S5 Geography Practice Paper: Weather and Climate, River Processes and Discharge, Industrial Location, Urbanisation and Urban Renewal, Farming Systems, Energy and Pollution Management (100 marks)

Level: S5 | Subject: Geography | 75 minutes | 100 marks | 24 questions | answer key

Section A Weather and Climate (18 marks)

Show all working. Give units in every answer.

#	Question	Answer	Marks
1	On a morning the ground-level air temperature is 28.5 °C. A hill-top station lies at 958 m above sea level and the regional lapse rate is 6.5 °C per km. (a) Calculate the temperature at the hill top. (b) State the lapse rate that an air parcel would follow after rising above its condensation level, and explain why it changes.	Height difference = 958 / 1000 = 0.958 km; temperature fall = 0.958 x 6.5 = 6.2 °C. Hill-top temperature = 28.5 - 6.2 = 22.3 °C. (b) Above the condensation level the latent heat released by condensation (about 2,500 J/g) partly offsets the cooling, so the saturated adiabatic lapse rate is smaller, about 5-6 °C per km, compared with the dry adiabatic rate of 10 °C per km.	4
2	Air temperature in the city is 30 °C, the saturation vapour pressure is 42.4 hPa and the measured vapour pressure is 21.2 hPa. (a) Calculate the relative humidity. (b) State what would be observed if the temperature fell to 15 °C with the same vapour content. (c) Give one way the urban heat island affects these values.	Relative humidity = 21.2 / 42.4 x 100% = 50%. (b) At 15 °C the saturation vapour pressure is only about 17 hPa, well below the actual 21.2 hPa, so the air is supersaturated and the excess vapour condenses as dew or fog. (c) The urban heat island raises night temperature by 2-4 °C, so saturation vapour pressure is higher, relative humidity is lower and condensation starts later.	5
3	A catchment of 35 km2 receives 2,400 mm of rain a year and yields 1,680 mm of runoff. (a) Calculate the runoff coefficient. (b) Calculate the annual runoff volume in cubic metres. (c) Explain why the coefficient is not equal to 1.	(a) Runoff coefficient = 1,680 / 2,400 = 0.70 (70%). (b) Volume = 35 x 10^6 m2 x 1.68 m = 5.88 x 10^7 m3. (c) The remaining 30% (720 mm) is intercepted, evaporated, transpired or infiltrated to groundwater, so not all rainfall becomes surface runoff.	4
4	Station data: hottest month 31.2 °C, coldest month 10.4 °C; rainfall is concentrated in summer (May-September) with 1,200 mm in summer and 250 mm in winter. (a) Calculate the annual temperature range. (b) State which hemisphere the station is in and give a reason. (c) Identify the climate type and one agricultural implication.	(a) Annual range = 31.2 - 10.4 = 20.8 °C. (b) The hottest months are July and August, so the station is in the northern hemisphere. (c) Hot wet summers and mild dry winters with about 1,450 mm of rain concentrated in the summer half-year indicate a humid subtropical monsoon climate (Cwa), allowing rice cultivation and multiple cropping.	5

Section B River Processes and Discharge (18 marks)

Write the formula, substitute the values and give units.

#	Question	Answer	Marks
5	A river cross-section has an area of 45 m2 and a mean velocity of 1.2 m/s. (a) Calculate the discharge in m3/s. (b)	(a) Q = A x v = 45 x 1.2 = 54 m3/s. (b) Daily volume = 54 x 86,400 s = 4,665,600 m3. (c) With area tripled at 135 m2 and the same velocity, Q = 162	5

	Calculate the volume discharged in one day. (c) If the area triples at the same velocity, how does discharge change?	m3/s, i.e. discharge triples; discharge is directly proportional to cross-sectional area.	
6	During a storm the water level rises 1.8 m in a 60 m wide rectangular channel and the mean velocity becomes 1.5 m/s. (a) Calculate the extra cross-sectional area. (b) Calculate the extra discharge. (c) Explain why natural banks give a less abrupt flood peak than concrete channels.	(a) Extra area = 60 x 1.8 = 108 m2. (b) Extra discharge = 108 x 1.5 = 162 m3/s. (c) Natural banks have vegetation, floodplains and rough beds, giving a higher Manning roughness and more storage, so the flood peak is lower and lasts longer; smooth concrete channels carry water faster with no floodplain storage, giving a sharp high peak.	4
7	Bed sand has a median grain size D50 = 0.10 mm with a critical erosion velocity of about 0.20 m/s. (a) Name the sediment class of 0.10 mm material. (b) Describe what happens if velocity rises from 0.15 to 0.35 m/s. (c) Give one engineering use of D50 data.	(a) 0.10 mm material is sand (0.0625-2 mm). (b) At 0.15 m/s the flow is below the critical 0.20 m/s so sediment settles; at 0.35 m/s it exceeds the threshold, so sand is eroded and carried in suspension and the bed is lowered. (c) D50 is used to size bank protection rock (about 2-3 times D50), estimate dredging volumes and check channel stability.	4
8	A catchment of 120 km2 receives 80 mm of rain in 3 hours with a runoff coefficient of 0.65. (a) Calculate the runoff volume. (b) Calculate the mean peak discharge in m3/s. (c) Explain how urbanisation changes these values.	(a) Volume = 120 x 10^6 m2 x 0.080 m x 0.65 = 6.24 x 10^6 m3. (b) Mean discharge = 6.24 x 10^6 / 10,800 s = 577.8 m3/s. (c) Urbanisation raises the runoff coefficient from about 0.3 to over 0.7 and shortens the lag time, so both volume and peak discharge increase and arrive earlier, requiring larger drains and storage.	5

Section C Industrial Location (16 marks)

Show your calculations and name the type of location factor involved.

#	Question	Answer	Marks
9	A factory needs 4 tonnes of raw materials to make 1 tonne of product. (a) Calculate the material index. (b) Decide whether it should locate near the raw material or the market, and explain. (c) Give one example of such an industry.	(a) Material index = weight of raw material / weight of product = 4 / 1 = 4. (b) The index exceeds 1 (a weight-losing industry), so the plant should be near the raw material to avoid transporting bulky input. (c) Iron and steel, sugar refining, cement and paper pulping.	4
10	Freight costs 0.8 dollars per tonne-km. Option 1: plant at the raw material, shipping 1 tonne of product 400 km. Option 2: plant at the market, shipping 4 tonnes of raw material 150 km. (a) Calculate the freight cost per tonne of product for each option. (b) State the better option. (c) Would the answer change at 1.5 dollars per tonne-km?	(a) Option 1 = 1 x 400 x 0.8 = 320 dollars; Option 2 = 4 x 150 x 0.8 = 480 dollars. (b) Option 1 is cheaper (320 < 480), saving 160 dollars per tonne. (c) At 1.5 dollars: Option 1 = 600 and Option 2 = 720, so the conclusion holds; the gap widens to 120 dollars in favour of the raw-material site.	4
11	A factory pays 24 million dollars in wages against total costs of 80 million dollars. (a) Calculate wages as a percentage of total cost. (b) If wages rise 15% with other costs unchanged, by what percentage does total cost rise? (c) Name the location orientation of this industry and give an example.	(a) 2,400 / 8,000 x 100% = 30%. (b) Wages rise by 360 million, so total cost goes from 8,000 to 8,360 million, a rise of 4.5%. (c) With wages at 30% of cost this is a labour-intensive (labour-oriented) industry, sited where wages are low and labour is plentiful; examples are garments, toys and electronics assembly.	4

12	After an industrial estate attracts similar plants, the average supplier distance falls from 300 km to 40 km, with 1,000 lorry trips a year costing 12 dollars per km per trip. (a) Calculate the annual freight saving. (b) Name this phenomenon and give two other benefits.	(a) Saving per trip = (300 - 40) x 12 = 3,120 dollars, so 3,120 x 1,000 = 3,120,000 dollars a year. (b) This is agglomeration economies. Other benefits: shared infrastructure such as sewers, power and roads; a pooled skilled labour force; and knowledge spillover with easier subcontracting and shorter lead times.	4

Section D Urbanisation and Urban Renewal (17 marks)

Give units in all calculations and explain the concepts.

#	Question	Answer	Marks
13	A city region has 5.6 million people, of whom 4.2 million live in urban areas. (a) Calculate the urbanisation rate. (b) If ten years later the population is 6.0 million and the rate reaches 85%, calculate the urban population. (c) Relate the urbanisation rate to economic development.	(a) 4.2 / 5.6 x 100% = 75%. (b) 6.0 million x 85% = 5.1 million. (c) Low-income economies are mainly agricultural with low rates; industrialisation pulls workers into cities and raises the rate to 50-70%; high-income service economies reach over 80% and then stabilise, sometimes with suburbanisation or counter-urbanisation.	4
14	An urban district covers 2.4 km2 with 180,000 residents. (a) Calculate the population density in persons per km2. (b) Given a rural district density of 1,500 persons per km2, calculate how many times denser the urban district is. (c) State two effects of high density on transport and public services.	(a) 180,000 / 2.4 = 75,000 persons per km2. (b) 75,000 / 1,500 = 50 times. (c) Transport: short trips suit walking and mass transit, which run efficiently but become congested at peak hours. Public services: schools, clinics and markets have small catchment areas and low per-capita cost, yet open space per person is limited and facilities saturate.	4
15	A redevelopment site covers 0.6 ha. The plot ratio is 4 before and is allowed to rise to 9 after renewal. (a) Calculate the gross floor area before and after in m2. (b) Calculate the percentage increase. (c) Give two benefits and one cost of the higher plot ratio.	(a) Site area = 0.6 x 10,000 = 6,000 m2; before = 6,000 x 4 = 24,000 m2 and after = 6,000 x 9 = 54,000 m2. (b) Increase = (54,000 - 24,000) / 24,000 x 100% = 125%. (c) Benefits: more efficient land use and extra housing supply, plus safer and healthier buildings with ground-level open space. Costs: over-dense blocks worsen ventilation and daylight, intensify the heat island and traffic load and raise rents.	5
16	After renewal, average residential rent in an old district rises from 240 dollars to 396 dollars per m2. (a) Calculate the percentage rise in rent. (b) Name the phenomenon. (c) State one effect on original residents.	(a) (396 - 240) / 240 x 100% = 65%. (b) This is gentrification: environmental improvement attracts higher-income residents and pushes up rents and prices. (c) Low-income original residents are displaced to cheaper outlying areas, losing community networks and facing longer and costlier commutes.	4

Section E Farming Systems (16 marks)

Answer using systems concepts; give units in calculations.

#	Question	Answer	Marks
17	A farm uses 12 units of energy input (fuel, fertiliser, feed) and produces 30 units of food energy. (a) Calculate the energy output to input ratio. (b) State whether this	(a) 30 / 12 = 2.5, so each unit of input energy yields 2.5 units of food energy. (b) A ratio above 1 with large purchased inputs indicates commercial farming selling a surplus. (c) Cut fuel and fertiliser	4

	is commercial or subsistence farming and why. (c) Give two ways to raise the ratio.	use, raise yield per hectare through better seed, precise irrigation and rotation, or reduce post-harvest losses.	
18	A farm of 0.8 ha employs 6 full-time workers. (a) Calculate workers per hectare. (b) Decide whether the farm is intensive or extensive. (c) Contrast labour inputs in Asian rice farming and North American wheat farming.	(a) 6 / 0.8 = 7.5 workers per hectare. (b) 7.5 workers per hectare means high inputs on a small area, so it is intensive farming. (c) Asian paddy fields are small and use much hand labour per hectare, whereas North American wheat farms of hundreds of hectares rely on large machines with very few workers, an extensive system.	4
19	A rice farmer harvests 5.2 tonnes per hectare at 3,600 dollars per tonne, with production costs of 14,000 dollars per hectare. (a) Calculate revenue per hectare. (b) Calculate profit per hectare. (c) Calculate the profit margin.	(a) Revenue = 5.2 x 3,600 = 18,720 dollars. (b) Profit = 18,720 - 14,000 = 4,720 dollars. (c) Margin = 4,720 / 18,720 x 100% which is about 25.2%. A 10% price fall to 3,240 dollars cuts profit to 2,848 dollars (16.9% margin), showing high price sensitivity for smallholders.	4
20	Rice needs 900 mm of water over the growing season and receives 420 mm of effective rainfall. (a) Calculate the irrigation depth needed in mm. (b) Calculate the volume of water needed per hectare in m3. (c) Explain the effect of a water shortage on yield and give one water-saving method.	(a) 900 - 420 = 480 mm. (b) One hectare is 10,000 m2, so volume = 10,000 x 0.48 = 4,800 m3. (c) Shortage stunts plants, reduces tillering and raises empty grains, cutting yield by 20-50%. Alternate wetting and drying (AWD) irrigation, re-flooding only when the water falls below about 15 cm, saves 20-30% of water with little yield loss.	4

Section F Energy and Pollution Management (15 marks)

Give units in calculations and name management measures.

#	Question	Answer	Marks
21	A power mix is 40% coal, 30% natural gas, 20% nuclear and 10% renewables, with carbon intensities of 0.90, 0.40, 0 and 0 kg CO2 per kWh. (a) Calculate the average carbon intensity. (b) Explain why nuclear is low-carbon but not renewable.	(a) Average = 0.40 x 0.90 + 0.30 x 0.40 = 0.36 + 0.12 = 0.48 kg CO2 per kWh. (b) Nuclear generation burns no fossil fuel and emits almost no CO2, but uranium is a finite resource and spent fuel needs long-term storage, so it is low-carbon but not renewable.	4
22	A household uses 4,800 kWh a year and the grid carbon intensity is 0.48 kg CO2 per kWh. (a) Calculate the annual emissions in kg. (b) Express this in tonnes. (c) Give two practical actions to cut emissions and estimate the saving for one of them.	(a) 4,800 x 0.48 = 2,304 kg CO2. (b) That is 2.30 tonnes. (c) Raising the air-conditioner set point from 22 to 25 °C cuts cooling energy about 15%; if cooling is 40% of the 4,800 kWh, saving 288 kWh avoids about 138 kg CO2. Switching to LED lighting and grade-1 appliances and removing standby loads saves a further 10%.	4
23	A chimney emits 60 g/s of sulphur dioxide. Wind speed is 3 m/s, mixing height 200 m and the plume width 5 km downwind is 300 m. (a) Use a box model to calculate ground-level concentration in micrograms per m3. (b) Explain why concentrations are higher at night. (c) Give one emission control measure.	(a) C = Q / (u x H x W) = 60 / 180,000 = 3.33 x 10^-4 g/m3 = 333 micrograms per m3. (b) At night surface cooling forms an inversion and the mixing height falls from 200 m to tens of metres while wind speeds drop, so the same emission gives much higher concentrations. (c) Use low-sulphur fuel, fit flue-gas desulphurisation (over 90% efficient) and raise stack height with continuous monitoring.	4
24	A factory flue gas carries 200 mg/m3 of dust and the electrostatic precipitator is	(a) 200 x (1 - 0.95) = 10 mg/m3. (b) At 99% efficiency the outlet is 200 x 0.01 = 2 mg/m3, an	3

	95% efficient. (a) Calculate the emission concentration. (b) Compare it with a 99% efficient unit.	80% further cut from 10 to 2 mg/m3, but capital and power costs rise, so the benefit must be weighed against cost with continuous monitoring.	