

PART III

Attempt **TWO** questions in this Part, which carries 24% of the marks for the examination. All of these questions carry equal marks. You are advised to spend about **40 minutes** on this Part. Write your answers to this Part in the **SEPARATE ANSWER BOOK** provided.

Remember to write your name, personal identifier and examination number on your answer book.

Question 4

part a, 4%
part b, 5%
part c, 3%

It is generally agreed that the planet Mars has a differentiated structure.

(a) Outline the processes that are thought to have occurred during, and subsequent to its formation that could have led to it becoming differentiated.

(b) State the names of the layers that you expect Mars to consist of today, that differ in composition. List their different compositions, and state qualitatively the relative volumes of the layers.

(c) (i) What evidence is available about the composition of the surface rock on Mars?

(ii) What single type of measurement would you most like a mission to Mars to provide in order to test whether your interpretation of the internal structure in part b is reasonable? Be realistic!

Question 5

part a, 4%
part b, 8%

(a) State and account for the main differences between a troposphere and a thermosphere in a planetary atmosphere.

(b) Sketch the change in atmospheric temperature with altitude in the atmospheres of Mars and Titan, labelling the different regions appropriately. Indicate cloud layers, giving their composition.

Question 6

part a, 3%
part b, 4%
part c, 5%

While out walking their dog, two people find what they consider to be an unusual black stone, partially buried in grassland. Suspecting that it might be a meteorite they take the sample to the Natural History Museum in London, in order to secure a professional opinion.

(a) (i) Explain why, without breaking the sample apart, a simple visual examination of the surface could have confirmed an extraterrestrial origin.

(ii) It is eventually established that the sample is a meteorite. How will the sample be named (not classified)?

(b) (i) Upon analysis, the sample is found to contain traces of purines and amino acids, which are thought *not* to be terrestrial contaminants. Explain what sort of meteorite you think it is.

(ii) Name four of the several other general categories of constituents likely to be present in the meteorite.

(c) Two refractory minerals are identified in the meteorite, corundum (Al_2O_3) and perovskite (CaTiO_3). How were these minerals formed? What isotope measurements could be made on these minerals to understand aspects of the nature of the young solar nebula, and what are these aspects?

During condensation in the solar nebula, Al_2O_3 & CaTiO_3 are refractory, condensing ≥ 1600 K. Possible measurements include oxygen isotope composition measurements, to explore the rate the presence of pre-solar materials and the extent of mixing/isotope exchange between dust and gas reservoir

planetary
kernel formed of more refractory material
volcanism
merging of planetary
heating
led to
SiO₂/SiO₂/iron metal
Mars? Meteorites / spectra / images sent
Viking missions
seismic

gloomy surface formed by fraction heating
after soil where found
CC
CAI / dark grained material / chondrules / hydrated minerals