S5 Geography Practice Paper: Plate Tectonics and Seismic Waves, River Discharge and Runoff, Coastal Erosion and Wave Energy, Lapse Rate and Rainfall, Urban Population Density and Land Use, Map Scale and Gradient

S5 | Geography | Time: 60 minutes | Total: 100 marks | 24 questions

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Plate Tectonics and Seismic Waves

Part A: Plate tectonics and seismic waves (16 marks)

1. An earthquake produces P waves travelling at 7 km/s and S waves at 4 km/s. A station records a 24 s gap between the arrivals of the two wave types. (a) Calculate the distance from the epicentre to the station. (b) Explain why the P waves arrive first. [5]

Answer: (a) Let d be the distance in km: d/4 - d/7 = 24, so d x (7 - 4) / (7 x 4) = 24 and d = (7 x 4) / (7 - 4) x 24 = 224 km. (b) P waves are longitudinal and travel faster through solid rock than the transverse S waves, so they reach the station earlier.

2. Rocks on two sides of a plate boundary move apart at an average of 6 cm per year. Two matching points are now 1,800 km apart. (a) Calculate the time needed for them to separate, in millions of years. (b) State one assumption of this calculation. [4]

Answer: (a) 6 cm per year equals 60 km per million years; time = 1,800 / 60 = 30 million years. (b) Assume the rate of plate movement stayed constant and the direction of movement did not change.

3. A region recorded 5 earthquakes of magnitude 6 or above in the past 20 years. (a) Calculate the average return period. (b) State one use of the return period in urban earthquake planning. [3]

Answer: (a) Average return period = 20 / 5 = 4 years. (b) It can set the design standard for earthquake-resistant buildings and the cycle for drills and risk assessment.

4. Most of the world earthquakes are concentrated in the Circum-Pacific belt and the Mediterranean-Himalayan belt. (a) State the main type of plate boundary at each belt. (b) Explain why convergent boundaries produce frequent and strong earthquakes. [4]

Answer: (a) The Circum-Pacific belt is dominated by convergent (subduction) and transform boundaries; the Mediterranean-Himalayan belt is a continent-continent convergent boundary. (b) Rocks are strongly compressed and faults stay locked, so stress builds up until it exceeds rock strength and is released suddenly as slip, giving frequent earthquakes from shallow to deep foci.

River Discharge and Runoff

Part B: River discharge and runoff (17 marks)

5. A river channel is 25 m wide with a mean depth of 3.2 m and a mean velocity of 1.5 m/s. (a) Calculate the discharge. (b) If the width is unchanged but the depth rises to 4.5 m while the velocity falls to 1.2 m/s, find the new discharge and the percentage change. [5]

Answer: (a) Discharge = width x depth x velocity = 25 x 3.2 x 1.5 = 120 m3/s. (b) New discharge = 25 x 4.5 x 1.2 = 135 m3/s; change = (135 - 120) / 120 x 100% = +12.5%.

6. A catchment of 480 km2 receives 2,400 mm of rain a year and has a runoff coefficient of 0.45. (a) Calculate the annual runoff volume in m3. (b) Find the equivalent depth of runoff in mm per year. [4]

Answer: (a) Runoff volume = area x rainfall x coefficient = 480 x 10^6 m2 x 2.4 m x 0.45 = 518400000 m3, about 518.4 million m3. (b) Equivalent depth = 2,400 x 0.45 = 1,080 mm.

7. The peak discharge of a river before and after urbanisation is 120 m3/s and 480 m3/s. (a) Find the multiple and the percentage increase. (b) Explain why urbanisation raises the peak discharge. [4]

Answer: (a) Multiple = 480 / 120 = 4 times; increase = (480 - 120) / 120 x 100% = 300%. (b) Concrete and asphalt reduce infiltration and raise surface runoff, while drains and channelised streams deliver water faster, so the peak arrives sooner and higher.

8. (a) State the dominant processes in the upper, middle and lower courses of a river. (b) Explain why broad floodplains form in the lower course. [4]

Answer: (a) The upper course is dominated by erosion (downcutting), the middle course by erosion and transport together, and the lower course by transport and deposition. (b) The gentle gradient lowers velocity and carrying capacity, so fine sediment settles on the banks; meander migration and overbank flooding spread alluvium across the valley floor, building a broad flat floodplain.

Coastal Erosion and Wave Energy

Part C: Coastal erosion and wave energy (16 marks)

9. Longshore drift along a coast averages 0.8 m per year. (a) Calculate the distance sediment travels along the shore in 50 years. (b) Explain how longshore drift contributes to spit formation. [4]

Answer: (a) Distance = 0.8 x 50 = 40 m. (b) Sediment moves in a zigzag path along the shore; where the coast turns at a river mouth or bay, deposition slows and the load builds out into the sea as a spit attached to the land at one end.

10. A sea cliff retreats at an average of 2.5 m per year and the cliff foot is now 60 m from a coastal road. (a) In how many years will erosion reach the road if nothing is done? (b) Name one soft coastal management method. [4]

Answer: (a) Years = 60 / 2.5 = 24 years. (b) A soft method such as beach nourishment, dune stabilisation by planting, or a coastal buffer zone that limits development.

11. Waves at a site have a period of 8 s and a wavelength of 100 m. (a) Calculate the wave speed. (b) Explain how wind speed, fetch and wind duration affect wave height, and state the link between wave height and erosive power. [4]

Answer: (a) Speed = wavelength / period = 100 / 8 = 12.5 m/s. (b) Stronger wind, longer fetch and longer duration input more energy and raise wave height; higher waves exert greater hydraulic pressure and air compression on cliff faces, so erosive power increases.

12. (a) Put sea cave, sea arch, sea stack and wave-cut platform in order of formation. (b) Explain how a sea arch finally becomes a sea stack. [4]

Answer: (a) Order: sea cave, then sea arch, then sea stack; the wave-cut platform forms at the cliff foot as the cliff retreats. (b) Caves erode inward from both sides and cut through a headland to form an arch; the unsupported roof collapses and the isolated pillar left behind is a sea stack.

Lapse Rate and Rainfall

Part D: Lapse rate and rainfall (17 marks)

13. The foot of a mountain is at 28.0°C and the environmental lapse rate is 6.5°C per km; the summit is 1.5 km above the foot. (a) Calculate the expected summit temperature. (b) If the measured summit temperature is 16.5°C, find the actual lapse rate. [5]

Answer: (a) Cooling = 6.5 x 1.5 = 9.75 degrees C; summit temperature = 28.0 - 9.75 = 18.25 degrees C. (b) Actual lapse rate = (28.0 - 16.5) / 1.5 = 7.67 degrees C per km.

14. On a day when the air is 30 degrees C the actual vapour pressure is 24 hPa and the saturation vapour pressure at that temperature is 42 hPa. (a) Calculate the relative humidity. (b) If the air cools while the vapour content stays the same, describe the change in relative humidity and condensation. [4]

Answer: (a) Relative humidity = 24 / 42 x 100% = 57.1%. (b) Cooling lowers the saturation vapour pressure, so relative humidity rises; at the dew point the air becomes saturated and vapour condenses into cloud, fog or dew.

15. A weather station recorded a daily maximum of 30.4 degrees C, a minimum of 22.6 degrees C, and 2,160 mm of rain over twelve months. (a) Find the daily temperature range. (b) Find the mean monthly rainfall. [4]

Answer: (a) Daily range = 30.4 - 22.6 = 7.8 degrees C. (b) Mean monthly rainfall = 2,160 / 12 = 180 mm.

16. (a) State the prevailing monsoon wind direction over Hong Kong in summer and in winter, with the cause. (b) List three conditions required for tropical cyclone formation. [4]

Answer: (a) Summer brings the south-west monsoon because a thermal low over the Asian interior draws air from the sea; winter brings the north-east monsoon as a cold continental high pushes dry cool air seaward. (b) Sea surface temperature above about 26 degrees C supplies latent heat, the Coriolis effect gives rotation, and weak vertical wind shear lets convection persist.

Urban Population Density and Land Use

Part E: Urban density and land use (17 marks)

17. A city has a population of 5,400,000, a total area of 1,100 km2 and a built-up area of 220 km2. (a) Calculate the population density of the built-up area. (b) Calculate the density for the whole city. [4]

Answer: (a) Built-up density = 5,400,000 / 220 = 24,545 people per km2. (b) City-wide density = 5,400,000 / 1,100 = 4,909 people per km2, about 5.0 times lower, showing heavy concentration in the urban core.

18. A city population grows from 3,200,000 to 4,480,000. (a) Calculate the growth rate. (b) Using the rule of 70, estimate how long a doubling would take at that rate. [4]

Answer: (a) Growth = (4,480,000 - 3,200,000) / 3,200,000 x 100% = 40%. (b) Doubling time is about 70 / 40 = 1.8 years, though a precise answer would use the annual rate rather than the total.

19. About 12 km2 of farmland is converted to built-up land each year in a city of 1,100 km2. (a) Calculate the farmland lost in 20 years. (b) Express this as a percentage of the city area. [4]

Answer: (a) Area lost = 12 x 20 = 240 km2. (b) Percentage = 240 / 1,100 x 100% = 21.8%.

20. (a) Explain three causes of the urban heat island effect. (b) Suggest two ways to ease the land use conflict between old district redevelopment and new town expansion. [5]

Answer: (a) Buildings and asphalt absorb and store solar radiation and release it at night; vegetation and water surfaces are scarce so little heat is lost by evapotranspiration; traffic, air conditioning and industry add anthropogenic heat, and dense tall blocks block ventilation. (b) Apply a brownfield-first and mixed-use zoning policy to build on already degraded land first, and require ventilation corridors, rooftop greening and community facilities in redevelopment while providing transport links before new town expansion.

Map Scale and Gradient

Part F: Map scale, area and gradient (17 marks)

21. A map has a scale of 1:20,000 and two points are 6.5 cm apart on the map. (a) Find the real distance in km. (b) State how many metres 1 cm on the map represents. [4]

Answer: (a) Real distance = 6.5 x 20,000 cm = 130,000 cm = 1.3 km. (b) 1 cm represents 200 m.

22. Using the same 1:20,000 scale, a farmland plot measures 4.0 cm2 on the map. (a) Find its real area in m2 and km2. (b) Express the area in hectares. [4]

Answer: (a) 1 cm2 represents (200 m)^2 = 40,000 m2, so the real area = 4.0 x 40,000 = 160,000 m2 = 0.16 km2. (b) That is 16 hectares, since 1 hectare = 10,000 m2.

23. Two points on a map are 500 m apart horizontally and differ in height by 75 m. (a) Express the gradient as a percentage. (b) Express it in the form 1:n. [4]

Answer: (a) Gradient = rise / horizontal distance x 100% = 75 / 500 x 100% = 15%. (b) 1 : 6.67, that is 1:6.7, rising 1 m for every 6.67 m forward.

24. (a) State three locational factors, giving one that favours heavy industry and one that favours light industry. (b) Use an inputs-outputs system to explain how farming intensity affects yield per unit area. [5]

Answer: (a) Heavy industry such as steel locates near raw materials, power and port transport (material and transport oriented), while light industry such as garments locates near markets, labour and transport nodes (market and labour oriented); land rent, government policy and agglomeration also matter. (b) Intensive farming applies more labour, machinery, fertiliser and irrigation and multiple cropping on the same area, raising output per hectare, though marginal returns diminish as inputs grow.
