# National Exams May 2016

# 98-Pet-B3, Oil and Gas Evaluation and Economics

#### 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. Only and Approved Casio or Sharp non-programmable and non-communicating calculator is permitted.
- 4. The exam consists of a mix of short answer and multiple choice questions which cover general areas of knowledge about evaluation of oil and gas properties, and two spreadsheet questions to indicate a knowledge of basic economic evaluations related to future value and cash flow.
- Distribution of marks for the four response areas: a) Short answer (7 questions worth 5 marks each, total 35); Multiple Choice (10 questions worth 4 marks each, total 40); Future Value (complete table total 5%); Cash Flow (complete table total 20%)
- 6. Short answer questions require written response of 2-3 sentences or a short list of response, please write clearly. Ten questions are provided, but only 7 are required, indicate the responses you want graded with an (\*) beside the 7 responses, otherwise responses will be marked in the order they appear. If a formula is required it will be provided.
- 7. Multiple Choice. Circle the best answer on the sheet or list question numbers and letter responses separately.
- 8. Future Value complete the table to show the future value of the asset in each year.
- 9. Cash Flow complete the table all formulas required are provided as well as criteria for passing hurdle rate.

## - Page 2 of 9

(35 marks)

Short Answer Questions – ANSWER ONLY 7 OF THE 10 QUESTIONS (5% each – Total 35%). If you answer more select the 7 you want to count with an (\*).

1. Describe three reasons why there are few consistent numbers for international oil and gas reserves estimates? (1.5 point each + 0.5 for getting all three)

2. What two countries are most affected by "Freehold Leases"? How are freehold leases different in the two countries? (1.5 for each country, 2 for the explanation of the difference)

3. List and generally describe four new types of unconventional gas resources being developed. (1 for each right; 1 extra for all four)

4. Describe the four main historic energy transitions which have caused oil prices to peak and describe why transitions cause prices to spike? (1 for each transition + 1 for reason)

5. Using the formula and information provided below calculate the oil resource in place for a conventional reservoir. (5 marks)

N = VR x Φ x 1/B<sub>o</sub> x (1-S<sub>w</sub>)

N = oil in place (m<sup>3</sup>)

Area of the reservoir – 30 km<sup>2</sup>

Average pay thickness – 25 m

Porosity – 8%

Formation volume factor – 0.9 m<sup>3</sup>/stm<sup>3</sup>)

Water saturation – 15%

- 6. List 3 oil quality factors which affect crude prices and why these make heavy oil prices lower than light oil. (1 point each factor + 2 for explanation)
- 7. Explain 3 ways in which Steam-Oil-Ratio (SOR) might impact capital costs for thermal oil sands or heavy oil project. (1.5 for each reason + 0.5 for 3)
- 8. List and describe three factors which limit fracture growth (in hydraulic fracturing). (1.5 for each, 0.5 for all three)
- 9. Describe tornado and spider diagrams that are two useful tools for displaying economic sensitivities. (2.5 each)
- 10. Describe the three classifications of conventional gas reserves based on the condition of the gas in the reservoir? (1.5 for each, 0.5 for all three)

# – Page 3 of 9

#### Page 4 of 9

#### (40 marks)

Multiple Choice Questions – ANSWER All QUESTIONS (4% each – Total 40%) Circle the letter representing the correct answer.

- 1. The role of property evaluation is to...... (Complete the sentence)
  - a. To set an economic value on an oil and gas property
  - b. To determine the size of the reserves in a given reservoir
  - c. To determine the next best energy sources to develop
  - d. To facilitate turning resources into reserves
  - e. To calculate the after tax benefits of developing a property
- 2. What region contains most of the World's proved conventional gas reserves?
  - a. Middle East
  - b. Asia Pacific
  - c. North America
  - d. Europe and Eurasia
  - e. None of the above
- 3. Which country is not an exporter of hydrocarbon resources?
  - a. Russia
  - b. Brasil
  - c. Australia
  - d. Japan
  - e. Nigeria
- 4. Which is the best description of "effective oil in place" for the oilsands?
  - a. Only the in-situ bitumen which might be heated
  - b. Only the bitumen in deposits over 10 m thick
  - c. Bitumen deposits which have some recovery assigned to them
  - d. All bitumen which is in thick zones which cannot be mined
  - e. Amount of production which can be produced at a SOR < 5

#### – Page 5 of 9

- 5. Why aren't traditional economic calculations including projections of inflation, exchange rates, time value of money and taxes not used as much today as they were in the past?
  - a. Very difficult to get agreement on future economic environment
  - b. Not required to prioritize projects
  - c. Detailed financial information is too proprietary to share widely
  - d. Oil and gas prices are changing too quickly
  - e. All of the above
- 6. What factors are caused global natural gas prices to diverge in the last 3-4 years?
  - a. Development of shale gas resources in North America
  - b. Shutdown of nuclear reactors in Japan
  - c. Lack of gas pipelines and LNG terminals on the west coast of North America
  - d. Economic downturn
  - e. All of the above
- 7. Oil and gas facilities are more likely to experience major losses at what time in their lives?
  - a. After they have been abandoned
  - b. During some maintenance activity
  - c. During normal operations
  - d. At start-up
  - e. b) and d) above
- 8. What are the two main GHG emissions from upstream oil and gas operations?
  - a. Sulphur dioxide and methane
  - b. Nitrogen and carbon dioxide
  - c. Carbon dioxide and methane
  - d. Hydrogen sulphide and ethane
  - e. None of the above

#### Page 6 of 9

- 9. What term below means the same as "Associated Gas"?
  - a. Free gas found in a gas hydrate deposit
  - b. Gas that is dissolved in oil
  - c. Gas that is adsorbed onto coal or shale
  - d. Gas that is contained in a gas cap
  - e. None of the above
- 10. Which of the following is not a capital cost category for oil and gas production?
  - a. Lease facility costs
  - b. Land acquisition costs
  - c. Central gas plant processing fees
  - d. Drilling and completion costs
  - e. Flowline and gathering system costs

# (5 marks) Page 7 of 9

Complete the Future Value Table below to determine the minimum sales price for the asset to realize the desired Hurdle Rate at the time it is to be sold in the next 10 years. (5% - .5% for each correct column; 3% for correct answer)

Problem	Statement		A STATE OF THE STA	THE PERSON OF TH	1		
AMERICAN PROPERTY OF THE PARTY	Company buys a s	hale gas property for	·\$25,000,000				
	In years 3, 6 and 9 to	they undertake drillin	g projects each cost \$	5,000,000 of additional i	nvestme	nt in those year	<b>'S</b>
	Desired Hurdle Rat	te for Sale after 10 ye	ars is 15% (Ignoring in	flation and taxes)			
	What is the value th	ne property must hav	e to achieve the hurdle	e rate?			
CARLES AND AND AND ASSESSMENT OF THE PARTY O							
\\	In the state of the Co	Cumulative Investment (k\$)	Cumulative Expected Value (k\$)	Value added for end of Year @ 15% (k\$)			
Year	Investment (k\$)	investment (k\$)	Value (K\$)	1ear (ω 1570 (κψ)			
							4.4
1							
							0000
2							
							*****
3				<u> </u>			
							a de la companya de l
4							
_							- A
5				<del> </del>			
							Contract on Contract of Contract on Contra
6							
					1		
7							and a second and a
<u>'</u>							-
8						to the state of th	
							25.00
9							
<del></del>							900 mm m m
					1		de la companya de la
10	<u> </u>				<b>-</b>		
		IIIII.a. D.a.k.a.		الم			
Minii	mum to meet	Hurdie Kate	\$ -	k\$	_		
					100		***
		The second secon	THE RESERVE OF THE PERSON NAMED IN COLUMN TWO IS NOT THE PERSON NAMED IN COLUMN TO THE PERSON NA				
							***
Column				THE PARTY OF THE P			
1	Year of investment a	t start of year> some	times shown as time zero	O			
2	Annual investment at	t start of each year		and the second states and the second states are second states and the second states are second states and the second states are second sta			
3	Cumulative Investme	ent = total af inputs with	out interest	f previous year + return ea	med at ter	d of previous ve	. ! ar
4	Expected value at th	e start of each year = E	xpected Value at start of	rate/100	meu al lei	a of provious ye	
5	Return at end of curr	ent year = Cumulative i	Expected Value * Hurdle				
	The state of the s	The state of the s	THE RESIDENCE OF THE PROPERTY	The second secon			

Complete the Cash Flow Table below (20% - 1 mark for each correct column, 3 marks for hurdele rate yes or no) See description of columns on last page  Cash Flow for Oil  Cigaroning Taxes and Inflation)  Problem Statement  Problem Statement  Flow of the column of the c				•	, , ,		•		-	<	_	-
Cash Flow for Oil (grounding Taxes and Inflation)  Problem Statement (Robel of Cash Flow for Oil (and the Cash Flow for Oil (grounding Taxes and Inflation))  Problem Statement (Robel of Cash Flow for Oil (fracture and tie-in = \$6,000 000)  Norking Interest = 75% (and till fracture and tie-in = \$6,000 000)  Shale oil well cost to drill, fracture and tie-in = \$6,000 000  Norking Interest = 75% (and till fracture and tie-in = \$6,000 000)  Norking Interest = 75% (and till fracture and tie-in = \$6,000 000)  Norking Interest = 75% (and till fracture and tie-in = \$6,000 000)  Norking Interest = 75% (and till fracture and tie-in = \$6,000 000)  Norking Interest = 75% (and till fracture and tie-in = \$6,000 000)  Norking Interest = 75% (and till fracture and tie-in = \$6,000 000)  Norking Interest = 75% (and till fracture and tie-in = \$6,000 000)  Norking Interest = 10% (and till fracture and tie-in = \$6,000 000)  Norking Interest = 10% (and till fracture and tie-in = \$6,000 000)  Norking Interest = 10% (and till fracture and tie-in = \$6,000 000)  Norking Interest = 10% (and till fracture and tie-in = \$6,000 000)  Norking Interest = 10% (and till fracture and tie-in = \$6,000 000)  Norking Interest = 10% (and till fracture and tie-in = \$6,000 000)  Norking Interest = 10% (and till fracture and tie-in = \$6,000 000)  Norking Interest = 10% (and till fracture and tie-in = \$6,000 000)  Norking Interest   Production   Norking   No	Complete the	Cash Flov	v Table	below	. (20% -	1 mark	for eac	sh corre	sct colu	mn, 3 n	narks to	or payout, 3
g Taxes and Inflation)  nt:  well cost to drill, fracture and tie-in = \$6,000,000  Interest = 75%  roduction = Average 500 barrels of oil per day (BOPD) in y rate = 10%  = \$30 in year one increasing by \$10/yr  tate = 10%  cash flows for this investment for the WI owner for in the investment meet the Hurdle Rate with these assurist the investment meet the Hurdle Rate with these assurist the investment meet the Hurdle Rate with these assurist the investment on investment for the initial capital investing the approximate payout?  s a	ROI, 3 marks fo	or hurdle r	ate yes	or no)	See de	scriptic	on of co	sumnic	on las	t page		
Faxes and Inflation)  Self cost to drill, fracture and tie-in = \$6,000,000  Ferest = 75%  Huction = Average 500 barrels of oil per day (BOPD) in y  Self 10%  Salf in year one increasing by \$10/yr  Sign in year one increasing by \$10/yr  Sign of Capital in year 1, increasing by 10% per yr  Self 10%  Self 10	Cash Flo	w for Oil						-				
terest = 75%  luction = Average 500 barrels of oil per day (BOPD) in y  = 10%  \$30 in year one increasing by \$10/yr  \$830 in year one increasing by \$10/yr  \$840 of Capital in year 1, increasing by 10% per yr  \$850 in year one increasing by \$10/yr  \$950 in year one increasing by \$10/yr  \$100	tor uniterioral Alle independent of the control of	(Ignoring Ta	xes and In	flation)								The state of the s
Working Interest = 75%   Notice   State   St	Problem	Statement:										
Working Interest = 75%	3	Shale oil well	cost to drill	, fracture a	ind tie-in = 9	36,000,000	(	Control of the Contro		And the state of t	Catalogue and the purpose of the property of the state of	
Gross Piroduction = Average 500 barrels of oil per day (BOPD) in year 1 declining by 30%/yr  Royalty year = 10%  OPEX = 15% of Capital in year 1, increasing by 10%  OPEX = 15% of Capital in year 1, increasing by 10%  OPEX = 15% of Capital in year 1, increasing by 10% per yr  Hurdle Rate = 10%  1. Show cash flows for this investment for the Will owner for initial a years  2. Does the investment meet the Hurdle Rate with these assumptions? Yes or No  3. What is the return on investment for the initial capital investment?  4. What is the return on investment for the initial capital investment?  2. Does the investment meet the Hurdle Rate with these assumptions? Yes or No  3. What is the return on investment for the initial capital investment?  4. What is the return on investment for the initial capital investment?  5. What is the return on investment for the initial capital investment?  4. What is the return on investment for the initial capital investment for fature revenue for the formation per fature reven	Anna paralementa de la mandande de la mandande como paralementa de la mandande como paralement	Working Inter	est = 75%		***************************************	-						
Royalty rate = 10%  Off Pice = 530 in year or increasing by \$10/yr  Off Pice = 530 in year or increasing by \$10/yr  Hurdle Rate = 10%  1. Show cash flows for this investment for the Wild womer for initial 4 years  2. Does the investment meet the Hurdle Rate with these assumptions 7 yes or No  3. What is the return on investment for the initial capital investment?  4. What is the approximate payout?  5. Manual Gross interest interes		Gross Produc	tion = Ave	rage 500 b	arrels of oil	l per day (E	30PD) in ya	ear 1 declir	ning by $30^\circ$	%/yr		STATE AND ADDRESS.
Yes or No  9 10 11 12 Operating Net Cumulative Hurdle Rate Expenses Production Net Income NP © 10% OPEX (k\$) Income (k\$) (k\$) (k\$)	AND	Royalty rate =	10%					NB Show	all values	to the nea	arest k\$ (t	housand dollar
FS         FS           Yes or No         11         12           9         10         11         12           Operating Expenses         Net Droduction Net Income NPV © 10% (K\$)         Net Droduction NPT (K\$)         Net Droduction NPT (K\$)	THE PERSON NAMED IN COLUMN TWO IS NOT THE PERSON NAMED IN COLUMN TO PE	Oil Price = \$3	0 in year o	ne increas	ing by \$10/	5						
S	THE REAL PROPERTY OF THE PROPE	OPEX = 15%	of Capital	in year 1, i	ncreasing b	y 10% per	.yr	A STATE OF THE STA				
Frest or No         11         12           9         10         11         12           Operating Expenses Production Net Income (k\$) Income (k\$) Income (k\$) (k\$)         (k\$)         (k\$)	THE THE PARTY OF T	Hurdle Rate =	: 10%									
9         10         11         12           Operating Expenses Production Net Income (K\$)         (K\$)         (K\$)           OPEX (K\$) Income (K\$)         (K\$)         (K\$)	THE PARTY OF THE P	1. Show cas		r this inve	stment for	the WI ow	vner for in	itial 4 yea	ည			
9 10 11 12 Operating Net Cumulative Hurdle Rate Expenses Production Net Income (K\$) (K\$) (K\$)	THE PROPERTY OF THE PROPERTY O	2. Does the i	nvestmen	t meet the	Hurdle Ra	ate with th	ese assur	nptions? `	Yes or No		The state of the s	commence of the production of the commence of
9 10 11 12 Operating Net Cumulative Hurdle Rate Expenses Production Net Income (K\$) (K\$) (K\$)	As the production of the content spring for the service.	3. What is th	e return o	n investm	ent for the	initial car	oital inves	tment?				
9 10 11 12 Operating Net Cumulative Hurdle Rate Expenses Production Net Income (K\$) (K\$) (K\$) OPEX (K\$) Income (K\$) (K\$) (K\$)	HARMATA AND AND AND AND AND AND AND AND AND AN	4. What is th	e approxir	nate payc	out?							
Operating Net Cumulative Hurdle Rate Expenses Production Net Income (K\$) (K\$) (K\$) (K\$)												
Operating Net Cumulative Hurdle Rate Expenses Production Net Income (NE) (KS) OPEX (KS) Income (KS) (KS) (KS) (KS)	1	2	3	4	5	9	7	8	9	10	11	12
OPEX(K\$) Income (K\$) (K\$)			Working	Royalty	Net		acit; por	stad letine	Operating	Net	Cumulative Net Income	
1   2   2   2   2   2   2   2   2   2	Year	Annual Gross Production (bbls)	Interest Share (bbls)	(bbls)	(bbls)	(\$/bbl)	Revenue (k\$)	CAPEX (k\$)	OPEX (k\$)	Income (k\$)	(k\$)	(k\$)
2   4	1											
Totals   Economic Indicators   Payout   Return on hivestment (ROI) = (cum income)/(total investment)   ROI =												
Totals   Feature   Formation   Totals   Feature   Feat	7											
Totals   Economic Indicators   Payout   Years   Return on Investment (ROI) = (cum income)/(total investment)   ROI =   Colums 12-1, P=F*(1/(1+i) <sup>(n-1)</sup> ) = Discounted value of future revenue F, at a discount rate of I, after n periods   Hurdle Rate Condition Met when   (12) > (8)   Yes or No	3				-							
Economic Indicators Payout Return on hivestiment (ROI) = (cum income)/(total investment) Return on hivestiment (ROI) = (cum income)/(total investment) Colums 12-14 P=F*(1/(1+i) <sup>(n-1)</sup> = Discounted value of future revenue F, at a discount rate of 1, after n periods Hurdle Rate Condition Met when (12) > (8) Substitute	4											
Economic Indicators    Payout   Years   Payout	Totals											
Payout   Return on Investment (ROI) = (cum income)/(total investment)   ROI =	Economic	: Indicators										
Return on hwestment (ROI) = (cum income)/(total investment)  Colums 12-1, P=F*(1/(1+i) <sup>(n-1)</sup> ) = Discounted value of future revenue F, at a discount rate of I, after n periods  Hurdle Rate Condition Met when (12) > (8)  Is the Hurdle Rate Met for this investment?  Yes or No		Payout			And the state of t		Years		action and is a section of the secti	A Parameter of the American State of the Control of		
Solums 12-14 P=F*(1/(1+i) <sup>(n-1)</sup> ) = Discounted value of future revenue F, at a discount rate of I, after n periods  Hurdle Rate Condition Met when (12) > (8)  Is the Hurdle Rate Met for this investment?		Return on Invest	ment (ROI) =	(cum income	)/(total investr	ment)	ROI=					
Hurdle Rate Condition Met when (12) > (8)  Is the Hurdle Rate Met for this investment?  Yes or No		.1, P=F*(1//1+i) <sup>(n-1)</sup>	= Discount	od value of fu	fure revenue F	at a discou	untrate of Laf	ter n periods				
this investment?		Cote a olbania	Andition Mov	nody.	(42) > (8)							- Commission of the Commission
this investment?	ANTHONORISM ANTHONORISM CO.	Huldie Nate O										
The state of the s		s the Hurdle Ra		investment	~		Yes or No					

Explanatior	Explanation of Columns for the Conventional Oil Spreadsheet	adsheet Page 9 of 9
Columns:		
2	Annual Gross Production = Production measured at the wellhead	the wellhead
3	Working Interest Share = Producers share of operati	Working Interest Share = Producers share of operating interest in the well production = $(2)*(Working Interest)$
4	Royalty Interest = Production that is paid to the owner of the mineral rights = (3)*Royalty Rate	ner of the mineral rights = (3)*Royalty Rate
5	Net Production = Producers share of the production	of the production from the well = $(3) - (4)$
9	Oil Price = Price of oil expected in a forecast or actual average received over the year	ial average received over the year
7	Production Revenue = Revenue from oil sales = (5) * (6)	(9) *
8	Capital Costs = Producers share of capital expenditures in the year = Total capital * WI	ures in the year = Total capital * WI
6	Operating Expenses = Producers share of operating costs in the Year = Total operating * WI	; costs in the Year = Total operating * WI
10	Net Production Revenue = Net revenue received by the producer = (7) - (8) - (9)	y the producer = $(7) - (8) - (9)$
Ţ	Cumulative Net Revenue = Running balance of revenues vs. Investment	enues vs. Investment
12	Net Present Value $P=F^*(1/(1+i)^{(n-1)}) = Dis$	P=F $^*(1/(1+i)^{(n-1)})$ = Discounted value of future revenue F, at a discount rate of 1, after n periods
And Andrew Statement of the Control of Contr		