

National Exams December 2011

09-MMP-A4, Mine Valuation and Mineral Resource Estimation

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 an CLOSED BOOK EXAM.
A Casio or Sharp approved calculator is permitted.
3. The candidate is allowed one only 8.5x11 inch reference sheet, hand written both sides.
4. Question 1 and FOUR (4) candidate choice questions constitute a complete exam paper.
Only question 1 and the first four candidate choice questions as they appear in the answer book will be marked.
5. Question 1 is compulsory and has 40 marks. The first four other questions (chosen from questions 2 to 7) as they appear on the candidates exam booklet will be marked for 15 marks each. The total mark is 100.
6. Most questions require an answer in essay format. Neat sketches should be used where and when ever appropriate. Clarity and organization of the answer are important.

You must answer **compulsory Question 1**, parts 1.1 to 1.7 inclusive, worth 40 marks total.

Of the remaining 6 questions (2 to 7) you must select **four** to answer. Any extra questions answered after the four required will not be marked. The four you choose each have 15 marks.

The total marks possible will then be $40 + 4 \times 15 = 40 + 60 = 100$

Question 1 This question (1.1 to 1.7 inclusive) is **compulsory** and worth 40 marks

1.1 What are the prices of the following metals and mined resources the day before this exam (an answer within +/- 10% is acceptable) (1 mark each)

Gold US\$/tr oz

Silver US\$/tr oz

Oil US\$/bbl (West Texas)

Copper US\$/lb

Zinc US\$/lb

Total 5 marks

1.2 What do you understand by the term "spherical variogram" (Note that in this exam the term variogram is used interchangeably with the more correct term semi-variogram). Include in your answer an explanation of terms such as sill, nugget and range and how the value for a typical "bin" or "step" is calculated.

Total 6 marks

1.3 Explain the term "kriging" and discuss why resource estimates found by kriging are superior to both "inverse distance power" and "polygonal" estimates. (5 marks)

Total 6 marks

1.4 Most metalliferous open pit porphyry or epithermal deposits are mined as a series of "shells" (an initial pit with subsequent push-backs). What are the economic advantages and operational disadvantages of such a mining sequence.

Total 6 marks

- 1.5 What do you understand by the term “capital cost allowance”. (3 marks)

With respect to Canadian Federal Taxation, what is the rate for Class 41m and discuss Class 41a with regard to “commencement of production” and “availability for use”.
(3 marks)

Total 6 marks

- 1.6 Recently the use of “price participation” has been omitted from the smelter contracts of large international mining corporations and Asian smelters. What are the advantages and disadvantages to the miner and smelter.

Total 5 marks

- 1.7 In the early 1970’s McKelvey produced a box diagram relating “increasing degree of feasibility or recovery” versus “increasing degree of geological assurance” for the US Geological Survey. Make a sketch of the McKelvey diagram including the various classifications of mineral resources and reserves.

Total 6 marks

You must now choose **FOUR** questions to answer from the remaining questions 2 to 7. If you answer more than four questions of your choice, the first four of questions 2 to 7 chosen will be marked, and the remainder discarded.

Question 2 (15 marks) Only answer this question if it is one of four chosen from questions 2 to 7

- 2.1 A nested spherical variogram has a range (1) of 15 meters, and a range(2) of 100 meters. The nugget is 0.05 %Cu² and sill(1) 0.10 %Cu² and sill(2) 0.5 %Cu².

What are the variogram values (gamma g) at

- | | | |
|-------|------------|-----------|
| 2.1.1 | 0 meters | (1 mark) |
| 2.1.2 | 10 meters | (2 marks) |
| 2.1.3 | 50 meters | (2 marks) |
| 2.1.4 | 150 meters | (1 mark) |

Draw a neat sketch to scale of the variogram. (3 marks)

2.2 With reference to variograms, what do you understand by the following terms

- 2.2.1 "regional" and "random" components. (1 mark)
- 2.2.2 step (bin) size (1 mark)
- 2.2.2 included angle (tolerance) (1 mark)
- 2.2.3 band width (1 mark)
- 2.2.4 anisotropy (2 marks)

Question 3 (15 marks) Only answer this question if it is one of four chosen from questions 2 to 7

3.1 What do you understand by the following methods of kriging (2marks each)

- 3.2.1 Point
- 3.2.2 Block
- 3.2.3 "Simple"
- 3.2.4 Ordinary
- 3.2.5 Indicator

3.2 Explain the terms in a typical "ordinary" "point" kriging matrix where the point value is estimated from 3 nearby samples. Clearly show how each value input to the matrix is found. (3 marks)

How are the four answers produced by the matrix calculation used. (2 marks)

Question 4 (15 marks) Only answer this question if it is one of four chosen from questions 2 to 7

4.1.1 A mining company has estimated a "mineral resource (rt)" for an open pit mine of 200 million short tons (st) before dilution and recovery. What would you expect dilution "df" and recovery "rf" to be for a well- managed operation.

4.1.2 What is "Taylors rule" and express this as a formula in terms of C (capacity of ore production st/d), T, L and dpy. (Note T is based on values for "rt", "df" and "rf").

- 4.1.3 Estimate "T" the total tonnage (st) of ore to be mined
- 4.1.4 Estimate "L" the "life of mine" in years
- 4.1.5 Estimate the mine capacity "C₁" (short tons per day based on a 350 day 24/7 operation)

(2 marks each or 10 marks)

Some formulae that may be of use

$$T = rt * rf * (1+df)$$

$$L = 0.2 * T^{0.25}$$

$$C = T / (L * dpy)$$

$$C_1 = T / (350 * L)$$

$$C_1 = T^{0.75} / 70$$

- 4.2 With regard to the Canadian "National Instrument 4-101", differentiate between a resource and a reserve. What qualifications are necessary for a "qualified person" to produce such values. (5 marks)

Question 5 (15 marks) Only answer this question if it is one of four chosen from questions 2 to 7

A junior mining company has the opportunity to purchase certain non-core assets from another company. The cash cost of purchasing the assets is \$0.7 million, and the salvage value (scrap minus environmental liabilities) is \$0.1 million.

The following table lists the revenues, operating costs and anticipated taxes.

Year	1	2	3	4	5
Revenues (\$ millions)	1.1	0.9	1.0	1.2	0.8
Operating Costs (\$ millions)	0.41	0.39	0.4	0.42	0.2
Taxes (\$ thousands)	159	162	166	168	92

Using an 8% cost of capital, what are the after tax cash flows and what is the net present value (NPV) of the asset. (10 marks)

Discuss the use of NPV and the rate of 8% cost of capital in the investment decision making process. Explain and compare rate of return (ROR) and discounted cash flow ROR (DCF-ROR) with NPV in the decision making process. (5 marks)

Question 6 (15 marks) Only answer this question if it is one of four chosen from questions 2 to 7

6.1 With respect to typical smelter contracts for metal concentrates, explain the following (1 mark each, total 10 marks)

- 6.1 contract duration
- 6.2 shipment and discharge conditions
- 6.3 environmental responsibility for concentrates
- 6.4 treatment charges
- 6.5 minimum payable content
- 6.6 deductions from payable
- 6.7 refining charges
- 6.8 impurities
- 6.9 splitting limits
- 6.10 umpires

6.2 Define and differentiate between "NSV" (net smelter value) and "NSR" (net smelter return). Discuss how you would estimate the net value of "rock in the ground" (after smelting, refining and transportation costs but before mining and concentrating) in order to find a suitable cut-off grade. (5 marks)

Question 7 (15 marks) Only answer this question if it is one of four chosen from questions 2 to 7

Non ferrous and oil mineral deposit types can be broken into several main groups comprising about 90% of the value of the Canada's mined production in this category. These are summarised below with example mining districts or mines.

- 7.1.1 Highland Valley Porphyry Cu/Mo
- 7.1.2 Pine Point Mississippi Valley Type
- 7.1.3 Ekati Kimberlite Diamonds

- 7.1.4 Sudbury Magmatic Ni-Cu-Platinum Group Element
- 7.1.5 Bathurst Volcanic Massive Sulphide (VMS)
- 7.1.6 Timmins Lode Gold
- 7.1.7 Sullivan Sedimentary Exhalative (SEDEX)
- 7.1.8 Elliot Lake (Athabaskan) Uranium

Select **five** of the above deposit types that you feel you are best able to describe.

In about 150 words with suitable sketches for each of five chosen,

- 7.2 Compare and contrast the geological conditions exhibited by the deposit types (the deposit examples you choose need not be Canadian).
- 7.3 Describe the ease or complexity of grade control exhibited during their mining, and if mining is most often by open pit or underground methods.
- 7.4 How do geological conditions and grade control impact resource estimates in each case.

(3 marks per type chosen)

End of the Exam