

# National Exams May 2018

## 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.
5. The first five sections as they appear in the answer book will be marked.
6. All questions are of equal value unless otherwise stated and all parts in a multipart question have equal weight.
7. Clarity and organization of your answers are important, clearly explain your logic.
8. Pay close attention to units, some questions involve oilfield units, and these should be answered in the field units. Questions that are set in other units should be answered in the corresponding units.

### **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 (8 marks)** What are the main types of kerogen, and what are the dominant hydrocarbons produced from these kerogen types?
- Q1-3 (2 marks)** Define anoxia and suboxia.
- Q1-4 (6 marks)** Draw cross sections through three settings in which large amounts of organic matter can accumulate (enough to form source rocks). For each setting briefly 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 (6 marks)** What are the typical viscosities of light oil? Heavy oil? Bitumen?
- Q2-3 (2 marks)** Define:
- Kerogen
  - Bitumen
- Q2-4 (4 marks)** What are the temperature ranges for the oil window? Gas window?
- Q2-5 (4 marks)** Provide the structural formulas for the following:
- Octane
  - Cyclopentane
  - Benzene
  - Ethyne

### **Section 3 – Migration (20 Marks)**

- Q3-1 (2 marks)** What is the difference between primary and secondary migration of hydrocarbons?
- Q3-2 (2 marks)** What is effective porosity and how does it relate to permeability?

**Q3-3 (6 marks)** **A)** Define the Young-LaPlace Equation as it applies to the displacement pressure of water by hydrocarbons in a pore throat. Define all the variables. (4 marks) **B)** If pore throats decrease in size, what happens to the displacement pressure? What does that mean in terms of hydrocarbon column height? (2 marks)

**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?

**Q3-6 (2 marks)** What rock types make the best seals for hydrocarbon traps?

**Q3-7 (2 marks)** The same fault can be both a transport pathway and seal. Explain how this is possible?

#### **Section 4 – Siliciclastic Reservoirs (20 Marks)**

**Q5-1 (2 marks)** What is an estuary?

**Q5-2 (10 marks)** Produce a vertical log for a 25 m thick normally prograding shoreface-beach succession and indicate the general position and thickness of the various subenvironments (e.g., lower shoreface, 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 shale gas considered to be an unconventional resource?

### Section 5 – Carbonate Reservoirs (20 Marks)

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

### Section 6 – 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.