# National Exams December 2014

## 04-Geol-B6-1, Petroleum Deposits

3 hours duration

**NOTES:**

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.
2. This is a CLOSED BOOK exam.
3. Candidates may use one of two calculators, the Casio or Sharp approved models.
4. FIVE (5) sections constitute a complete exam paper. Each section contains between 1 and 5 questions.
5. The first five sections as they appear in the answer book will be marked.
6. All sections are of equal value. All parts in a multipart question have equal weight.
7. Clarity and organization of your answers are important, clearly explain your logic.

## Section 1 – Source Rock Geology and Characteristics (20 Marks)

**Q1-1 (4 marks)** What depositional conditions favour the accumulation and preservation of organic matter?

**Q1-2 (4 marks)** What are the main types of kerogen, and what are the dominant hydrocarbons produced from these kerogen types?

**Q1-3 (12 marks)** Draw cross sections through four possible settings in which large amounts of organic matter can accumulate (the precursors to source rocks). For each setting explain why the environmental conditions enable organic matter to accumulate.

## Section 2 – Hydrocarbon Chemistry and Generation (20 Marks)

**Q2-1 (4 marks)** The density of oil is often given in API. What is the formula for calculating API? What is the typical API range for light oil? Heavy oil?

**Q2-2 (2 marks)** Define:
a) Kerogen
b) Bitumen

**Q2-3 (8 marks)** On the attached graph paper, produce a pressure versus depth plot. On the P-T plot, graphically illustrate where the oil and gas windows occur and the relative volume of each hydrocarbon that would be produced along the depth profile. Also, provide the typical temperature ranges for the oil and gas window. To properly complete the chart, assume that the average surface temperature is 0 °C and the geothermal gradient is 30 °C $km^{-1}$.

**Q2-4 (6 marks)** Describe and illustrate three mechanisms that enable primary migration of hydrocarbons out of source rocks.

## Section 3 – Migration (20 Marks)

**Q3-1 (2 marks)** What are the main driving forces of secondary migration of hydrocarbons?

**Q3-2 (2 marks)** What is effective porosity and how does it relate to permeability?

**Q3-3 (10 marks)** On the following attached plan-view maps indicate the dominant migration pathways for hydrocarbons. Use a **1**, 2 and 3 to indicate your top three areas for exploration based on potential hydrocarbon charge.

**Q3-4 (2 marks)** What is irreducible water saturation? What would this value be in a hydrocarbon-bearing reservoir that is water wet and is dominated by medium-grained sandstone?

**Q3-5 (4 marks)** Draw a typical pressure versus depth graph for a normally pressured region. Include the lithostatic and hydrostatic pressure curves. On the plot, how would you identify an impermeable boundary such as a shale bed?

## Section 4 – Diagenesis (20 Marks)

**Q4-1 (20 marks)** List step-by-step, the diagenetic processes that sand may or does experience after it is deposited and during burial. Are they early or late stage processes? Do they increase or decrease porosity? Permeability? Be as specific as possible.

## Section 5 – Siliciclastic Reservoirs (20 Marks)

**Q5-1 (2 marks)** What is a delta?

**Q5-2 (10 marks)** Produce a vertical log for a 25 m thick wave-dominated delta and indicate the general position and thickness of the delta subenvironments (e.g., prodelta, etc.). Beside the vertical sequence, draw the gamma ray profile for the vertical succession.

**Q5-3 (2 marks)** What is the maximum porosity that can be achieved in sand assuming spherical grains? In the same sand, what is the minimum porosity that can be achieved simply through repacking of the grains?

**Q5-4 (4 marks)** What effect does a change in grain size have on porosity and permeability? What about a change in sorting (e.g., well sorted to moderately sorted)?

**Q5-5 (2 marks)** Why is coal bed methane considered to be an unconventional resource?

## Section 6 – Carbonate Reservoirs (20 Marks)

**Q6-1 (20 marks)** Draw a plan view and cross-section through a detached, rimmed platform. Define the depositional environments across the platform and discuss the reservoir potential of each environment.

## Section 7 – Structural Traps (20 Marks)

**Q7-1 (4 marks)** Draw a cross section through a simple anticline trap. Assume that it is filled with oil, water and gas. Indicate the relative positions of each fluid type and label all contacts, and rock types. Give the name of an oil field that is an anticline.

**Q7-2 (8 marks)** Draw a cross-section through a salt dome. Indicate at least 5 types of traps that can occur around salt domes. Don't forget a scale. Name an oil field or oil-producing region dominated by salt domes.

**Q7-3 (8 marks)** Draw a cross-section through a compressional tectonic regime dominated by thrust faults (e.g., Alberta foothills), and include at least 3 thrust sheets. Discuss the benefits and risks of exploring for hydrocarbons in thrust sheets versus in undeformed rocks.

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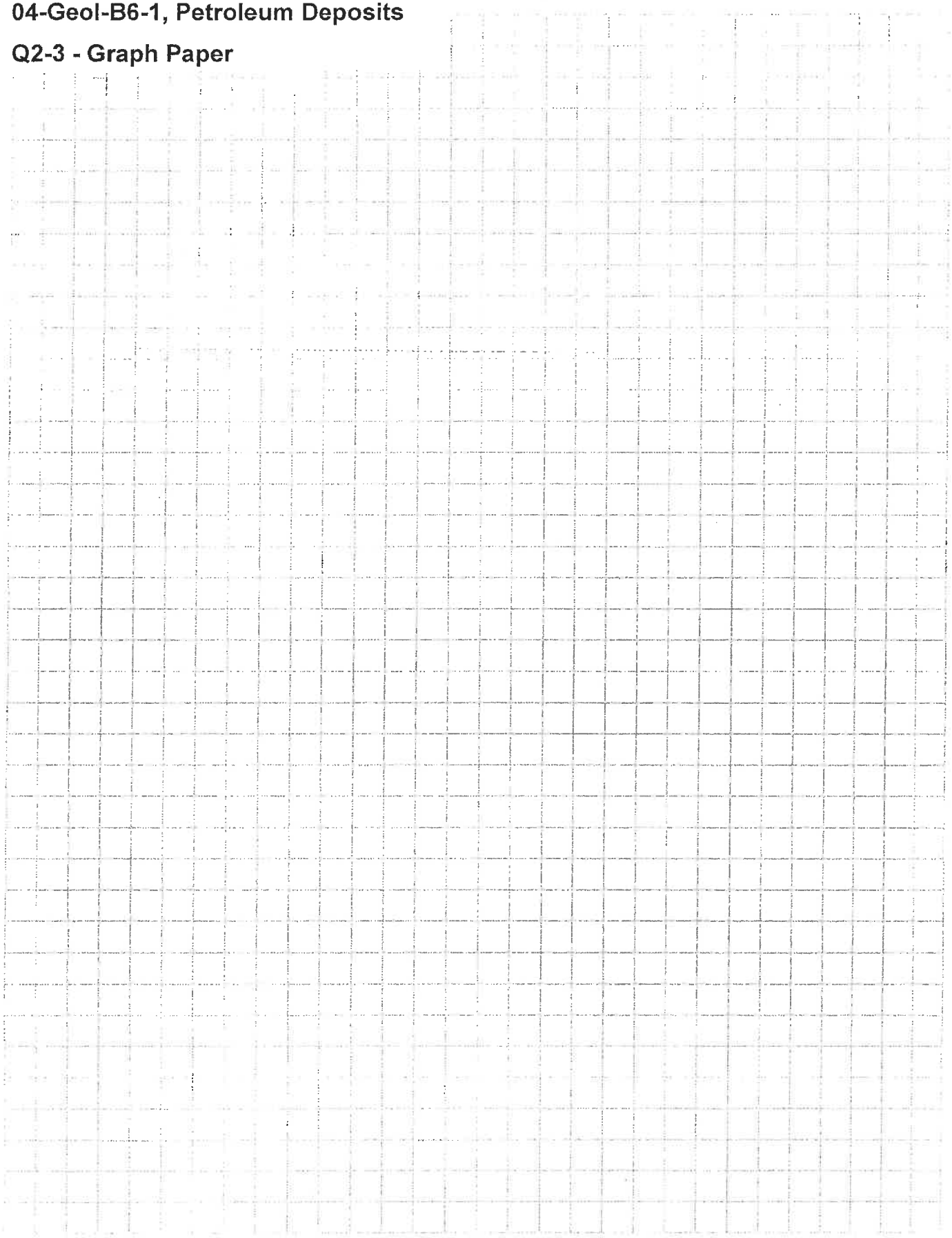
## Q2-3 - Graph Paper



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## Q3-3 - Plan View Maps