Comments on Grading

1. At least 25 questions should be answered.
    a. Maximum 4 points/question | Minimum 0 points/question.
    b. A subset of answered questions will be used to assess the final grade.
    c. Answering more than 25 questions cannot hurt your grade.
2. Each question always has 4 correct choices. A correct choice means that the choice is selected correctly, i.e.
    a. For each question you give your selection of all choices from the complete set (a b c d) that you believe answer the question. Every question has at least one answer from the four choices.
    b. The choices you give that are believed to answer a question also implicitly give the selection of choices that you believe do *not* answer the question.
3. A correct choice for a question gives +1 point.
4. An incorrect choice gives 0 points.
5. Examples:

Question X. What defines a reservoir flow unit (RFU)? b

a. Connate water.	b. Flow barriers.
c. Porosity.	d. Compressibility.

Correct Answer: [b]

Your Answer: [b]	Points = +4(a b c d) = +4
Your Answer: [b c]	Points = +3(a b d) = +3 : choice (c) was wrong
Your Answer: [c]	Points = +2(a d) = +2 : choices (b c) were wrong
Your Answer: [a b c d]	Points = +1(b) = +1 : choices (a c d) were wrong
Your Answer: [a c d]	Points = 0 : all choices (a b c d) were wrong

Question X. Which are not conventional reservoirs? **a b c d**

a. Heavy oil.	b. Shale gas.
c. Naturally fractured.	d. Shale oil.

Correct Answer: [a b c d]

Your Answer [a b c d]	Points = +4(a b c d) = +4
Your Answer [a c d]	Points = +3(a c d) = +3 : choice (b) was wrong
Your Answer [a d]	Points = +2(a d) = +2 : choices (b c) were wrong
Your Answer [a]	Points = +1(a) = +1 : choices (b c d) were wrong

Question 1. What defines a reservoir flow unit (RFU)? _____

a. Connate water.	b. Flow barriers.
c. Porosity.	d. Compressibility.

Question 2. What are the typical characteristics defining a RFU? _____

a. Very-low permeability layers.	b. High permeability layers.
c. High porosity layers.	d. Faults.

Question 3. What are the types of wells used to produce oil and gas? _____

a. Horizontal.	b. Multi-fractured horizontal.
c. Vertical.	d. Multi-lateral.

Question 4. What are the most common types of enhanced oil recovery (EOR)? _____

a. Low-salinity water.	b. Sea water.
c. Oxygen.	d. Hydrocarbon gas.

Question 5. What are the two categories of Improved Oil Recovery (IOR)? _____

a. Enhanced Oil Recovery (EOR).	b. Depletion.
c. Polymer injection.	d. Advanced well completion.

Question 6. What are the key characteristics defining a reservoir? _____

a. Flow barriers.	b. Water density.
c. Spatial permeability variation.	d. Water salinity.

Question 7. What are the main mechanisms of EOR? _____

a. Financial gain.	b. Areal sweep.
c. Vertical sweep.	d. Pore-level sweep (saturation change).

Question 8. What are the main reservoir fluid phases? _____

a. Gas.	b. Stock-tank oil.
c. Oil.	d. Brine.

Question 9. Can you have water below the free water contact? _____

a. Never.	b. Sometimes if Paleo oil exists.
c. Always.	d. Never if Paleo oil exists.

Question 10. What is the water saturation at the free water contact (FWC)? _____

a. 100%.	b. Connate water.
c. Defined by $P_{cow}(S_{w@FWC})=0$.	d. 100 – residual oil saturation.

Question 11. Is the free-water contact equal to the hydrocarbon-water contact (HWC)? _____

a. Never.	b. FWC slightly deeper than HWC.
c. Only if Paleo oil exists.	d. Always.

Question 12. What defines an aquifer in a petroleum reservoir? _____

a. A reservoir with high water saturation, connected hydro-dynamically to a hydrocarbon reservoir.	b. Water below the FWC.
c. Contains connate water.	d. Water above the FWC.

Question 13. What are transition zone characteristics? _____

a. Non-zero k_{rw} and k_{ro}.	b. Zero k_{rw} and k_{ro}.
c. $k_{rw} < k_{ro}$.	d. $k_{rw} > k_{ro}$.

Question 14. What determines pressure vs depth in a reservoir? _____

a. Reservoir saturations.	b. Capillary pressure curves.
c. Reservoir phase densities.	d. Relative permeability.

Question 15. Does gas pressure = oil pressure for a *saturated* gas-oil contact? _____

a. Always.	b. Usually.
c. Never.	d. Seldom.

Question 16. Which are <u>not</u> conventional reservoirs? _____

a. Heavy oil.	b. Shale gas.
c. Naturally fractured.	d. Shale oil.

Question 17. Which <u>are</u> conventional reservoirs? _____

a. Coal bed methane.	b. Eagle Ford shale.
c. Ormen Lange.	d. Troll field.

Question 18. What are characteristics of a heavy oil reservoir? _____

a. Low API gravity.	b. High oil viscosity.
c. High permeability.	d. Natural fractures.

Question 19. What are always important characteristics of depletion performance? _____

a. PVT properties.	b. Initial solution gas-oil ratio.
c. Relative permeability.	d. Initial reservoir pressure.

Question 20. What are always important to depletion material balance $p_R(Q_p)$? _____

a. Aquifer size.	b. Relative permeability.
c. Permeability.	d. Hydrocarbon pore volume.

Question 21. What are "Pot" aquifer characteristics? _____

a. Aquifer ≈ Reservoir pressure all times	b. Aquifer >> Reservoir pressure
c. Aquifer << Reservoir pressure	d. High permeability & small aquifer

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Question 22. What is <u>not</u> important to Pot aquifer water influx? _____

a. Compressibilities.	b. Initial pressure.
c. Aquifer size.	d. Dimensionless time.

Question 23. What depletion characteristics result in exponential rate decline? _____

a. Straight line material balance.	b. Vogel rate equation.
c. Pressure-squared rate equation.	d. Straight-line rate equation.

Question 24. Darcy velocity is different than pore velocity due to? _____

a. Porosity.	b. Permeability.
c. Saturations.	d. Capillarity.

Question 25. Mobility ratio is usually given by the ratio of which two mobilities? _____

a. Displaced over displacing.	b. Displacing over displaced.
c. Connate water over displaced.	d. Residual oil over connate water.

Question 26. Water is fractional flow (f_w) for water-oil system (v=Darcy velocity)? _____

a. $f_w = v_w / (v_w + v_o)$	b. $f_w = (v_w + v_o) / v_w$
c. $f_w = v_w / v_o - 1$	d. $f_w = v_o / (v_w + v_o)$

Question 27. Buckley-Leverett displacement results in? _____

a. Shock saturation front.	b. Leaky piston displacement.
c. Piston displacement.	d. Residual oil at & after breakthrough.

Question 28. For a two-layer no-crossflow water injection two-well system with k_1=200 md, k_2=100 md, ϕ_1=0.2, ϕ_2=0.1, and $h_1=h_2$, water breakthrough occurs where/when? _____

a. In layer 1 first.	b. In layer 2 first.
c. At same time in both layers.	d. At different times in the two layers.

Question 29. After 50% recovery in a high-pressure gas reservoir where pot aquifer model is valid, what is average reservoir pressure compared with the same reservoir without aquifer? _____

a. p_R (Pot) < p_R(no aquifer)	b. p_R (Pot) > p_R(no aquifer)
c. p_R (Pot) = p_R(no aquifer)	d. p_R (Pot) << p_R(no aquifer)

Question 30. For a pot aquifer "water volume parameter" M>0? _____

a. $c_e > c_w+c_f$	b. $c_e < c_w+c_f$
c. $c_e = c_w+c_f$	d. c_e increases with decreasing p_R.

Question 31. Extrapolated p_R/Z vs G_p data for gas reservoir with pot aquifer (G=IGIP)? _____

a. Extrapolated G > Actual G.	b. Extrapolated G < Actual G.
c. Extrapolated G = Actual G.	d. Extrapolated G shouldn't be used.

Question 32. What is <u>not</u> a method to model reservoir recovery? _____

a. Material balance.	b. OLGA transient pipeline simulator.
c. Numerical reservoir simulation.	d. Decline curve analysis.

Question 33. Decline curve analysis in boundary dominated flow implicitly "uses"? _____

a. Material balance equation.	b. Archies saturation equation.
c. Pseudosteady-state rate equation.	d. Finite-difference methods.

Question 34. Who combined boundary-dominated and infinite-acting q(t) behavior? _____

a. Muskat.	b. Whitson.
c. Fetkovich.	d. Kleppe.

Question 35. Key quantities in J of the pseudosteady-state rate equation $q=J(p_R-p_{wf})$? _____

a. Porosity.	b. Relative permeability.
c. Permeability-thickness product.	d. Initial reservoir pressure.

Question 36. Key quantities in J' of the pseudosteady-state rate equation $q=J'(p_R^2-p_{wf}^2)$? _____

a. Porosity.	b. p_x.
c. Skin factor.	d. Permeability-thickness product.

Question 37. Fundamental laws used to derive the straight-line gas material balance? _____

a. van der Waal equation of state.	b. Ideal gas law.
c. Real gas law.	d. Darcy's law.

Question 38. The pseudosteady-state rate equation $q=J(p_R-p_{wf})+J'(p_R^2-p_{wf}^2)$ is used for? _____

a. High pressure gas reservoirs.	b. Undersaturated oil reservoirs.
c. Gas coning wells.	d. Gas & water coning wells.

Question 39. $p_R=f(Q_p)$ represents a general equation for? _____

a. Multi-phase flow.	b. A single RFU.
c. Depletion material balance.	d. Inflow performance relation.

Question 40. Producing gas-oil ratio vs time for solution gas drive (SGD) reservoirs? _____

a. Intially increases, flattens, decreases.	b. Initially constant, may decrease slightly, increases, decreases.
c. Initially decreases, flattens, decreases, increases.	d. Changes as a function of $k_{rg}/k_{ro}(S_o)$.

Question 41. Oil mobility at average reservoir pressure for depletion in SGD reservoir? _____

a. Remains constant.	b. ≈Constant then monotonically decreases.
c. Monotonically increases.	d. Initially increases then decreases.

Question 42. Average reservoir pressure during depletion in SGD reservoir? _____

a. Remains constant.	b. Monotonically increases.
c. Monotonically decreases.	d. May change non-monotonically.

Question 43. Borthne-Walsh general SGD material balance is a function of? _____

a. Steady-state flow everywhere.	b. $k_{rg}/k_{ro}(S_o)$.
c. PVT (B_g, B_o, R_s, r_s, μ_g, μ_o).	d. Skin factor.

Question 44. Multi-phase steady-state flow assumptions? _____

a. Constant flowing surface GOR everywhere.	b. Constant flowing composition everywhere.
c. Relative permeabilities k_{rg} & k_{ro} function of k_{rg}/k_{ro} and not saturation.	d. k_{rg}/k_{ro} function of pressure-dependent PVT and producing GOR.

Question 45. Multi-phase steady-state flow assumptions for gas condensates? _____

a. Constant flowing surface GOR everywhere.	b. Constant flowing surface GOR <u>limited</u> from wellbore outwards.
c. Constant flowing composition everywhere.	d. Constant flowing composition <u>limited</u> from wellbore outwards.

Question 46. Rate-time forecasting related to? _____

a. Combining material balance and rate equations.	b. Decline curve analysis.
c. Transient pipeline flow models.	d. Rate of drilling.

Question 47. Rate-time forecasting quantification? _____

a. More historical data more certainty.	b. Totally uncertain.
c. Numerical reservoir simulation used.	d. Using a ruler on linear grid paper.

Question 48. Field rate-time forecasting dependent on? _____

a. Sum of individual well q(t) behavior.	b. Daily contract quota (DCQ) and plateau period for large gas fields.
c. Pressure drops throughout the flow system.	d. Time variation in number of wells producing.

Question 49. Layered no-crossflow well and field depletion behavior? _____

a. Differential depletion may result.	b. Shut-in pressure may drop rapidly when plotted vs cumulative production
c. Long producing lives.	d. Easy to assess upon discovery.

Question 50. Layered no-crossflow well and field depletion behavior? _____

a. Early shut-in pressures extrapolated to most-depleted reservoir initial fluid in place (IFIP).	b. Early shut-in pressures extrapolated to least-depleted reservoir initial fluid in place (IFIP).
c. Should be mapped initially by possible flow barriers.	d. Can often safely be ignored; may provide a “low” reserve estimate.

Question 51. Layered no-crossflow well and field depletion behavior? _____

a. Contains 1 RFU (reservoir flow unit).	b. Contain multiple RFUs.
c. Each RFU $p_R(Q_p)$ behaves independently.	d. Single wells produce from multiple RFUs.

Question 52. Water Influx? _____

a. Increases hydrocarbon pore volume (HCPV) during depletion.	b. Decreases hydrocarbon pore volume (HCPV) during depletion.
c. Usually kills gas wells when water starts producing without artificial lift.	d. May kill oil wells when water starts producing because of artificial lift.

Question 53. Water influx impact on estimated ultimate recovery (EUR)? _____

a. Gas EUR can be reduced.	b. Oil EUR seldom increases.
c. Gas EUR usually increases.	d. Oil EUR usually increases.

Question 54. Water influx model types? _____

a. Pot aquifer yields maximum influx.	b. Pot aquifer yields minimum influx.
c. Transient aquifer models never yield more influx than pot aquifer model.	d. Transient aquifer models always yield more influx than pot aquifer model.

Question 55. Parameters affecting rate decline curve performance? _____

a. Archie exponent.	b. Tubing diameter.
c. Permeability-thickness product.	d. Initial fluid in place and recovery.

Question 56. Decline curve analysis parameter b? _____

a. b=0 : exponential decline.	b. b=1: exponential decline.
c. 0≤b≤1: Arps range.	d. 0≤b≤0.5: Fetkovich range single RFU.

Question 57. Decline curve analysis parameter D? _____

a. Quantifies rate of depletion.	b. Proportional to ratio of initial decline rate to theoretical ultimate reserve.
c. Includes “b” term in definition.	d. Expressed as %-decline/year for exponential.

Question 58. Decline curve analysis parameter q_i? _____

a. Initial rate at end of decline.	b. Initial maximum rate potential.
c. Rate at start of decline.	d. Function of kh product and skin.

Question 59. Decline curve analysis plotted on semi-log of rate vs time (log q vs t)? _____

a. Exponential b=0: curved.	b. Exponential: b=0: straight line.
c. b=0.5: curved concave down (crosses the b=0 line).	d. b=0.5: curved concave up (doesn’t cross the b=0 line).

Question 60. Generalized Fetkovich decline type curves? _____

a. Combines linear and radial flow periods.	b. Combines infinite acting and boundary dominated flow periods.
c. Introduces new dimensionless rate and time quantities.	d. Uses standard dimensionless rate and time quantities.

Question 61. Generalized Fetkovich decline type curves? _____

a. Can be used with superposition.	b. Can be used with pressure-rate normalization if $p_{wf}(t)$ is smooth.
c. Assumes $p_{wf}(t)$=constant.	d. Should never be used.

Question 62. Generalized Fetkovich decline type curves? _____

a. Simplifies to radial infinite-acting flow.	b. Simplifies to linear infinite-acting flow.
c. Simplifies to Arps equations.	d. Treats harmonic rate decline.

Question 63. Generalized Fetkovich decline type curves? _____

a. Used for single wells.	b. Used for fields / groups of wells.
c. Commonly used in shale wells.	d. Replaces reservoir simulation.

Question 64. Residual oil saturation range? _____

a. from 0.05 – 0.35.	b. from 0.25 – 0.5.
c. from 0.5 – 0.85	d. from 0.5 – 1.

Question 65. Residual oil saturation S_{or} for "gas" (S_{org}) vs "water" (S_{orw}) displacement? _____

a. Usually (S_{org}) < (S_{orw})	b. Usually (S_{org}) > (S_{orw})
c. Usually (S_{org}) = (S_{orw})	d. Depends on rock-fluid interactions.

Question 66. Residual oil saturation dependence on capillary number ($N_c=v_p/\sigma$)? _____

a. S_{or} decreases with decreasing N_c.	b. S_{or} decreases with increasing N_c.
c. $S_{or} \rightarrow 0$ as $N_c \rightarrow \infty$.	d. $S_{or} \rightarrow 0$ as $N_c \rightarrow 0$.

Question 67. Buckley-Leverett water saturations in water displacing oil? _____

a. $S_{wi} > S_{wf} > (1-S_{orw})$	b. $S_{wi} < S_{wf} < (1-S_{orw})$
c. $S_{wi} < S_{wf} = (1-S_{orw})$	d. $S_{wi} < S_{wf} > (1-S_{orw})$

Question 68. Saturation definitions (piston | leaky piston) in water displacing oil? _____

a. Leaky-Piston: $S_{wf} = (1-S_{orw})$.	b. Leaky-Piston: $S_{wf} = 1$
c. Piston: $S_{wf} = 1$	d. Piston: $S_{orw} = 0$

Question 69. Buckley-Leverett 1D vertical flow, injection from below? _____

a. Leaky-Piston displacement expected.	b. Better pore level sweep than horizontal 1D flow.
c. Worse pore level sweep than horizontal 1D flow.	d. Same pore level sweep than horizontal 1D flow.

Question 70. Buckley-Leverett displacement? _____

a. Used for gas injection.	b. Used for water injection.
c. Considered in miscible gas injection.	d. Wrong.

Question 71. Buckley-Leverett displacement used in which layered models? _____

a. Used in Muskat 1950 paper.	b. Used by Dystra-Parsons in 1948.
c. Used by Stiles method in 1949.	d. Used by Snyder & Ramey in 1967.

Question 72. Buckley-Leverett displacement theoretical foundation? _____

a. Mathematically proven by BL.	b. Muskat questioned theoretical foundation for BL theory.
c. Can be proven mathematically by method of characteristics.	d. Not yet proven mathematically.

Question 73. Layer permeability variation models? _____

a. Laws proposed log-normal permeability distribution model.	b. Muskat used linear, exponential, and log-normal models.
c. Dystra-Parson and Standing et al. use log-normal model.	d. Laws log-normal model proven wrong by Muskat.

Question 74. Layer permeability variation models? _____

a. "Dystra-Parson" (Laws) parameter V related to standard deviation.	b. $V \rightarrow 0$: small permeability variation.
c. $0.3<V<0.7$: expected permeability variation.	d. $V \rightarrow 1$: large permeability variation.

Question 75. Layer permeability variation models vs single-layer homogeneous model? _____

a. More permeability variation, lower recovery after 1 PV injected.	b. More permeability variation, higher recovery after 1 PV injected.
c. Permeability variation has no effect on recovery after 1 PV injected.	d. Permeability variation impacts recovery only >1 PV injected.

Question 76. Voidage Replacement? _____

a. Method of balancing injection and production volumes to increase reservoir pressure.	b. Method of balancing injection and production volumes to decrease reservoir pressure.
c. Method of balancing injection and production volumes to maintain reservoir pressure ≈ constant.	d. Method of balancing injection and production volumes to save money.

Question 77. Developed miscible gas injection EOR? _____

a. Miscible gas injection results in constant residual oil saturation ≈0.1	b. Miscible gas injection results in very low residual oil saturation (≈0).
c. Miscible gas injection always develops at p>5000 psia.	d. Miscible gas injection always develops when injecting CO_2.

Question 78. Developed miscible gas injection EOR? _____

a. Vaporization is often important.	b. Condensation is often important.
c. Condensation and vaporization combined are often both important.	d. First contact miscibility is common.

Question 79. Purely Immiscible gas injection EOR? _____

a. Little or no vaporization.	b. Substantial vaporization.
c. Gravity can be important.	d. Buckley-Leverett flow dominates.

Question 80. Developed miscible gas injection EOR? _____

a. Slimtube laboratory test used to determine minimum miscibility pressure (MMP).	b. Slimtube laboratory test determines recovery mechanism: vaporizing or condensing/vaporizing.
c. Gas-Oil mobility ratio important.	d. Gas-oil viscosity ratio important.