

Instructions

Answer one question from each of parts A, B, and C of the examination. The examination is marked out of 60. Equal weight is given to each part of the examination.

The examination is closed book.

Calculators may be used, but information may not be stored in calculator memory.

Candidates are encouraged to use properly labelled diagrams to illustrate answers, but they must be explained with adequate text. Consideration will be given to the organization of responses, including neatness, grammar, word use and spelling.

The time allowed for the examination is 3 hours.

Marks**Part A. The following question must be attempted.**

A.1. For **ten (10)** of the following terms, (a) define the term; (b) state what is the significance of the term to a geomorphologist.

- 10x2
- (i) subduction
 - (ii) fault scarp
 - (iii) stratovolcano
 - (iv) colluvium
 - (v) tor
 - (vi) earthflow
 - (vii) lodgement till
 - (viii) moraine
 - (ix) longshore drift
 - (x) baymouth bar
 - (xi) parabolic dune
 - (xii) karst
 - (xiii) palsa
 - (xiv) active layer

Part B. Answer one of the following two questions.

B.2. The infinite slope stability equation is:

$$F = \frac{c + (\gamma_d z_d + \gamma_{sat} z_w - \gamma_w z_w) \cos \beta \tan \phi}{(\gamma_d z_d + \gamma_{sat} z_w) \sin \beta}$$

(where c is cohesion, ϕ the friction angle, z is thickness, γ unit weight and β slope angle. The subscripts d , sat and w refer to dry soil, saturated soil and water respectively)

- 5 a) Define the Factor of Safety.
- 5 b) What is the Factor of Safety for a completely dry slope, with a friction angle of 35° , slope angle of 30° , soil failure thickness of 2 m and zero cohesion?
- 5 c) What is the Factor of Safety for the same slope as in b), but with water table at the ground surface?
- 5 d) What type of seepage flow is implied by the water table coinciding with the ground surface, as assumed in (c)?

B.3. The mean annual flood in Fraser River at Mission is $9790 \text{ m}^3 \text{ s}^{-1}$. The channel has a sand bed and sandy banks.

- 6 a) Using the equations of hydraulic geometry, compute the equilibrium (expected) width and mean depth of the channel.
- 3 b) Thence, compute the expected mean velocity.
- 2 c) The channel gradient, S , is 0.000085 m/m. Using the formula $v = R^{2/3} S^{1/2} / n$, compute the Manning flow resistance number, n . R is hydraulic radius.
- 4 d) In fact, the channel has been constrained by dykes to be 525 m wide and the effect is mainly taken up by an increase in velocity. Estimate new values of v and n on the basis of this change in width.
- 5 e) The old railway bridge at Mission substantially constricts the channel. If the bridge were removed, what would be the effect (qualitatively stated) on flow depth and velocity?

Table 1, to accompany this question, is on the next page.

Question B.3 continued.

Table 1

Hydraulic Geometry of River Channels

$$w_b = aQ^{0.50}; \quad d_* = cQ^{0.36}$$

where w_b = bankfull width of the channel (m); d_* = hydraulic mean depth of the channel (m);

Q = discharge ($\text{m}^3 \text{s}^{-1}$); a and c are constants selected from the following table.

River channel type	a	c
Gravel bed and banks (not braided)	3.2	0.25
Sand bed and banks	6.3	0.57
Sand bed and cohesive banks	4.7	0.48
Cohesive bed and banks	4.0	0.41

(Values adapted from D. B. Simons and M. L. Albertson)

Part C. Answer one of the following two questions.

C.4. “Facies” is the term used to describe the character of a body of sediment deposited under uniform environmental conditions. Around glaciers, four facies can be identified: (i) “ice facies”, denoting sediments deposited directly from the ice; (ii) “ice + water facies”, denoting sediments deposited from the ice in the presence of meltwater; (iii) “water + ice facies”, denoting sediments deposited by water in direct contact with ice; (iv) “water facies”, denoting sediments deposited by water away from the ice margin. Using these facies as a classification device for glacial landforms, complete the following table (copy the table into your answer book).

(1 point for each item correctly listed.)

Glacial facies	Two landforms associated with this facies	Characteristic sediment texture*	Characteristic sediment consolidation**	Characteristic sediment permeability**
Ice				
Ice + water				
Water + ice				
Water				

* Widely or narrowly graded and dominant component(s) (gravel/sand/silt);

** On a qualitative scale from high to low.

C.5. Perennially frozen ground, also called “permafrost”, is widespread in Canada (it underlies nearly 50% of the country). Therefore, it is important for the geomorphologist to be able to recognize and analyze it.

- 3 (a) Give a formal definition of “permafrost”.
- 4 (b) List four landform features, *identifiable on an air photograph*, that indicate the presence (or, possibly, former presence) of perennially frozen ground.
- 4 (c) Define “solifluction” (also called “gelifluction”) and briefly explain the mechanism by which it occurs.
- 4 (d) Describe surface drainage conditions over permafrost.
- 5 (e) Discuss the hazards presented to structures by the presence of permafrost.