UNIVERSITY COLLEGE LONDON

University of London

EXAMINATION FOR INTERNAL STUDENTS

For The Following Qualifications:-

B.Sc. *M.Sci.*

Astronomy 3C11: Planetary Geology

COURSE CODE	:	**ASTR3C11**
UNIT VALUE	:	**0.50**
DATE	:	**13-MAY-03**
TIME	:	**14.30**
TIME ALLOWED	:	**2 Hours 30 Minutes**

03-C0084-3-80

TURN OVER

Answer THREE questions.

The numbers in brackets indicate the provisional allocation of marks for each sub-section of the question.

Stephan-Boltzmann constant σ	$= 5.67\text{x}10^{-8}\text{Wm}^{-2}\text{K}^{-4}$
Mean Sun-Earth distance (1 AU, Astronomical Unit)	$= 150\text{x}10^{9}$ m
Earth's radius r_E	$= 6.37\text{x}10^{6}$ m
Solar constant S	= 1363 W/m^2
Gravitational Constant G	$= 6.67\ 10^{-11}$ N m^2 kg^{-2}
Wien's law (with T in K and λ in cm)	λ=0.29/T

Question 1:

Asteroid 2 *Pallas* has an orbital semimajor axis of a=2.770 AU and eccentricity of e=0.2347. Comet *Halley* has an orbital semimajor axis of a=17.8 AU and eccentricity of e=0.967. The perihelion is given by $a(1-e)$ and the aphelion by $a(1+e)$.

Calculate the aphelion and perihelion and orbital periods for 2 *Pallas* and comet *Halley*. Describe the orbits of the two bodies. Which regions of the solar system do asteroids and comets typically populate? Name the regions and distinguish between short period and long period comets. Is *Halley* a short period or long period comet? (Hint: you can make use of Kepler's third law to calculate orbital periods and use the fact that Earth is located near 1 AU distance from the Sun) [8]

Sketch and describe the different parts of a comet. Describe the processes that generate its dust tail and state what causes the tail's brightness. Discuss what role its surface composition and orbital eccentricity play in generating the dust tail. What are the possible reasons for any unexpected brightness changes? [8]

Asteroids, like comets, spin. Assuming an asteroid is held together only by self-gravity, explain why there is an upper limit to its spin rate. Derive an expression for this upper limit and calculate its value. You may assume the mean asteroid density to be 3 times that of water. For simplicity, assume a spherical shape for the asteroid. [4]

Question 2:

Explain the mechanics of acoustic fluidisation in the context of impact cratering, including the resulting variation in the stress-strain ratio produced in the target material. [3]

Show how acoustic fluidisation can be used to explain the morphological variations seen with increasing crater size, assuming a vertical impact into a uniform target material. [9]

The formation of ring faults around an impact crater is also caused by subsurface fluidisation. Describe the unique conditions which result in the formation of these ring faults, relate this to why very large impact basins on terrestrial planets often have multiple rings surrounding them, and explain why icy moons like Callisto have many hundreds of rings associated with them. [8]

Question 3:

Describe how rising magma is trapped within deep magma reservoirs. Describe the difference between diapirs and plumes, and detail the processes involved in forming deep magma reservoirs for each of them, assuming a stationary lithosphere, and a uniform mantle. [6]

Describe the general morphology of Coronae in the context of Planetary surfaces. [2]

Describe the formation of Coronae on Venus, using the related volcanic features involved (novae and arachnoids) as an indication of what is happening in the underlying mantle. [7]

Coronae have only been found on Venus. Explain why Mars and Earth have no Coronae. [5]

Question 4:

In observing a newly discovered body in the solar system we might start by making a simple light curve measurement. What is a "light curve" and what can it tell us about the body? [3]

We can then compare the intensity of solar radiation reflected to the amount of infrared radiation the body emits. What further information does this provide? [4]

As a further stage of analysis we might look at the spectra reflected and emitted by the body, at a range of phase angles. What is the "phase angle" and what information might the spectra add about the body? [5]

A new asteroid is discovered. It is studied while it is at opposition (ie further out from the Sun along the same radius vector as the Earth). It is estimated to be at 2.3 Astronomical Units (AU) from the Sun. Photometric measurements indicate that over the visible wave band 0.25×10^{-11} Wm^{-2} of reflected light reaches the Earth from the body. Its infra-red emission spectrum peaks at 14.5 μm. What are the body's albedo and radius? (Assume the body has a uniform temperature distribution over its illuminated side and the temperature on its nightside is negligible. Assume the body reflects uniformly into the 2π steradians centred around the asteroid-Sun line. Explain the other assumptions you make in your calculations.) [8]

Question 5

What is a Yardang and how is it created? [3]

What is a Barchan and how is it created? [3]

In the theory of Plate Tectonics there are three types of boundaries between joining plates. What are these possible boundaries and what happens at each? Which type of boundary is the 'Mid-Atlantic Ridge'? [7]

A geological survey ship lies 400km to the west of the Mid-Atlantic Ridge. A sample of rock is taken from the sea bed and analysed. In the sample of rock there are, per kg, 0.0915×10^{8} Pb^{207} atoms and 1.000×10^{8} atoms of U^{235}. There are also 3.4467×10^{5} atoms of Pb^{204}. Given that the half life of the U^{235} to Pb^{207} decay is 0.71×10^{9} years, assuming that the Pb^{204} is totally non-radiogenic in origin and given that the non-radiogenic proportions of Pb^{208} : Pb^{207} : Pb^{206} : Pb^{204} are known to be in the ratio 26:21:52:1.4, estimate the age of the rock.

Using this information, estimate how long ago the South American and African coastlines were last joined together. South America and Africa are 3040 km apart at the latitude of the survey vessel. [7]