma A T^4 = \sigma 4\pi r^2 T^4$$

Even though $T \downarrow$, initially $r \uparrow$
 $\therefore L \uparrow$.

[1] : Temperature – GPE rises therefore KE falls therefore T falls.[1] : Luminosity – L depends on r^2 and so, as r increases, L increases.

Note(s) : In both cases the mark can only be given IF there is a change AND a valid reason.

e)



[1] : The initial move off the MS is upwards AND right or vertical.

[1] : subsequent path:

- goes through MS on the left of the starting point
- finishing within the shaded box shown in the above diagram.

Question 2. [10 marks]

a)

- 'homogenous' or 'heterogeneous' is determined by the rate of cooling of the nebula as the planets form.
- homogeneous is felt to be more likely because the cooling rate was comparatively high

[1] : type determined by rate of cooling/how fast the cooling is

[1] : homogeneous because cooling rate is high

b)

[2] : Any two from:

- ✓ Density
- ✓ Composition
- ✓ Magnetism
- ✓ Seismic studies

Note(s) : 'Earthquakes' is NOT a suitable answer for 'seismic studies'.

c)

[2] : Any two from:

- Accretional/collision heating
- Radiogenic/radioactive heating
- Core formation
- Tidal heating

d)

[1] : Radiogenic/Radioactive

[1] : Some radioactive isotopes are very long lived / around for billions of years / half lives of billions of years

Note(s) : reference to 'millions' in the second marking point is NOT good enough.

e)

	Differentiation is still happening	Differentiation is NOT happening
The Terrestrial Planets :		✓
The Gas Giants :	✓	

[1] : One mark for each correct tick

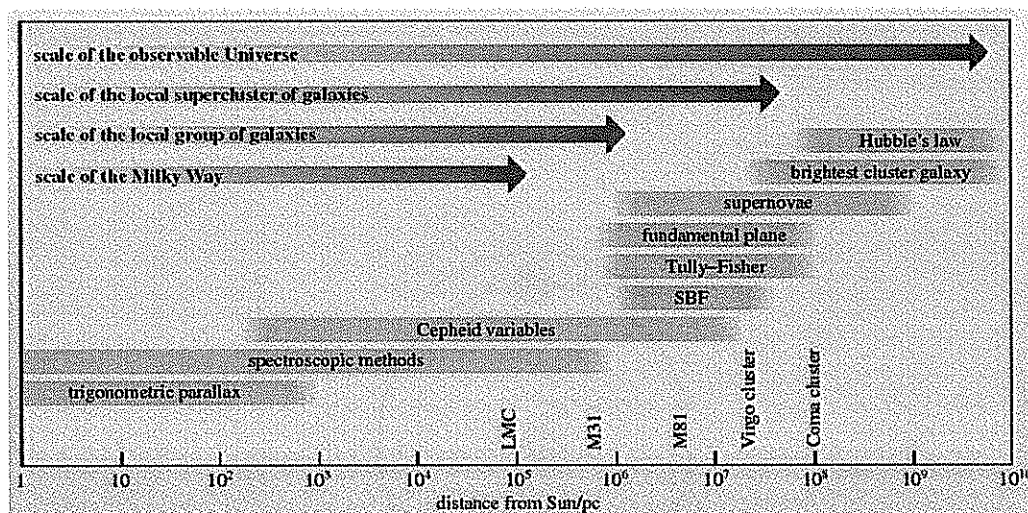
Question 3. [10 marks]

a)

[1] : - (trigonometric parallax) method is only suitable to 10^3 pc AND
 - nearest galaxy is further than this / Milky Way bigger than this.

[1] : angles are too small / uncertainties are too big

b)

**Standard Candle**

[1] : Method selected must be one of:

- Cepheid Variables.
- Supernovae.

[1] : Range must agree with that stated on the given Figure

[1] : Correct description of basic method.

Galactic Property

[1] : Method selected must be one of:

- Tully-Fisher.
- Brightest Cluster galaxy.
- Hubble's Law.

[1] : Range must agree with that stated on the given Figure

[1] : Correct description of basic method.

c)

[1] : Hubble's law.

[1] : $1/H_0$ = age of universe

Question 4. [10 marks]

a)

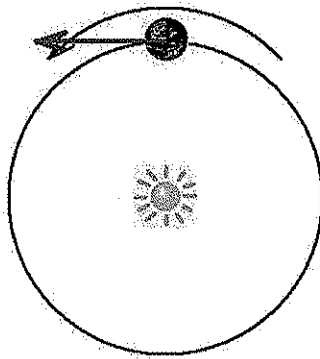
$$F = \frac{G M m}{r^2} = \frac{6.67 \times 10^{-11} \times 1.99 \times 10^{30} \times 6.0 \times 10^{24}}{(1.5 \times 10^{11})^2}$$

$$\underline{\underline{F = 3.5 \times 10^{22} \text{ N}}}$$

[1] : Correct working

[1] : Correct answer = $3.5 \times 10^{22} \text{ (N)}$

b)



[1] : (always) towards the Sun / towards the centre of the motion/orbit

c)

[1] : Arrow must be straight

[1] : directed to the left (by eye)

d)

[1] : the speed of light / $3 \times 10^8 \text{ m/s}$

e)

$$v = \frac{d}{t} \Rightarrow t = \frac{d}{v} = \frac{1.5 \times 10^{11}}{3 \times 10^8} = \underline{\underline{500 \text{ s}}}$$

$$= \underline{\underline{8.3 \text{ min}}} \quad (\underline{\underline{8 \text{ min } 20 \text{ s}}})$$

[1] : correct working

[1] : Correct answer = $500 \text{ s} = 8.3 \text{ min} = 8 \text{ min } 20 \text{ s}$

f)

[1] : The Sun('s mass) distorts the (local) spacetime

[1] : The Earth moves on (this) spacetime

Section B (20 marks)

Question 5. [2 marks]

a)

Black Hole:

[1] : dead star / object with a grav field strong/large enough to prevent light escaping

Galaxy

[1] : Answer must include

- large collection/number of stars
- held together with/by gravity

b)

[1] : mass is millions of times greater / found at the centre of a galaxy / galaxy revolves around them

c)

[2] : Any two from:

- ✓ UV
- ✓ X-rays
- ✓ Gamma rays
- ✓ High energy particles

d)

[1] : emissions occur when material falls/is sucked/drops into the BH

[1] : material is heated to very high temperatures.

e)

[1] : Active

[1] : because the excess is in a localised region ORA

f)

Distance = 20,000 light years

Distance = 1.9×10^{20} m (20,000 \times 9.5×10^{15})

[1] : correct conversion

Note : This mark is for the conversion NOT the correct answer.

g)

$$F = \frac{G M m}{r^2} = \frac{6.67 \times 10^{-11} \times (1 \times 10^{11} \times 1.99 \times 10^{30})^2}{(1.9 \times 10^{20})^2}$$

$$= 7.3 \times 10^{31} \text{ N}$$

[1] : indication that the mass of EACH galaxy is $1 \times 10^{11} \times 1.99 \times 10^{30} = 1.99 \times 10^{41}$ kg[1] : correct answer = 7.3×10^{31} kg

h)

[1] : it is not emitted spherically / in all directions ORA

i)

[1] : O₃ / 3 atoms of oxygen in a molecule

j)

[1] : ozone excited / ozone absorbs energy / photons collide with molecules

[1] : breaking the bonds

k)

[1] : atmosphere is not in equilibrium

[1] : (possibly) contain life

l)

[1] : compresses gas / nebulae

[1] : decrease Jeans mass of the cloud

Question 6. [1 mark]

a)

Auroras

[1] : light emitted from the upper atmosphere

[1] : side of planet away from the Sun

b)

[1] : (banding is due to) convection cells / convention cycles / Hadley cells

[1] : colour is due to chemicals contained within them

c)

[1] : normal telescope uses visible light

[1] : Jupiter's auroras emit x-rays

d)

$$\text{Speed} = \frac{d}{t} = \frac{1.5 \times 10^{11}}{(2 \times 24 \times 3600)} = 8.7 \times 10^5 \text{ m/s}$$

[1] : 2 days = $2 \times 24 \times 3600 / 1.7 \times 10^5 \text{ s}$

[1] : correct method

[1] : correct answer = $8.7 \times 10^5 \text{ m/s}$ Note : only using '2' for the time give $7.5 \times 10^{10} \text{ m/s} = 1 \text{ mark}$

e)

[1] : the Sun's gravitational field

[1] : produces an attractive force against the motion

f)

$$F = \frac{L}{A} = \frac{L}{4\pi r^2} \Rightarrow F \propto \frac{1}{r^2}$$

So, if distance is $\times 5.2$, Flux reduces
by a factor of $1/5.2^2 = 3.7 \times 10^{-2}$ is
27 times less.

[1] : some indication that F is proportional to $1/r^2$ [1] : correct answer = 27 times smaller / $1/5.2^2 / \times 3.2 \times 10^{-2}$

g)

[1] : Jupiter is seen to rotate

[1] : it is not solid / gaseous

h)

[1] : One from:

- ✓ reverse it
- ✓ increase it
- ✓ squash the lines/flux/field together
- ✓ produce magnetic reversal

i)

[1] : volcanic eruptions

[1] : on Io

j)

[1] : Moon is the Earth's only sensible option

[1] : Moon is no longer volcanic