UNIVERSITY OF MINES AND TECHNOLOGY, TARKWA

SECOND SEMESTER EXAMINATIONS, MAY 2015

COURSE NO : PE 274
COURSE NAME: **FUNDAMENTALS OF NATURAL GAS ENGINEERING**
CLASS : PE II TIME: **3 HOURS**

Name**:** ____Index Number: _______________

PART I (50 Marks)

SECTION A (0.5 Mark Each)
Answer ALL questions in this section. Circle the most appropriate answer.

1. Pipelines can be divided into different categories, including the following except?
   (a) Export pipelines (b) carbon coated pipelines (c) Flowlines from satellite wells (d) Infield flowlines (e) none of the above
2. Natural gas can be stored in the following except
   (a) Depleted fields (b) Aquifers (c) LNG Cryogenic tankers (d) Salt caverns (e) None of the above
3. What chemical gives gas fuel in homes or industry distinctive odour for easy evidence in case of leakages (a) odourant (b) toluene (c) xylene (d) mercaptan (e) benzene
4. Which equipment provide the energy required for transportation of natural gas through pipelines (a) pumps (b) pressure gauges (c) compressors (d) A and C (e) all of the above
5. The modern trend coating technique of transmission pipelines includes the following except
   (a) coal tar enamel (b) Fusion Bond Epoxy (c) cathodic protection (d) thermoset polymer coatings (e) none of the above
6. Pipeline construction procedure includes the following except
   (a) The pipe is assembled and contoured (b) Trenches are dug alongside the laid out pipe
   (c) hydrostatic testing (d) Pigging (e) Stringing the pipe
7. The two (2) distinct types of compressors include
   (a) Reciprocating and Rotary compressors (b) Reciprocating and Turbine compressors (c)Rotary and Turbine compressors (d) Turbine and Engine powered compressors (e) Rotary and Valve compressors
8. Safety precautions associated with natural gas pipelines include
   (a) Aerial patrols (b) Leak detection (c) Gas sampling (d) A and B (e) all of the above
9. At every stage of the upstream or downstream process, strict safety measures must be maintained to prevent
   (a) Gas over measurement (b) Fires (c) Explosions (d) Ecological disasters (e) B, C and D
10. Tailgate or toolbox meetings should focus on the following except
    (a) Gas sampling analysis (b) Safe work practices (c) Scope of work activities
    (d) Identification of potential safety hazards (e) Review of unsafe acts or near misses

11. The following are types of safety valves available in the Petroleum Industry except
    (a) Surface Safety Valves (SSV's) (b) Subsurface Safety Valves (SSSV's) (c) Semi Surface Safety Valves (SSSV's) (d) Subsurface-Controlled Subsurface Safety Valves (SSCSV's) (e) Surface-Controlled Subsurface Safety Valves (SCSSV's)
12. Gas viscosity is a function of except (a) Pressure (b) Temperature, (c) Fluid density (d) Fluid composition (e) specific gravity
13. The most popular and commonly used correlation(s) for predicting viscosity of petroleum reservoir fluids is (are)

(a) Lohrenz-Bray-Clark (LBC) correlation method (b) Carr-Kobayashi-Burrow (CKB) (c) Nikola Tesla correlations (d) A and B (e) all of the above

14. Which of the following affect the quality of PVT laboratory data?

(a) Poorly trained laboratory technicians, (b) type of fluid used

(c) poor fluid sampling techniques. (d) A and C (e) all of the above

15. Properties of gases such as gas deviation factor, density, compressibility and viscosity are important for the following except?

(a) Calculating gas in place and well flow rates, (b) Simulating the gas volume changes (c) Well abandoning procedure (d) Analyzing reservoir pressure behaviour, and (e) Design of hydrocarbon-handling systems

16. Gas and liquid may be measured using various measurement techniques, including

(a) Orifice meters (b) Positive displacement meters, (c) Critical flow provers (d) A and C (e) all of the above

17. The selection of any gas flow measurement is based on the following except.

(a) Initial cost and cost of operation (b) Availability of parts (c) Range of temperature (d) Origin of manufacturer (e) Maintenance requirement

18. Measuring gas flow rate is necessary for

(a) Gas reserve estimation (b) pressure profiling (c) pipeline and plant applications (d) A and C (e) all of the above

19. The minimum cross sectional area of the jet (orifice meter) is known as.

(a) orifice diameter area (b) restriction zone (c) hour glass area (d) pressure drop zone (e) vena contracta

20. The orifice meter is used most commonly in the gas production and transportation industry because of its (a) Fixed orifice diameter (b) Simplicity (c) Accuracy (d) B and C (e) all of the above

21. The criterion for reaching critical flow velocity is that the ratio between the downstream and upstream…?...must be below a critical ratio.

(a) Pressures (b) velocities (c) flow rates (d) diameters (e) viscosities

22. The flow rate of critical flow provers depend on the following except

(a) Upstream Pressure (b) Downstream Pressure (c) Upstream Temperature (d) Gas Gravity

(e) Orifice Diameter

23. Automatic control systems should have the following except

(a) Loading Element (b) Measuring Element (c) Controlling Element (d) Final Control Valve (e) None of the above

24. There are usually more pressure gauges used in a process plant than any other instrument to monitor and control processes because

(a) Pressure is a good, quick indication of the work done by pumps and compressors.

(b) It gives the best status of operating pressure vessels.

(c) Gives a rapid respond on the effect on boiling, condensation points

(d) Providing rapid responds to changes in values. (e) All of the above

25. Smart pigs can

(a) Test pipe’s thickness and roundness (b) check for sign of corrosion (c) detect minute leaks (d) B and C (e) all of the above

26. In the compressor station, natural gas is compressed by the following except (a) pump (b) turbine (c) motor (d) engine (e) none of the above

27. Pipeline may need to restrict gas flow in certain areas if a section of pipe requires

(a) Replacement (b) maintenance (b) valves to be closed at the ends (d) A and B (e) all of the above

28. Sour gases

(a) Are corrosive (b) have high sulphur content (c) contain high CO_2 concentration (d) B and C (e) all of the above

29. The major types of pipelines along natural gas transportation route include the following except (a) Infield flowlines (b) gathering system (c) interstate pipeline system (d) distribution system (e) intrastate pipeline system

30. Which of the following pipeline system have low pressure and small diameter pipes?
(a) Interstate pipelines system (b) gathering system (c) distribution system (d) B and C (e) All of the above

SECTION B. GIVE BRIEF ASNWERS TO THE FOLLOWING QUESTIONS

31. Natural gas is considered 'dry' if? (2 mks)
32. What is one (1) British thermal unit (Btu)? (2 mks)
33. Differentiate between dry gas and wet gas fluid in terms of the position of surface separator pressure. (2 mks)
34. What is gas formation volume factor Bg? (2 mks)
35. Name three (3) ways in which methane (and natural gas) is believed to be formed. (3 mks)
36. State three (3) factors that are affected by the composition of reservoirs fluids. (3 mks)
37. Name four (4) major factors that determine the composition of reservoir fluids. (3 mks)
38. State four (4) important uses of phase diagram. (4 mks)
39. State the functions of the three (3) basic components of all gas regulators. (6 mks)
40. Give three (3) differences between natural gas produced from 'oil well' and those produced from 'gas well'. (6 mks)

PART II (50 Marks)

Answer ALL questions in this section

Note: All relevant equations, graph(s) and tables are attached.

1. (a) Calculate the gas flow rate through a choke nipple given the following data: d_o = 0.500 in., P_f = 300 psig, T_f = 85 ^oF, γ_g = 0.79
(b) What would be the flow rate if the choke nipple is replaced with critical flow prover with?
(i) 2 in. pipe (ii) 4 in. pipe
(c) To attain maximum flow rate which of these devices should be considered and why? **(15 marks)**

2. Calculate the gas flow rate through an orifice meter for the following conditions.
h_w= 60 in. of water.
P_f = 106 psig (**measured downstream**).
T_f = 98 ^oF
P_{sc}=14.0 psia.
T_{sc}= 60^oF.
d = 2.067 in.
do = 0.875 in.
γ_g= 0.76
Taps = Flange type.
Assume z =0.92
Assume $F_m F_l F_a = 1.0$ **(20 marks)**

3. Using Lee et al.'s correlation estimate the gas viscosity at 250 ^oF and 2186 psig for a gas sample having a deviation factor of 0.98 with the following composition.

Component	Mole fraction, (y_i)
CH_4	0.78
C_2H_6	0.21
C_3H_8	0.01

1.00

NB: Take the atomic mass of C, H to be 12 and 1 ***lbm/lb-mole*** respectively **(15 marks)**

Relevant Equations, Tables and Charts:

$$q_{gh} = C' \sqrt{h_w P_f}$$

$$C' = F_b F_{pb} F_{Tb} F_g F_{Tf} F_{pv} F_{\mathrm{Re}} Y F_m F_l F_a$$

F_b = Basic Orifice Factor
F_{pb} = 14.73/Psc (**Pressure Base Factor**),
F_{tb} = Tsc/520 (**Temperature Base Factor**),
F_g = $(1/\gamma g)^{0.5}$ (**Specific Gravity Factor**
F_{Tf} = $(520/T_f)^{0.5}$ (**Flowing Temperature Factor**),.
F_{pv} = $(1/zf)^{0.5}$(**gas Deviation Factor**

$F_{Re} = 1 + b/\left(h_w p_f\right)^{0.5}$

Lee et al's correlation:

$$\mu_g = \left(1*10^{-4}\right)*K*\exp(X\rho^Y)$$

$$\rho = 1.4935*10^{-3}*(PM/zT)$$

$$K = \frac{\left(9.379+0.01607M\right)*T^{1.5}}{\left(209.2+19.26M*T\right)}$$

$$X = 3.448 + \frac{986.4}{T} + 0.01009M$$

$$Y = 2.447 - 0.2224X$$

$$q_{gh} = Cp_f/\sqrt{\gamma_g T_f}$$

Table 1 Flange Taps: Basic Orifice Factors, F_b.

TABLE 3.1—FLANGE TAPS: BASIC ORIFICE FACTORS, F_b (AFTER REF. 3)

d_o	*d* (in.)														
		2				3				4				6	
(in.)	1.689	1.939	2.067	2.300	2.626	2.900	3.068	3.152	3.438	3.826	4.026	4.897	5.189	5.761	6.065
0.250	12.695	12.707	12.711	12.714	12.712	12.708	12.705	12.703	12.697	12.687	12.683	—	—	—	—
0.375	28.474	28.439	28.428	28.411	28.393	28.382	28.376	28.373	28.364	28.353	28.348	—	—	—	—
0.500	50.777	50.587	50.521	50.435	50.356	50.313	50.292	50.284	50.258	50.234	50.224	50.197	50.191	50.182	50.178
0.625	80.090	79.509	79.311	79.052	78.818	78.686	78.625	78.598	78.523	78.450	78.421	78.338	78.321	78.296	78.287
0.750	117.09	115.62	115.14	114.52	113.99	113.70	113.56	113.50	113.33	113.15	113.08	112.87	112.82	112.75	112.72
0.875	162.95	159.56	158.47	157.12	156.00	155.41	155.14	155.03	154.71	154.40	154.27	153.88	153.78	153.63	153.56
1.000	219.77	212.47	210.22	207.44	205.18	204.04	203.54	203.33	202.75	202.20	201.99	201.34	201.19	200.96	200.85
1.125	290.99	276.20	271.70	266.35	262.06	259.95	259.04	258.65	257.63	256.69	256.33	255.31	255.08	254.72	254.56
1.250	385.78	353.58	345.13	335.12	327.39	323.63	322.03	321.37	319.61	318.03	317.45	315.83	315.48	314.95	314.72
1.375	—	448.57	433.50	415.75	402.18	395.80	393.09	391.97	389.03	386.45	385.51	382.99	382.47	381.70	381.37
1.500	—	—	542.26	510.86	487.98	477.36	472.96	471.14	466.39	462.27	460.79	456.93	456.16	455.03	454.57
1.625	—	—	—	623.91	586.82	569.65	562.58	559.72	552.31	545.89	543.61	537.77	536.64	535.03	534.38
1.750	—	—	—	—	701.27	674.44	663.42	658.96	647.54	637.84	634.39	625.73	624.09	621.79	620.88
1.875	—	—	—	—	834.88	793.88	777.18	770.44	753.17	738.75	733.68	721.03	718.69	715.44	714.19
2.000	—	—	—	—	—	930.65	906.01	896.06	870.59	849.41	842.12	823.99	820.68	816.13	814.41
2.125	—	—	—	—	—	1,091.2	1,052.5	1,038.1	1,001.4	970.95	960.48	934.97	930.35	924.07	921.71
2.250	—	—	—	—	—	—	1,223.2	1,499.9	1,147.7	1,104.7	1,089.9	1,054.4	1,048.1	1,039.5	1,036.3
2.375	—	—	—	—	—	—	—	—	1,311.7	1,252.1	1,231.7	1,182.9	1,174.2	1,162.6	1,158.3
2.500	—	—	—	—	—	—	—	—	1,498.4	1,415.0	1,387.2	1,320.9	1,309.3	1,293.8	1,288.2
2.625	—	—	—	—	—	—	—	—	—	1,595.6	1,558.2	1,469.2	1,453.9	1,433.5	1,426.0
2.750	—	—	—	—	—	—	—	—	—	1,797.1	1,746.7	1,628.9	1,608.7	1,582.1	1,572.3
2.875	—	—	—	—	—	—	—	—	—	—	1,955.5	1,801.0	1,774.5	1,740.0	1,727.5
3.000	—	—	—	—	—	—	—	—	—	—	2,194.9	1,986.6	1,952.4	1,907.8	1,891.9
3.125	—	—	—	—	—	—	—	—	—	—	—	2,187.2	2,143.4	2,086.4	2,066.1
3.250	—	—	—	—	—	—	—	—	—	—	—	2,404.2	2,348.8	2,276.5	2,250.8
3.375	—	—	—	—	—	—	—	—	—	—	—	2,639.5	2,569.8	2,479.1	2,446.8
3.500	—	—	—	—	—	—	—	—	—	—	—	2,895.5	2,808.1	2,695.1	2,654.9
3.625	—	—	—	—	—	—	—	—	—	—	—	3,180.8	3,065.3	2,925.7	2,876.0
3.750	—	—	—	—	—	—	—	—	—	—	—	—	3,345.5	3,172.1	3,111.2
3.875	—	—	—	—	—	—	—	—	—	—	—	—	3,657.7	3,435.7	3,361.5
4.000	—	—	—	—	—	—	—	—	—	—	—	—	—	3,718.2	3,628.2
4.250	—	—	—	—	—	—	—	—	—	—	—	—	—	4,354.8	4,216.6
4.500	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4,900.9

Table 2 **Flange Taps: Parameters used for F_{Re}, b**

TABLE 3.3—FLANGE TAPS: PARAMETER USED FOR F_{Re}, *b* (AFTER REF. 3)

d_o	*d* (in.)										
		2				3				4	
(in.)	1.689	1.939	2.067	2.300	2.626	2.900	3.068	3.152	3.438	3.826	4.026
0.250	0.0879	0.0911	0.0926	0.0950	—	0.0820	0.0836	0.0844	—	—	0.0779
0.375	0.0677	0.0709	0.0726	0.0755	0.0792	0.0677	0.0695	0.0703	0.0867	—	0.0670
0.500	0.0562	0.0576	0.0588	0.0612	0.0648	0.0566	0.0583	0.0591	0.0728	0.0763	0.0578
0.625	0.0520	0.0505	0.0506	0.0516	0.0541	0.0486	0.0498	0.0504	0.0618	0.0653	0.0502
0.750	0.0536	0.0485	0.0471	0.0462	0.0470	0.0433	0.0438	0.0442	0.0528	0.0561	0.0442
0.875	0.0595	0.0506	0.0478	0.0445	0.0429	0.0403	0.0402	0.0403	0.0460	0.0487	0.0396
1.000	0.0677	0.0559	0.0515	0.0458	0.0416	0.0396	0.0386	0.0383	0.0411	0.0430	0.0364
1.125	0.0762	0.0630	0.0574	0.0495	0.0427	0.0408	0.0388	0.0381	0.0380	0.0388	0.0344
1.250	0.0824	0.0707	0.0646	0.0550	0.0456	0.0435	0.0406	0.0394	0.0365	0.0361	0.0336
1.375	—	0.0772	0.0715	0.0614	0.0501	0.0474	0.0436	0.0420	0.0365	0.0347	0.0338
1.500	—	—	0.0773	0.0679	0.0554	0.0522	0.0477	0.0457	0.0378	0.0345	0.0350
1.625	—	—	—	0.0735	0.0613	0.0575	0.0524	0.0500	0.0402	0.0354	0.0370
1.750	—	—	—	—	0.0669	0.0628	0.0574	0.0549	0.0434	0.0372	0.0395
1.875	—	—	—	—	0.0717	0.0676	0.0624	0.0598	0.0473	0.0398	0.0427
2.000	—	—	—	—	—	0.0715	0.0669	0.0642	0.0517	0.0430	0.0462
2.125	—	—	—	—	—	—	0.0706	0.0685	0.0563	0.0467	0.0501
2.250	—	—	—	—	—	—	—	—	0.0607	0.0507	0.0540
2.375	—	—	—	—	—	—	—	—	0.0648	0.0548	0.0579
2.500	—	—	—	—	—	—	—	—	0.0683	0.0589	0.0615
2.625	—	—	—	—	—	—	—	—	—	0.0626	0.0647
2.750	—	—	—	—	—	—	—	—	—	0.0659	—

Table 3 **Flange Taps: Expansion Factors, Y, Static Pressure taken from Downstream Taps**

TABLE 3.7—FLANGE TAPS: EXPANSION FACTORS, *Y*, STATIC PRESSURE TAKEN FROM DOWNSTREAM TAPS (AFTER REF. 3)

	$\beta = d_o/d$												
h_w/p_f	0.1	0.2	0.3	0.4	0.45	0.50	0.52	0.54	0.56	0.58	0.60	0.61	0.62
0.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
0.1	1.0007	1.0007	1.0007	1.0006	1.0006	1.0006	1.0006	1.0006	1.0006	1.0006	1.0005	1.0005	1.0005
0.2	1.0013	1.0013	1.0013	1.0013	1.0013	1.0012	1.0012	1.0012	1.0012	1.0011	1.0011	1.0011	1.0011
0.3	1.0020	1.0020	1.0020	1.0020	1.0019	1.0018	1.0018	1.0018	1.0017	1.0017	1.0016	1.0016	1.0016
0.4	1.0027	1.0027	1.0027	1.0026	1.0026	1.0025	1.0024	1.0024	1.0023	1.0023	1.0022	1.0022	1.0021
0.5	1.0033	1.0033	1.0033	1.0032	1.0031	1.0030	1.0029	1.0029	1.0028	1.0028	1.0027	1.0027	1.0027
0.6	1.0040	1.0040	1.0040	1.0039	1.0038	1.0036	1.0036	1.0035	1.0034	1.0033	1.0032	1.0032	1.0031
0.7	1.0047	1.0047	1.0047	1.0045	1.0044	1.0043	1.0042	1.0041	1.0040	1.0039	1.0038	1.0038	1.0037
0.8	1.0053	1.0053	1.0053	1.0051	1.0050	1.0049	1.0048	1.0047	1.0046	1.0045	1.0044	1.0043	1.0043
0.9	1.0060	1.0060	1.0060	1.0058	1.0057	1.0055	1.0054	1.0053	1.0052	1.0050	1.0049	1.0048	1.0048
1.0	1.0067	1.0066	1.0066	1.0064	1.0063	1.0061	1.0060	1.0059	1.0058	1.0056	1.0055	1.0054	1.0053
1.1	1.0074	1.0073	1.0073	1.0071	1.0069	1.0067	1.0066	1.0065	1.0063	1.0061	1.0060	1.0059	1.0058
1.2	1.0080	1.0080	1.0079	1.0077	1.0075	1.0073	1.0072	1.0071	1.0069	1.0067	1.0066	1.0065	1.0064
1.3	1.0087	1.0087	1.0086	1.0084	1.0082	1.0080	1.0078	1.0077	1.0075	1.0073	1.0071	1.0070	1.0069
1.4	1.0094	1.0093	1.0093	1.0090	1.0088	1.0086	1.0084	1.0083	1.0081	1.0079	1.0077	1.0076	1.0074
1.5	1.0100	1.0100	1.0099	1.0097	1.0094	1.0091	1.0090	1.0088	1.0086	1.0084	1.0082	1.0081	1.0080
1.6	1.0108	1.0107	1.0106	1.0104	1.0101	1.0097	1.0097	1.0095	1.0093	1.0090	1.0088	1.0086	1.0085
1.7	1.0114	1.0114	1.0113	1.0110	1.0108	1.0104	1.0103	1.0101	1.0099	1.0096	1.0094	1.0092	1.0091
1.8	1.0121	1.0120	1.0120	1.0117	1.0114	1.0110	1.0108	1.0106	1.0104	1.0102	1.0100	1.0097	1.0096
1.9	1.0128	1.0127	1.0126	1.0123	1.0120	1.0116	1.0115	1.0112	1.0110	1.0107	1.0104	1.0103	1.0101
2.0	1.0134	1.0133	1.0132	1.0129	1.0126	1.0122	1.0121	1.0118	1.0116	1.0113	1.0110	1.0108	1.0106
2.1	1.0140	1.0140	1.0139	1.0136	1.0133	1.0129	1.0127	1.0124	1.0122	1.0119	1.0115	1.0114	1.0111
2.2	1.0147	1.0147	1.0146	1.0142	1.0139	1.0135	1.0133	1.0130	1.0128	1.0125	1.0121	1.0120	1.0118
2.3	1.0154	1.0154	1.0153	1.0149	1.0146	1.0141	1.0139	1.0136	1.0133	1.0130	1.0127	1.0125	1.0123
2.4	1.0160	1.0160	1.0159	1.0154	1.0151	1.0146	1.0144	1.0141	1.0138	1.0135	1.0133	1.0130	1.0128
2.5	1.0167	1.0167	1.0166	1.0162	1.0158	1.0153	1.0150	1.0148	1.0145	1.0141	1.0137	1.0135	1.0133
2.6	1.0174	1.0173	1.0172	1.0168	1.0164	1.0159	1.0156	1.0154	1.0151	1.0147	1.0143	1.0141	1.0139
2.7	1.0183	1.0182	1.0181	1.0176	1.0172	1.0167	1.0164	1.0161	1.0158	1.0154	1.0150	1.0148	1.0146
2.8	1.0187	1.0186	1.0185	1.0180	1.0176	1.0171	1.0168	1.0165	1.0162	1.0158	1.0154	1.0152	1.0149
2.9	1.0194	1.0194	1.0192	1.0187	1.0183	1.0177	1.0175	1.0172	1.0168	1.0164	1.0160	1.0157	1.0155
3.0	1.0200	1.0200	1.0198	1.0193	1.0189	1.0183	1.0180	1.0177	1.0173	1.0169	1.0165	1.0162	1.0160
3.1	1.0207	1.0206	1.0205	1.0200	1.0195	1.0189	1.0186	1.0183	1.0179	1.0175	1.0171	1.0168	1.0166
3.2	1.0213	1.0213	1.0211	1.0206	1.0201	1.0195	1.0192	1.0189	1.0185	1.0180	1.0176	1.0173	1.0171
3.3	1.0220	1.0220	1.0218	1.0213	1.0208	1.0202	1.0199	1.0195	1.0191	1.0186	1.0181	1.0178	1.0176
3.4	1.0227	1.0227	1.0225	1.0219	1.0214	1.0208	1.0205	1.0201	1.0197	1.0192	1.0187	1.0184	1.0182
3.5	1.0233	1.0233	1.0231	1.0225	1.0220	1.0214	1.0210	1.0207	1.0202	1.0198	1.0192	1.0190	1.0187
3.6	1.0240	1.0239	1.0237	1.0232	1.0227	1.0220	1.0216	1.0212	1.0208	1.0203	1.0198	1.0195	1.0192
3.7	1.0246	1.0246	1.0244	1.0238	1.0232	1.0225	1.0221	1.0217	1.0213	1.0208	1.0203	1.0200	1.0197
3.8	1.0252	1.0252	1.0250	1.0244	1.0238	1.0231	1.0227	1.0223	1.0219	1.0214	1.0209	1.0206	1.0203

Table 4: **Coefficients for Critical Flow Provers and Choke Nipple**

Orifice size (in.)		Value of *C*		
		Critical Flow Prover		
		2-in. pipe	4-in. pipe	Choke Nipple
1/16	0.063	1.524		
3/32	0.094	3.355		
1/8	0.125	6.301	—	6.25
3/16	0.188	14.47	—	14.44
7/32	0.218	19.97		
1/4	0.250	25.86	24.92	26.51
5/16	0.313	39.77	—	43.64
3/8	0.375	56.58	56.01	61.21
7/16	0.438	81.09	—	85.13
1/2	0.500	101.8	100.2	112.72
5/8	0.625	154.0	156.1	179.74
3/4	0.750	224.9	223.7	260.99
7/8	0.875	309.3	304.2	
1	1.000	406.7	396.3	
1 1/8	1.125	520.8	499.2	
1 1/4	1.250	657.5	616.4	
1 3/8	1.375	807.8	742.1	
1 1/2	1.500	1,002.0	884.3	
1 3/4	1.750	—	1,208	
2	2.000	—	1,596	
2 1/4	2.250	—	2,046	
2 1/2	2.500	—	2,566	
2 3/4	2.750	—	3,177	
3	3.000	—	3,904	

GOOD LUCK!!!
SOLOMON ADJEI MARFO