S6 Geography Practice Paper (Set 4): Plate Tectonics, Earthquakes and Volcanoes; Weathering and Mass Movement; Fluvial Landforms and Flood Management; Urban Climate and Air Pollution; Energy Production and Carbon Intensity; Globalisation and Industrial Location (100 marks)

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

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Section A: Plate Tectonics, Earthquakes and Volcanoes (16 marks)

Show all working with units; give answers to 3 significant figures.

1. A seismograph records a 20 s difference in arrival times of P and S waves. Given P-wave speed 6.0 km/s and S-wave speed 3.5 km/s, find the epicentral distance.

d = dt / (1/vS - 1/vP) = 20 / (1/3.5 - 1/6.0) = 20 / 0.1190 = 168 km.

2. A fault ruptures over 50 km2 with mean slip 2.0 m; the shear modulus is 3.0 x 10^10 N/m2. (a) Find the seismic moment M0; (b) find Mw using Mw = (log M0 - 9.1) / 1.5.

(a) M0 = mu*A*D = 3.0e10 x 50e6 x 2.0 = 3.0e18 N m. (b) Mw = (18.477 - 9.1) / 1.5 = 6.25.

3. A volcanic cone has a base radius of 2.0 km and a height of 1.5 km, assumed conical. (a) Find the slope angle; (b) find the volume.

(a) tan(theta) = 1.5 / 2.0 = 0.75, theta = 36.87 deg. (b) V = pi*r^2*h/3 = pi x (2000)^2 x 1500 / 3 = 6.28e9 m3.

4. A magma chamber holds 0.5 km3 and erupts at a steady 25 m3/s. Find the number of days needed to empty it.

V = 0.5e9 m3; t = 0.5e9 / 25 = 2.0e7 s = 231.5 days.

Section B: Weathering and Mass Movement (16 marks)

Show all working with units; give answers to 3 significant figures.

5. A limestone plateau lowers by 0.30 mm per year; rock density is 2700 kg/m3 over an area of 1.0 km2. Find the mass removed each year in tonnes.

m = 0.30e-3 x 1.0e6 x 2700 = 8.1e5 kg = 810 tonnes.

6. Chemical weathering proceeds at 0.05 mm/yr at 10 C, and the rate doubles for every 10 C rise. Find the rate at 30 C.

A 20 C rise is two 10 C steps: 0.05 x 2^2 = 0.2 mm/yr.

7. A slope has cohesion 10 kPa, normal stress 80 kPa, friction angle 30 deg and shear stress 60 kPa on the slip plane. (a) Find the factor of safety; (b) state whether it is stable.

(a) F = (c + sigma*tan(phi)) / tau = (10 + 80 x 0.5774) / 60 = 0.94. (b) F < 1, so the slope is unstable and may fail.

8. A rock falls freely from 60 m (air resistance neglected). Find its speed on reaching the base of the slope.

v = sqrt(2gh) = sqrt(2 x 9.81 x 60) = 34.3 m/s.

Section C: Fluvial Landforms and Flood Management (18 marks)

Show all working with units; give answers to 3 significant figures.

9. A river cross-section is 45 m2 with a mean velocity of 1.8 m/s. Find the discharge.

Q = A x v = 45 x 1.8 = 81 m3/s.

10. A 25 km2 catchment receives 180 mm of rain in 24 hours; the runoff coefficient is 0.35. (a) Find the runoff volume; (b) find the mean discharge.

(a) V = 0.35 x 0.180 x 25e6 = 1.58e6 m3. (b) Q = 1.575e6 / 86400 = 18.2 m3/s.

11. A flood peak of 120 m3/s lasts 6 hours while the downstream channel can carry only 60 m3/s. Find the volume that must be stored.

V = (120 - 60) x 6 x 3600 = 1.296e6 m3 (about 1.3e6 m3).

12. In 30 years of records, the design flood level was exceeded in 2 years. (a) Find the return period; (b) find the annual exceedance probability.

(a) T = 30 / 2 = 15 years. (b) P = 1 / 15 = 6.67%.

Section D: Urban Climate and Air Pollution (18 marks)

Show all working with units; give answers to 3 significant figures.

13. Rural temperature is 26.0 C and the city centre 29.5 C. Cooling uses 0.08 kWh per m2 per day per kelvin over 10,000 m2 of floor area. (a) Find the heat island intensity; (b) find the extra cooling energy.

(a) dT = 29.5 - 26.0 = 3.5 K. (b) E = 3.5 x 0.08 x 10,000 = 2800 kWh/day.

14. Inside an inversion layer the temperature rises 2.0 C per 100 m. Surface air is 20.0 C; find the temperature at 300 m.

T = 20.0 + 2.0 x 3 = 26 C, so pollutants cannot disperse vertically.

15. Nitrogen dioxide is measured at 80 ug/m3 at 25 C and 1 atm (molar volume 24.45 L, molar mass 46.01 g/mol). Express the concentration in ppb.

ppb = 80 x 24.45 / 46.01 = 42.5 ppb.

16. Box model: emission 500 kg/h, mixing height 500 m, wind speed 3.0 m/s and city width 10 km. Find the mean ground-level concentration in ug/m3.

C = Q / (u x H x W) = (500e9 / 3600) / (3 x 500 x 10,000) = 9.26 ug/m3.

Section E: Energy Production and Carbon Intensity (16 marks)

Show all working with units; give answers to 3 significant figures.

17. A wind farm of 50 MW installed capacity generates 131.4 GWh in a year. Find its capacity factor.

CF = 131.4 / (50 x 8.76) = 0.3, i.e. 30%.

18. A grid draws 40% of its power from coal (0.90 kg CO2/kWh) and 60% from gas (0.45 kg CO2/kWh), supplying 500 GWh a year. Find (a) the carbon intensity and (b) annual emissions.

(a) 0.4 x 0.90 + 0.6 x 0.45 = 0.63 kg/kWh. (b) 0.63 x 500e6 = 3.15e8 kg = 315,000 tonnes.

19. Solar irradiation is 5.0 kWh/m2/day, panel efficiency is 18% and the array covers 20 m2. Find the daily output.

E = 5.0 x 0.18 x 20 = 18 kWh/day.

20. A rooftop system costs HK$60,000 and saves HK$7,200 a year. Find the simple payback period.

Payback = 60,000 / 7,200 = 8.33 years.

Section F: Globalisation and Industrial Location (16 marks)

Show all working with units; give answers to 3 significant figures.

21. A region employs 12,000 in an industry out of 200,000 total jobs; nationally the industry employs 300,000 out of 10,000,000. Find the location quotient and interpret it.

LQ = (12,000/200,000) / (300,000/10,000,000) = 0.06 / 0.03 = 2; above 1 means the industry is concentrated and export-based.

22. Region A needs 2 hours for a unit of cloth and 8 hours for a computer; region B needs 4 and 6 hours. (a) Find the opportunity cost of a computer in each; (b) state comparative advantage.

(a) A: 8/2 = 4 units of cloth; B: 6/4 = 1.5 units. (b) B has the lower opportunity cost of computers, so B has comparative advantage in computers and A in cloth.

23. A plant uses 2.5 tonnes of raw material per tonne of output. Find the material index and the locational pull.

Material index = 2.5 / 1 = 2.5; greater than 1 means weight loss, so the plant is raw-material oriented.

24. Wages are 25% of total cost and rise by 12%; the profit margin was 8%. (a) Find the rise in total cost; (b) find the percentage fall in the margin.

(a) 0.25 x 12% = 3%. (b) The margin falls to 8% - 3% = 5%, a fall of 3 / 8 = 37.5%.

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