

CANADIAN BOARD OF EXAMINERS FOR PROFESSIONAL SURVEYORS

C6 – GEODETIC POSITIONING

March 2026

Note: This examination consists of 4 questions on 2 pages.

Marks

<u>Q. No</u>	<u>Time: 3 hours</u>	<u>Value</u>	<u>Earned</u>
1.	Astronomical measurements constitute a fundamental component of geodetic positioning, particularly in applications that demand very high levels of precision. By observing celestial bodies and relating their positions to the Earth's rotation and orientation in space, surveyors can determine essential geodetic parameters with great accuracy. This is especially significant in the determination of azimuths, where astronomical methods provide an independent and reliable reference, and in the establishment and orientation of geodetic control networks. a) Describe in detail how to determine the astronomical azimuth of a terrestrial line by observing both Polaris and the Sun. Outline the field observation steps and the subsequent computational procedure for each case. Clearly compare the observational approach for Polaris with that for the Sun, highlighting their practical and theoretical differences. Present the governing azimuth equation, define all variables involved, and specify which quantities are known, directly observed values, or unknowns to be determined. b) State the typical level of accuracy that can be achieved in astronomical azimuth determination using the methods described in part (a). c) Identify the principal error sources that influence the accuracy of astronomical azimuth results and discuss practical strategies to minimize these errors and improve overall precision.	17 5 8	
2.	Many applications in geodetic positioning demand a variety of observational techniques and the use of diverse instruments, depending on the required level of accuracy and the nature of the project. As a result, surveyors must work within multiple coordinate reference systems, including both local and global ones. This multiplicity of reference frameworks makes it necessary to understand the relationships between different coordinate systems and to apply appropriate mathematical models for transforming coordinates from one system to another. Consequently, proficiency in handling various coordinate systems and performing accurate coordinate transformations is a fundamental requirement in modern geodetic practice. a) To establish a geodetic baseline in an area that has only one available control station (station S) with known geodetic coordinates (ϕ_S, λ_S, h_S), a surveyor was tasked with the establishment of a new geodetic control station (station P) and obtain its geodetic coordinates (ϕ_P, λ_P, h_P) in NAD83 (CSRS). With no access to GPS equipment, only a total station, the surveyor occupied station S with the total station and obtained the following: - zenith angle θ_P - slope distance d_{SP} - geodetic azimuth α_{SP}. Describe the detailed approach with equations to compute the coordinates (ϕ_P, λ_P, h_P). In your approach, you can neglect the effect of the deflections of the vertical.	15	

	b) A geodetic baseline in an area with two control stations (station I and station K) with known geodetic coordinates (ϕ_I, λ_I, h_I) and (ϕ_K, λ_K, h_K) in NAD83 (CSRS), respectively. A surveyor was tasked with the computation of the local coordinates of station K (x_K, y_K, z_K) in a local coordinate system that has the origin at station I. Describe the detailed approach with equations to compute the coordinates (x_K, y_K, z_K). In your approach, you can neglect the effect of the deflections of the vertical.	15	
3.	One of the classic definitions of Geodesy was “<i>Geodesy is the determination of the Earth’s gravity field potential function</i>”. Another one was “<i>Geodesy is the measurement and representation of the Earth and its gravity field</i>”. a) What is the relationship between the gravity potential and the gravity vector? b) What are the components that constitute the Earth’s gravity vector, and what causes each component? c) Define a level surface and discuss its properties in detail. Give examples of known level surfaces used in geodetic positioning and how each one was/is obtained. d) Discuss the following vertical datums and geoid models: CGVD2013, GSD95, and CGG2013. For each, include: • The full form of the acronym. • A description of its definition and scope. • A summary of how the realization is determined.	3 5 7 6	
4.	With the rapid advancement of satellite-based positioning technologies, the Global Positioning System (GPS) has emerged as the most widely utilized Global Navigation Satellite System (GNSS) in surveying and geospatial applications. Owing to its reliability, global coverage, and high level of accuracy, surveyors now depend on GPS on a daily basis for a broad range of tasks, from establishing control networks to performing detailed topographic and engineering surveys. a) Differentiate between ICRS, ITRF, NAD83 (Original), NAD83(CSRS), and NATRF2022 including what the acronyms stand for and how realizations are obtained for each. b) Compare between the DGPS, PPP, and RTK techniques. Include what the acronyms stand for, observations, tools, obtained accuracy, advantages, disadvantages, and possible applications.	8 11	
	Total Marks:	100	