S6 Geography Practice Paper

S6 | Geography | Time: 75 minutes | Total: 100 marks | 24 questions

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Part 1: River Discharge and Hydrographs

Show the formula, the substitution and the unit in every part.

1. A catchment of 48 km2 receives 85 mm of rain in one storm and has a runoff coefficient of 0.35. Find the rainfall volume, the runoff volume and the mean discharge over 24 hours in m3/s.

Answer: Rainfall volume = 0.085 m x 4.80e+07 m2 = 4.08e+06 m3. Runoff volume = 0.35 x 4.08e+06 = 1.43e+06 m3. Mean discharge Q = V/t = 1.43e+06 / (24 x 3600) = 16.53 m3/s. The remaining 65% is lost to evaporation, interception and infiltration.

2. A river channel is 12 m wide with a mean depth of 1.8 m and a mean velocity of 1.25 m/s. Find the discharge in m3/s and state the effect of doubling the velocity.

Answer: Q = cross-section area x velocity = (12 x 1.8) x 1.25 = 27.0 m3/s. Doubling velocity doubles discharge to 54.0 m3/s because Q is proportional to v; erosive power, however, rises roughly with v squared.

3. For the same storm the pre-urbanisation peak flow is 62 m3/s with baseflow 8 m3/s and a lag time of 9 hours. After urbanisation the peak is 95 m3/s with a lag of 3 hours. Find the percentage rise in peak flow and explain it.

Answer: Rise = (95 - 62) / 62 x 100% = 53.2%. Impermeable surfaces replace vegetation so infiltration falls and the runoff coefficient rises, while drains and channel straightening speed the flow, cutting lag time from 9 to 3 hours and producing a higher, sharper peak with greater flood risk downstream.

4. The storm yields a runoff volume of 1.43e+06 m3 and the downstream reservoir holds 3.0e+06 m3 in total. Find the percentage of capacity filled and explain its value for flood control.

Answer: Percentage = 1.43e+06 / 3.0e+06 x 100% = 47.6%, leaving 1.57e+06 m3 of storage. One storm fills nearly half the reservoir, so it can shave the peak and delay the flood wave, but a second storm leaves little room and controlled release plus detention basins are needed or the storage benefit is lost.

Part 2: Soil Erosion and Agricultural Conservation

Universal soil loss equation A = R x K x LS x C x P, in t/ha/yr.

5. A field has R = 180, K = 0.032, LS = 1.6, C = 0.28 and P = 0.55. Find the annual soil loss and the loss if the field were completely bare (C = P = 1.0).

Answer: A = 180 x 0.032 x 1.6 x 0.28 x 0.55 = 1.419 t/ha/yr. If bare, A = 180 x 0.032 x 1.6 = 9.216 t/ha/yr, which is 6.5 times the present rate (9.2 / 1.42). Crop cover and contour tillage are therefore the strongest controls.

6. Slope length increases from 40 m to 80 m with all other factors unchanged. Given that LS is proportional to the square root of slope length, find the percentage increase in erosion.

Answer: LS ratio = sqrt(80/40) = 1.414, so erosion becomes 1.4 times the original, an increase of 41.4%. Longer slopes let runoff accumulate and accelerate, so terracing along the contour and grassed waterways are the standard remedies.

7. Changing from conventional tillage (C = 0.28) to no-till with residue retention (C = 0.12) leaves other factors unchanged. Find the percentage reduction in soil loss.

Answer: Reduction = (0.28 - 0.12) / 0.28 x 100% = 57.1%, leaving 42.9% of the original loss. Residue cover intercepts raindrops, slows runoff and raises infiltration, giving a large benefit at low cost.

8. The topsoil is 22 cm deep with a bulk density of 1.35 g/cm3 and, if bare, loses 9.22 t/ha/yr. Find the topsoil mass per hectare in tonnes and the years needed to remove it entirely, then comment.

Answer: Mass = 0.22 m x 10,000 m2 x 1350 kg/m3 = 2970 t/ha. Time = 2970 / 9.216 = about 322 years. Even bare soil takes centuries to lose all topsoil, but soil formation is far slower than erosion and a few centimetres lost already cuts yields sharply, so conservation is still urgent.

Part 3: Urban Sprawl and Land Use Conflict

Show your working and use geographical concepts to explain.

9. A city has 850,000 people over 180 km2. Ten years later the population is 120,000 higher and the built-up area has grown to 205 km2. Find both population densities and explain why density barely changes.

Answer: Initial density = 850,000 / 180 = 4,722 per km2; later 970,000 / 205 = 4,732 per km2. Growth in people and land kept pace, i.e. low-density sprawl: each extra resident absorbed about 208 m2 of land (25 km2 for 120,000 people), far above compact-city norms, reflecting suburbanisation, car dependence and loose development control.

10. Commercial rent is 24,000 per m2 at the centre, falling 3,000 per m2 per km; residential rent is 9,000 per m2, falling 600 per km. Find the distance d in km where the bid-rent curves cross and explain its land-use meaning.

Answer: Set 24,000 - 3,000d = 9,000 - 600d, so 15,000 = 2,400d and d = 6.25 km. Within 6.25 km commercial bids exceed residential and the CBD plus commercial belt form; beyond it residential bids dominate. The boundary is a transition zone of mixed use and land-use conflict.

11. The city converts 45 ha of farmland to urban use each year, 60% of it prime farmland. Find the prime farmland lost each year and the total over ten years.

Answer: Prime farmland lost per year = 45 x 0.6 = 27 ha; over ten years 450 ha in total (270 ha of it prime). Prime land lies on alluvial plains next to the city, so it is taken first, cutting local food self-sufficiency and making restoration hard because the topsoil is sealed.

12. After expansion the city covers 205 km2 and green plus open space rises from 18% to 25%. Find the added green area in km2 and comment on its feasibility where land is scarce.

Answer: Added green area = (0.25 - 0.18) x 205 = 14.35 km2. In built-up areas this needs redevelopment, brownfield reuse and pocket parks, which is costly and fragmented; in new towns planning standards can deliver it at once, so growth areas succeed more easily than old districts and vertical greening plus roof gardens must fill the gap.

Part 4: Industrial Location and Productivity

Costs are annual totals; show each cost item.

13. A plant makes 50,000 units a year. Site A (city centre): rent 1,500,000, transport 8 per unit, labour 32 per unit. Site B (suburb): rent 450,000, transport 19 per unit, labour 24 per unit. Find both annual totals, the better site and the percentage saved.

Answer: Site A: 1,500,000 + 400,000 + 1,600,000 = 3,500,000. Site B: 450,000 + 950,000 + 1,200,000 = 2,600,000. Site B is cheaper by 900,000, i.e. 25.7% of A. Its rent and labour savings outweigh the higher transport bill, a cost-minimising location choice.

14. Before automation output is 36,000 units with 120 workers; afterwards 54,000 units with 90 workers. Find labour productivity in units per worker and the percentage gain.

Answer: Before: 36,000 / 120 = 300 units per worker; after: 54,000 / 90 = 600. Gain = (600 - 300) / 300 x 100% = 100%. Output rose 50% while the workforce fell 25%, i.e. capital deepening, which raises retraining and job-transition issues.

15. A district has 160,000 jobs, 48,000 in manufacturing; nationally there are 6,000,000 jobs with 1,200,000 in manufacturing. Find the manufacturing location quotient and interpret it.

Answer: District share = 0.30; national share = 0.20. LQ = 0.30 / 0.20 = 1.5. An LQ above 1 means the district specialises in manufacturing, employing a larger share than the national average and exporting beyond local demand; below 1 it would import those goods.

16. Each unit weighs one unit, haulage costs 0.085 per unit-km and the market is 120 km away. Find the transport cost per unit and explain how location changes if the product becomes bulky but light, such as furniture.

Answer: Cost per unit = 0.085 x 120 = 10.2. A bulky, light product raises transport as a share of total cost because loading is inefficient, so the plant moves towards the market to cut distance, damage and stockholding; where the raw material loses much weight, such as aluminium smelting, the plant instead locates at the material source.

Part 5: Energy Mix and Generation Cost

Units: MW, kWh, cost per kWh, tonnes of CO2.

17. Peak demand is 4,800 MW against 6,000 MW of installed capacity. Find the reserve margin and explain why it is kept.

Answer: Reserve margin = (6,000 - 4,800) / 4,800 x 100% = 25%. Units need maintenance and can fail, renewable output varies with weather, and demand forecasts err, so spare capacity prevents blackouts; too much reserve idles capital and raises tariffs, so grids usually hold about 15-25%.

18. Annual demand is 3.2e+09 kWh. Coal costs 0.42 per kWh and gas 0.68 per kWh. Find the annual fuel cost for all-coal and all-gas generation and explain the difference.

Answer: All coal: 3.2e+09 x 0.42 = 1.344e+09 (about 1.34 billion). All gas: 3.2e+09 x 0.68 = 2.176e+09 (about 2.18 billion). The gap of 8.320e+08 reflects the higher cost per unit of heat for gas plus liquefaction and shipping, offset by higher efficiency and lower emissions, a trade-off between cost and environment.

19. A wind farm of 50 MW generates 131,400 MWh in a year. Find the capacity factor and explain why it is low.

Answer: Maximum possible output = 50 MW x 8,760 h = 438,000 MWh. Capacity factor = 131,400 / 438,000 = 30%. Wind speed varies, turbines stop below cut-in and above cut-out speeds, and maintenance outages cut output, so back-up capacity or storage and grid integration are essential.

20. Coal emits 0.82 kg CO2 per kWh and gas 0.42. With 3.2e+09 kWh a year, find the annual CO2 cut in tonnes and the percentage reduction if 40% shifts to gas.

Answer: Baseline = 3.2e+09 x 0.82 / 1,000 = 2,624,000 t CO2. Cut = 0.40 x 3.2e+09 x (0.82 - 0.42) / 1,000 = 512,000 t, a fall of 19.5%. Gas emits about 51% of coal per kWh, so replacing 40% of output removes nearly a fifth of emissions; deeper cuts need zero-carbon sources and demand management.

Part 6: Glacier Mass Balance and Sea Level

Mass balance is in metres water equivalent (m w.e.).

21. A glacier shortens from 12.5 km to 10.8 km. Find the percentage retreat and name two other measurable indicators of glacier change.

Answer: Retreat = (12.5 - 10.8) / 12.5 x 100% = 13.6%. Other indicators: the rising altitude of the terminus, mass balance in m w.e. per year, ice thickness and area change, plus ice temperature, surface velocity and seasonal meltwater runoff.

22. A glacier gains 1.15 m w.e. and loses 1.72 m w.e. each year. Find the net annual balance and the cumulative change over 30 years.

Answer: Net balance = 1.15 - 1.72 = -0.5700000000000001 m w.e. per year, a net loss. Over 30 years the total is -0.5700000000000001 x 30 = 17.1 m w.e., i.e. the glacier thins by that much water equivalent on average. Sustained deficit thins and retreats the glacier, boosting meltwater now but reducing dry-season baseflow later.

23. Sea level rise comes from thermal expansion 1.8 mm/yr, glacier melt 0.9 mm/yr and ice sheets 0.7 mm/yr. Find the total rate and the rise over 50 years in mm and cm.

Answer: Total = 1.8 + 0.9 + 0.7 = 3.4000000000000004 mm/yr, so 50 years gives 17 mm, or 1.7 cm. Low-lying coasts, deltas and small islands face inundation and saltwater intrusion, and a raised baseline makes storm surges far more costly to defend; the thermal expansion part persists for centuries even if emissions stop.

24. A mountain glacier covers 480 km2 with a mean thickness of 120 m and ice density 0.9 of water. If it melted entirely, find the water volume and the global mean sea level rise in mm, taking an ocean area of 3.62e+14 m2.

Answer: Volume = 4.80e+08 m2 x 120 m = 5.760e+10 m3; water equivalent = 5.760e+10 x 0.9 = 5.184e+10 m3. Rise = 5.184e+10 / 3.62e+14 = 0.143 mm. One mountain glacier therefore matters little globally (under 1 mm); Greenland and Antarctica dominate sea level while mountain glaciers matter most for regional water supply.
