

Duration: 50 minutes

ANSWER ANY 8 OF THE FOLLOWING 9 QUESTIONS

- Each question is worth 8 marks. There are a total of 64 marks available. 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. A sketch will often help.
- 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.

Question 1 (8 marks)

- a) Write down the equation that describes Newton's Law of Gravitation and explain the meaning of each of the terms. (3)
- b) Thus calculate an average value for the acceleration due to gravity on the Moon given that the diameter of the Moon is 3474 km, the mass of the Moon is 7.35×10^{22} kg, and that the gravitational constant $G = 6.67 \times 10^{-11} \text{ Nm}^2\text{kg}^{-2}$. Express the acceleration due to gravity on the Moon as a fraction of the acceleration due to gravity on Earth (e.g. 0.78 g). (5)

Question 2 (8 marks)

- a) Earth's core magnetic field varies with time in two different ways. What are the names and the characteristics of these changes? (4)

- b) Measurements of magnetic field strength at Earth's surface can vary with time due to two factors unrelated to the core field. What are names and origin of these magnetic field variations? (4)

Question 3 (8 marks)

- a) You are asked to carry out a seismic survey that will record seismograms with frequencies up to 80 Hz. Your seismograph can sample the recorded seismograms at an interval of 8 ms or 4 ms. Calculate the Nyquist frequency for each of these two sample intervals and determine which you should select for your survey. (5)

- b) Your field recordings are affected by oscillatory noise from a nearby irrigation pump that has a period of 90 ms. Which of the following filters should you select to remove the noise from your seismograms: 60 Hz notch filter, 15 Hz low-cut filter, 80 Hz low-cut filter, or 8 Hz high-pass filter? (3)

Question 4 (8 marks)

a) Write down reasonable values of density for the following materials: granite, basalt, sandstone, glacier ice. Make sure you specify the units correctly. (4)

b) Write down reasonable values of magnetic susceptibility for the following minerals: magnetite, halite. Give the names of the type of magnetism that these minerals exhibit. (4)

Question 5 (8 marks)

a) In gravity surveying, what is the geoid? (2)

b) Give two reasons why measurements of the acceleration due to gravity at the Earth's surface vary with latitude. (4)

c) What are Earth tides? (2)

Question 6 (8 marks)

- a) A gravity reading is made at an elevation of 450 m above mean sea level. The average subsurface rock density is 2700 kg m^{-3} . What is the value of the correction that you would need to apply to your readings to correct them to values that would have been recorded at mean sea level? [The Free Air correction is $3.086 \text{ g.u. per metre}$ and the Bouguer correction is $0.4192\rho \text{ g.u. per metre}$ where ρ is density in Mg m^{-3}]. (6)

- b) If a terrain correction is required for the above survey, would it be added or subtracted? (2)

Question 7 (8 marks)

- a) What is the difference in the origin of remnant and induced magnetization in a rock? (4)

- b) An east-west magnetic survey profile is acquired in the Yukon over a thin vertical basaltic dike that strikes north-south. Sketch the cross-section of the dike, indicating east and west, and show above it the total magnetic field profile that you would expect to record. What is the direction of the Earth's magnetic field relative to this cross-section? (4)

Question 8 (8 marks)

- a) What are the two most effective mechanisms by which electrical charge can flow through the ground? (4)
- b) Glacial melt water is almost pure water. What is the effect on the resistivity of a porous sandstone if its saline pore fluid is replaced with glacial melt water? (2)
- c) What is the difference in resistivity between a pure-quartz, porous sandstone saturated with saline groundwater, and one in which the rock matrix contains 50% feldspar, but the pore geometry and pore fluid are the same? (2)

Question 9 (8 marks)

a) Sketch the layout of a Wenner DC resistivity array, being sure to include its geometric characteristics. (3)

b) If a cylindrical core of length 20 cm, and diameter 5 cm has a resistance measured along its long axis of 2000 ohm, what is its resistivity? (5)