

EASC 207 Final Examination

ANSWER ANY 4 OF THE FOLLOWING 5 QUESTIONS

- If you answer all five questions indicate which four questions you want to be marked.
- There are a total of 100 marks available. 10% of the marks available on a question will be given as additional credit if the question is answered completely and correctly. The marks for each part of the question are indicated in brackets. You should include the units of measurement where appropriate.
- In questions where you are asked for an explanation or a description, an answer in point form is acceptable, but the meaning of what you write should be made clear. Your answer should be as complete as possible.
- In questions where you are asked to perform a calculation, you should state clearly any formulae you use and include all your working on the answer sheet.
- Numerical data provided in a question can be assumed to apply in all parts of that question.
- Any non-communicating calculator may be used.

THIS IS A CLOSED BOOK EXAM

Question A (25 marks)

- a) Write down the equation that describes Newton's Law of Gravitation. (2)
- b) Thus calculate an average value for the acceleration due to gravity on Mars given that the diameter of Mars is 6760 km, the mass of Mars is 6.45×10^{23} kg, and that the gravitational constant $G=6.67 \times 10^{-11} \text{ Nm}^2\text{kg}^{-2}$. (5)
- c) Assume that the geoid on Mars corresponds to the average presentday surface. Accurate measurements of the acceleration due to gravity across Mars are being made by a spacecraft orbiting 200 km above the surface of the planet. Would you apply a free air correction to these gravity data? Explain your answer. (4)
- d) Olympus Mons is a shield volcano on Mars constructed of basalt; it is 24 km high, and is the largest volcano in the solar system. A geophysicist climbs the volcano, and makes a gravity measurement at the summit.
- i) What is the value of the free air correction he has to apply to his reading?
- ii) What is the value of the Bouguer correction he has to apply to his reading? Is the Bouguer correction different because the geophysicist is on Mars rather than Earth?

[If necessary you should assume a reasonable value for the density of basalt. The gravitational attraction of an infinite horizontal slab of thickness, t , density, ρ , is $2\pi G\rho t$, where $G=6.67 \times 10^{-11} \text{ m}^3\text{kg}^{-1}\text{s}^{-2}$. A general formula for the free air correction is $2gh/R$ where g is the acceleration due to gravity, R is the radius of the planet, and h is the elevation above the surface]. (10)

- e) Why would you apply a terrain correction to the gravity reading made in (c)? If Olympus Mons were a topographic depression rather than a peak, and the gravity reading were taken at the bottom of the depression, how would the terrain correction differ? Explain your answer. (4)

Question B (25 marks)

- a) What is meant by the declination and inclination of the Earth's magnetic field? (4)
- b) If the Earth's magnetic field has an inclination of -25° at your location what is your magnetic latitude? [You may assume that inclination and magnetic latitude are related by $\tan I = 2 \tan \lambda$] (3)
- c) Explain clearly the four main ways in which the Earth's magnetic field can vary with time. How do these variations affect a magnetics survey, and which variations necessitate correction of magnetic survey data? (10)

- d) A magnetics survey is carried out along a north-south profile across a vertical gabbro dyke with no remnant magnetisation in the northern hemisphere. Sketch the shape of the total magnetic field anomaly that you would expect to observe if the strike of the dyke is east-west. Indicate the direction of north on your sketch. What would be the shape of the anomaly if the survey were carried out at a similar latitude in the southern hemisphere? Explain the reason for any differences if any. (8)

Question C (25 marks)

- a) Describe how you would carry out a seismic refraction survey to locate the top of basalt bedrock at around 10 m depth beneath an overburden of till where the top of the bedrock is planar and dips at approximately 4° to the east. Describe the sources, receivers, and the geometrical layout that you would employ. To help with your explanation, draw a cross-section, annotated with east and west, and show the critical refraction. (8)
- b) Below your cross-section, sketch the corresponding plot of the travel times that you would need to record to determine the seismic velocities in the two layers, the dip of the interface, and the depth of the bedrock. (4)
- c) Write down reasonable values for the P wave velocities of the two layers that you are investigating: till and basalt. (3)
- d) Calculate the critical angle corresponding to the critical refraction for the P velocities
- e) How would you modify the acquisition method used for the seismic survey to determine the S wave velocity. (4)
- f) Suggest reasonable values for the S wave velocities of the two layers that you are investigating: till and basalt. (3)
- g) If the basalt layer is in fact a sill lying above a sandstone layer, explain how you would modify the refraction survey to estimate its seismic velocity. (3)