S5 Geography Practice Paper (Set 3): River Discharge and Runoff Coefficient, Coastal Erosion and Wave Energy, Lapse Rate and Relative Humidity, Plate Tectonics and Earthquakes, Agricultural Output and Food Self-sufficiency, Urban Density and Industrial Location

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

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Section A: River Discharge and Runoff Coefficient (16 marks)

Show the formula and full working; give answers to 3 significant figures with units.

1. A catchment of 120 km^2 receives 80 mm of rain in six hours. The runoff coefficient is 0.45. Find the total runoff volume in m^3.

Runoff = 0.45 x 0.080 m x 120.0 x 10^6 m^2 = 4.32 x 10^6 m^3.

2. Assuming all runoff leaves within the six hours, find the mean peak discharge.

Q = 4.32 x 10^6 m^3 / (6 x 3600 s) = 200 m^3/s.

3. The channel is 40 m wide with mean depth 2.5 m and mean velocity 1.2 m/s. Find its capacity.

Q = 40 x 2.5 x 1.2 = 120 m^3/s.

4. Compare the two results: by what percentage does the peak exceed the channel capacity? State one urban planning measure that reduces peak flow.

Excess = (200 - 120) / 120 x 100% = 66.7%, about 1.7 times. Measure: permeable surfaces, detention ponds or green belts cut surface runoff.

Section B: Coastal Erosion and Wave Energy (16 marks)

Wave energy density E = rho*g*H^2/8 with rho = 1000 kg/m^3 and g = 9.81 m/s^2.

5. For waves of height 1.5 m, find the wave energy density in J/m^2.

E = 1000 x 9.81 x 1.5^2 / 8 = 2759 J/m^2 (about 2.76 kJ/m^2).

6. Water depth is 8 m. Find the shallow water wave speed c = sqrt(g*d).

c = sqrt(9.81 x 8) = 8.86 m/s.

7. Longshore drift carries 45000 m^3 of sediment a year along 1200 m of coast. Find the drift per metre per year.

Per metre = 45000 / 1200 = 37.5 m^3/m/yr.

8. A seawall costs $8500 per metre. Find the total cost for the whole frontage and state one side effect of seawalls.

Total = 8500 x 1200 = $10.2 x 10^6 (about $10.2 million). Side effect: wave reflection scours the toe, or reduced sediment supply speeds erosion downdrift.

Section C: Lapse Rate and Relative Humidity (16 marks)

Environmental lapse rate 6.5 deg C per km; vapour pressures in hPa.

9. The foot of a hill is at 28 deg C; the summit is 1800 m higher. Find the summit temperature.

Drop = 6.5 x 1.8 = 11.7 deg C; summit = 28 - 11.7 = 16.3 deg C.

10. At 25 deg C the saturation vapour pressure is 31.7 hPa and the actual vapour pressure is 21.0 hPa. Find the relative humidity.

RH = 21.0 / 31.7 x 100% = 66.25%.

11. Using Td = 243.5 ln(e/6.112) / (17.67 - ln(e/6.112)), estimate the dew point.

ln(21.0/6.112) = 1.2343; Td = 243.5 x 1.2343 / (17.67 - 1.2343) = 18.3 deg C.

12. A catchment of 250 km^2 receives 95 mm of rain. Find the volume of rain falling on it.

Volume = 250.0 x 10^6 m^2 x 0.095 m = 2.38 x 10^7 m^3.

Section D: Plate Tectonics and Earthquakes (16 marks)

P waves travel at 6.0 km/s and S waves at 3.5 km/s; log10(E) = 4.8 + 1.5M.

13. P and S waves from an earthquake arrive 24 s apart. Find the epicentral distance.

d = 24 / (1/3.5 - 1/6.0) = 201.6 km.

14. How much energy does a magnitude 5.5 earthquake release?

logE = 4.8 + 1.5 x 5.5 = 13.05; E = 10^13.05 = 1.12 x 10^13 J.

15. How many times more energy does a magnitude 6.5 event release than a magnitude 5.5 event?

Ratio = 10^(1.5 x (6.5 - 5.5)) = 10^1.5 = 31.6 times.

16. A plate moves 7 cm a year. How long does it take to accumulate 500 km of displacement?

Time = 5 x 10^5 m / 0.07 m per year = 7.14 x 10^6 years (about 7.1 million years).

Section E: Agricultural Output and Food Self-sufficiency (18 marks)

Yield is in tonnes per hectare (t/ha); 1 hectare = 10,000 m^2.

17. Farmland covers 12000 ha with average rice yield 5.4 t/ha. Find total production.

Production = 12000 x 5.4 = 64800 tonnes.

18. Annual rice demand is 78000 tonnes. Find the food self-sufficiency rate.

Self-sufficiency = 64800 / 78000 x 100% = 83.1%.

19. Fertiliser is applied at 180 kg/ha at $4.2 per kg. Find the total fertiliser bill in $ million.

Use = 12000 x 180 / 1000 = 2160 tonnes; cost = 2160 x 10^3 kg x $4.2 = $9.07 million.

20. Irrigation supplies 1,100 mm a year. Find the total water volume in m^3 and state one way to raise water efficiency.

Volume = 12000 x 10^4 m^2 x 1.1 m = 1.32 x 10^8 m^3. Method: drip or demand-based irrigation cuts evaporation and seepage losses.

Section F: Urban Density and Industrial Location (18 marks)

Compare land rent plus transport cost; give totals in $ million.

21. A city has 486000 people over 32 km^2. Find the population density.

Density = 486000 / 32 = 15188 people per km^2.

22. Land use is 45% residential, 12% industrial, 15% roads and 28% green space. Find the industrial and green areas in km^2.

Industrial = 0.12 x 32 = 3.84 km^2; green = 0.28 x 32 = 8.96 km^2.

23. A firm compares two sites: A rents at $95/m^2 with transport $12 per unit; B rents at $62/m^2 with transport $21 per unit. Each site is 20000 m^2 and output is 180000 units a year. Find both total costs and the better site.

A = 95 x 20000 + 12 x 180000 = $4.06 million; B = 62 x 20000 + 21 x 180000 = $5.02 million; A is cheaper by $0.96 million, so choose A.

24. Labour is 35% of total cost and wages rise 18%. By what percentage does unit cost rise?

Rise = 0.35 x 18% = 6.3%.

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