S5 Geography Practice Paper

S5 | Geography | Time: 75 minutes | Total: 100 marks | 24 questions

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Section 1 Plate Tectonics and Earthquakes (16 marks)

Each part carries 4 marks. Show all working.

1. A seismograph records a 12 s difference between the arrival of P waves and S waves. P waves travel at 6.0 km/s and S waves at 3.5 km/s in the crust. Find the distance of the epicentre from the station in km, to 1 decimal place.

Answer: Answer: d = 12 divided by (1/3.5 minus 1/6.0) = 12 / 0.1190 = 100.8 km, so the epicentre is about 100.8 km away.

2. The energy released by an earthquake follows log E = 4.8 + 1.5M with E in joules. Calculate the energy of a magnitude 6.0 quake and the ratio of its energy to that of a magnitude 5.0 quake.

Answer: Answer: log E = 4.8 + 1.5 x 6.0 = 13.8, so E = 6.3 x 10^13 J; for magnitude 5.0, log E = 12.3, giving a ratio of 10^1.5 = 31.6 times, i.e. about 31.6 times more energy per magnitude unit.

3. A transform fault slips at an average of 5 cm per year. Assuming a constant rate, how far have the two blocks offset after 100 years, and why is the offset not released as earthquakes every year?

Answer: Answer: offset = 5 cm per year x 100 years = 500 cm = 5 m. Friction locks the fault plane, so strain accumulates until it exceeds rock strength and ruptures suddenly, releasing energy in infrequent large quakes rather than every year.

4. Plate boundaries are divergent, convergent or conservative. State two landforms found at a convergent boundary where an oceanic plate meets a continental plate, and explain why earthquakes there range from shallow to very deep.

Answer: Answer: a trench, a volcanic arc (island arc or continental arc) and fold mountains. The oceanic plate subducts; shallow quakes occur along the contact, and the descending slab still fractures brittly at 300 to 700 km depth, producing intermediate and deep quakes.

Section 2 Volcanoes and Igneous Rocks (16 marks)

Each part carries 4 marks.

5. An eruption ejects 0.5 km3 of magma with a density of 2 600 kg/m3. Calculate the total mass of the erupted magma in kg in scientific notation.

Answer: Answer: 0.5 km3 = 5 x 10^8 m3; mass = 5 x 10^8 x 2 600 = 1.3e+12 kg, i.e. 1.3 x 10^12 kg.

6. That magma contains 800 ppm of sulphur dioxide. Calculate the mass of SO2 released in million tonnes (Mt) and explain how volcanic SO2 can affect global temperature.

Answer: Answer: SO2 = 1.3 x 10^12 kg x 800 x 10^-6 = 1.04 x 10^9 kg = 1.04 Mt. In the stratosphere SO2 forms sulphate aerosols that reflect sunlight, cooling the surface for a few years.

7. Magma rises from 5 km depth to the surface in 2 hours. Find the average ascent rate in km/h and in m/s. What happens to dissolved volatiles if the ascent suddenly speeds up?

Answer: Answer: rate = 5 / 2 = 2.5 km/h = 2 500 m / 7 200 s = 0.69 m/s. Rapid decompression exsolves water and gas, which expands and fragments the magma, turning an effusive eruption into an explosive one.

8. Compare basaltic and rhyolitic magma in silica content, viscosity and landform, and explain why their eruption styles differ.

Answer: Answer: basalt has about 50 per cent silica, low viscosity and easy gas escape, giving shield volcanoes and lava plateaus with effusive eruptions; rhyolite has about 70 per cent silica and high viscosity that traps gas, giving steep cones and domes with explosive eruptions.

Section 3 Weathering and Mass Movement (16 marks)

Each part carries 4 marks.

9. A slope has a resisting force of 480 kN per metre width and a driving force of 320 kN. Calculate the factor of safety and state whether the slope is stable (1.2 is the critical value).

Answer: Answer: FS = 480 / 320 = 1.50, above the critical 1.2, so the slope is stable.

10. After heavy rain the pore water pressure rises and the driving force becomes 420 kN. Recalculate the factor of safety and explain the link between rainstorms and mass movement.

Answer: Answer: FS = 480 / 420 = 1.14, below the critical 1.2, so the slope becomes unstable. Rain adds load, lowers effective stress and shear strength and lubricates the slip plane, which is why landslides follow rainstorms.

11. A shale cliff retreats 12 mm per year through weathering. How far does the cliff line retreat in 100 years, and state two processes that weather shale quickly.

Answer: Answer: retreat = 12 mm x 100 = 1 200 mm = 1.2 m. Shale is thinly bedded and its clays swell with water; freeze-thaw and salt crystallisation exert pressure in cracks and prise off blocks.

12. A 25 m granite block undergoes a 40 degrees C temperature change; its linear expansion coefficient is 8 x 10^-6 per degree C. Find the change in length in mm and explain how repeated cycling causes disintegration.

Answer: Answer: expansion = 25 x 40 x 8 x 10^-6 = 0.008 m = 8.0 mm. The surface expands by day and contracts at night while the interior lags, so differential stress shells off the surface in onion-skin exfoliation.

Section 4 Soil Erosion and Agriculture (16 marks)

Each part carries 4 marks.

13. A field loses 18 t/ha of topsoil each year; bulk density is 1.2 t/m3. Calculate the annual soil loss in mm of depth.

Answer: Answer: volume = 18 / 1.2 = 15 m3 per ha; depth = 15 / 10 000 m2 = 0.0015 m = 1.5 mm per year.

14. The field has 250 mm of effective topsoil. At the same erosion rate, how many years until it is lost, and state two human factors that accelerate erosion.

Answer: Answer: 250 / 1.5 = 166.7 years. Human factors include ploughing up and down slope and clearing vegetation, overgrazing or compaction by heavy machinery reducing infiltration, and farming steep land without terraces or contour planting.

15. Soil organic matter falls from 2.8 per cent to 2.1 per cent. Find the relative decrease in per cent and explain how this affects water retention and yield.

Answer: Answer: decrease = (2.8 - 2.1) / 2.8 x 100 = 25 per cent. Less organic matter breaks down aggregates, reduces pore space and water-holding capacity, so the field waterlogs in wet seasons and drought-stresses in dry ones, cutting nutrient supply and yield.

16. Adopting no-till farming cuts erosion by 60 per cent. Calculate the new annual loss in t/ha and state two other benefits of no-till.

Answer: Answer: new loss = 18 x 0.4 = 7.2 t per ha per year. Other benefits: crop residues shield the surface from raindrop impact and evaporation, earthworm and microbial activity improves structure, and fewer passes cut fuel and labour costs.

Section 5 Wind and Coal Power Generation (18 marks)

Each part carries 4 or 5 marks.

17. A wind farm has 30 turbines rated at 2.5 MW each with a capacity factor of 35 per cent. Find the installed capacity in MW and the annual output in GWh to the nearest whole number.

Answer: Answer: capacity = 30 x 2.5 = 75 MW; output = 75 x 8 760 x 0.35 = 229,950 MWh = 230 GWh.

18. If a household uses 4 500 kWh a year, how many households can the farm supply, and why is the real number lower?

Answer: Answer: 229,950 MWh x 1 000 / 4 500 = 51,100 households. The real figure is lower because wind output fluctuates with weather and needs backup capacity and grid balancing, and transmission loses about 5 to 8 per cent.

19. A coal plant is 38 per cent efficient; coal has a calorific value of 24 MJ/kg and an emission factor of 2.4 kg CO2 per kg of coal. Find the coal used per kWh and the emissions in kg CO2 per kWh.

Answer: Answer: each kWh needs 3.6 / 0.38 = 9.47 MJ; coal = 9.47 / 24 = 0.39 kg per kWh; emissions = 0.39 x 2.4 = 0.95 kg CO2 per kWh.

20. Gas-fired generation emits about 0.45 kg CO2 per kWh. Using the coal figure from part 3, find the percentage reduction from switching to gas and state two environmental costs of wind power compared with coal.

Answer: Answer: reduction = (0.95 - 0.45) / 0.95 x 100 = 52.5 per cent. Wind costs: manufacturing, transport and later decommissioning of blades and nacelles create a carbon footprint and solid waste, and turbines kill birds and bats and cause visual and noise impacts.

Section 6 Waste Management and Sustainability (18 marks)

Each part carries 4 or 5 marks.

21. A landfill has 12 million m3 of capacity left and receives 3.6 million m3 of waste a year. Find its remaining life in years to 1 decimal place.

Answer: Answer: 12 / 3.6 = 3.3 years, so it fills in about 3 years and 4 months.

22. The city generates 11 000 t of municipal solid waste a day and recycles 30 per cent. Find the daily tonnage sent to landfill.

Answer: Answer: landfill = 11 000 x (1 - 0.30) = 7,700 t per day.

23. If the recycling rate rises to 45 per cent, find the new daily landfill tonnage and the daily reduction, then estimate how many years the landfill life is extended.

Answer: Answer: new landfill = 11 000 x 0.55 = 6,050 t per day, a cut of 1,650 t per day. In volume terms waste falls 21.4 per cent, so landfill life rises from 3.3 to about 4.2 years, roughly 0.9 year longer.

24. Each tonne diverted from landfill avoids 0.6 t CO2e. Using the daily reduction in part 3, calculate the annual saving over 365 days in t CO2e.

Answer: Answer: annual diversion = 1,650 x 365 = 602,250 t; saving = 602,250 x 0.6 = 361,350 t CO2e, about the annual emissions of 15 000 private cars.
