PHYS 505
Solutions 1ˢᵗ Midterm Exam
Wednesday 18ᵗʰ November 2015

Instructor: Dr. V. Lempesis

Please answer all questions

1. Round the following recordings at the digit which is underlined:

Recorded Value	9.3<u>3</u>8	3<u>5</u>43	14.<u>7</u>47	0.0<u>2</u>46	<u>3</u>.501
Rounded Value	**9.34**	**3500**	**14.7**	**0.02**	**4**

(5 marks)

Some of you quote two answers for the recording 3.501. They put 3 or 4. This is a mistake. We never give two answers in a question.

2. Fill in the following table by keeping significant figures and rounding properly the recorded values taken in an experiment for a physical quantity:

Recorded value	Before the selection of significant figures		After the selection of significant figures		Final Result
	x	δx	δx	x	x
1	192.31	11	**11**	**192**	**192±11**
2	136.4	32	**30**	**140**	**140±30**
3	103.287	0.261	**0.26**	**103.29**	**103.29±0.26**
4	7.121	0.542	**0.5**	**7.1**	**7.1±0.5**
5	163	4.62	**5**	**163**	**163±5**

(5 marks)

3. You are given the following recordings for the length of a rod

ℓ_i mm	$\ell_i - \bar{\ell}$ mm	$\left(\ell_i - \bar{\ell}\right)^2$ mm
1.28	**0.014**	**0.000196**
1.26	**-0.006**	**0.000036**
1.28	**0.014**	**0.000196**
1.29	**0.024**	**0.000576**
1.22	**-0.046**	**0.002116**

$\sum_{i=1}^{5} \ell_i =$ 6.33	$\sum_{i=1}^{5} \left(\ell_i - \bar{\ell} \right) =$ 0	$\sum_{i=1}^{5} \left(\ell_i - \bar{\ell} \right)^2 =$ 0.00312

a) Find the average value of the length of the rod: **1.266**

(1 marks)

b) Fill in the table

(2 marks)

c) Find the absolute error: **0.012489996**

(2 marks)

d) Quote the experimental result: **(1.266±0.012) mm**

(2 marks)

e) Find the relevant error: **0.9%**

(1 marks)

4. Calculate the area between the curve of the standard normal distribution curve from: (a) $z=-0.23$ to $z=1.24$, (b) $z=0.60$ to $z=1.72$, (c) right of $z=-0.23$.

(3 marks)

5. We want to measure the volume of a cylinder. We are given that its diameter is $d = (10.0 \pm 1.0)\, cm$. The height of the cylinder is $h = (22.0 \pm 1.0)\, cm$. Find:

a) The volume of the cylinder.
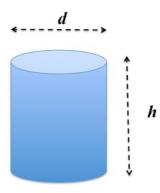
(1 mark)

b) The error of of the volume.

(3 marks)

c) Quote the result.

(3 marks)

d) Find the relevant error.

(2 marks)

(a) **The volume is given by** $V = \pi \left(d / 2 \right)^2 h = \pi d^2 h / 4 = 1727\, cm^3$

(b) **The error of the volume is given by**

$$\delta V = \sqrt{\left(\frac{\partial V}{\partial d}\delta d\right)^2 + \left(\frac{\partial V}{\partial h}\delta h\right)^2} =$$

$$= \sqrt{\left[\delta d\left(\pi h d/2\right)\right]^2 + \left[\delta h\left(\pi d^2/4\right)\right]^2} =$$

$$= 354.2081450 \text{ cm}^3$$

Please see that I use the diameter d in all the formulas and processing and not the radius r. This is because the experiment gives us the values of diameter and not of radius. If you have used the radius it is a mistake.

(c) $V = \left(1700 + 400\right) \; cm^3$

(d) $\dfrac{\delta V}{V} \times 100\% = \dfrac{400}{1700} \times 100\% = 23.52\% \approx 24\%$

See that I used the rounded values for calculating the relative error. If you have used the values of δV and V before rounding it is a mistake.

Standard Normal Distribution Table

Area under the Normal Curve from 0 to X

X	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.00000	0.00399	0.00798	0.01197	0.01595	0.01994	0.02392	0.02790	0.03188	0.03586
0.1	0.03983	0.04380	0.04776	0.05172	0.05567	0.05962	0.06356	0.06749	0.07142	0.07535
0.2	0.07926	0.08317	0.08706	0.09095	0.09483	0.09871	0.10257	0.10642	0.11026	0.11409
0.3	0.11791	0.12172	0.12552	0.12930	0.13307	0.13683	0.14058	0.14431	0.14803	0.15173
0.4	0.15542	0.15910	0.16276	0.16640	0.17003	0.17364	0.17724	0.18082	0.18439	0.18793
0.5	0.19146	0.19497	0.19847	0.20194	0.20540	0.20884	0.21226	0.21566	0.21904	0.22240
0.6	0.22575	0.22907	0.23237	0.23565	0.23891	0.24215	0.24537	0.24857	0.25175	0.25490
0.7	0.25804	0.26115	0.26424	0.26730	0.27035	0.27337	0.27637	0.27935	0.28230	0.28524
0.8	0.28814	0.29103	0.29389	0.29673	0.29955	0.30234	0.30511	0.30785	0.31057	0.31327
0.9	0.31594	0.31859	0.32121	0.32381	0.32639	0.32894	0.33147	0.33398	0.33646	0.33891
1.0	0.34134	0.34375	0.34614	0.34849	0.35083	0.35314	0.35543	0.35769	0.35993	0.36214
1.1	0.36433	0.36650	0.36864	0.37076	0.37286	0.37493	0.37698	0.37900	0.38100	0.38298
1.2	0.38493	0.38686	0.38877	0.39065	0.39251	0.39435	0.39617	0.39796	0.39973	0.40147
1.3	0.40320	0.40490	0.40658	0.40824	0.40988	0.41149	0.41308	0.41466	0.41621	0.41774
1.4	0.41924	0.42073	0.42220	0.42364	0.42507	0.42647	0.42785	0.42922	0.43056	0.43189
1.5	0.43319	0.43448	0.43574	0.43699	0.43822	0.43943	0.44062	0.44179	0.44295	0.44408
1.6	0.44520	0.44630	0.44738	0.44845	0.44950	0.45053	0.45154	0.45254	0.45352	0.45449
1.7	0.45543	0.45637	0.45728	0.45818	0.45907	0.45994	0.46080	0.46164	0.46246	0.46327
1.8	0.46407	0.46485	0.46562	0.46638	0.46712	0.46784	0.46856	0.46926	0.46995	0.47062
1.9	0.47128	0.47193	0.47257	0.47320	0.47381	0.47441	0.47500	0.47558	0.47615	0.47670
2.0	0.47725	0.47778	0.47831	0.47882	0.47932	0.47982	0.48030	0.48077	0.48124	0.48169
2.1	0.48214	0.48257	0.48300	0.48341	0.48382	0.48422	0.48461	0.48500	0.48537	0.48574
2.2	0.48610	0.48645	0.48679	0.48713	0.48745	0.48778	0.48809	0.48840	0.48870	0.48899
2.3	0.48928	0.48956	0.48983	0.49010	0.49036	0.49061	0.49086	0.49111	0.49134	0.49158
2.4	0.49180	0.49202	0.49224	0.49245	0.49266	0.49286	0.49305	0.49324	0.49343	0.49361
2.5	0.49379	0.49396	0.49413	0.49430	0.49446	0.49461	0.49477	0.49492	0.49506	0.49520
2.6	0.49534	0.49547	0.49560	0.49573	0.49585	0.49598	0.49609	0.49621	0.49632	0.49643
2.7	0.49653	0.49664	0.49674	0.49683	0.49693	0.49702	0.49711	0.49720	0.49728	0.49736
2.8	0.49744	0.49752	0.49760	0.49767	0.49774	0.49781	0.49788	0.49795	0.49801	0.49807
2.9	0.49813	0.49819	0.49825	0.49831	0.49836	0.49841	0.49846	0.49851	0.49856	0.49861
3.0	0.49865	0.49869	0.49874	0.49878	0.49882	0.49886	0.49889	0.49893	0.49896	0.49900
3.1	0.49903	0.49906	0.49910	0.49913	0.49916	0.49918	0.49921	0.49924	0.49926	0.49929
3.2	0.49931	0.49934	0.49936	0.49938	0.49940	0.49942	0.49944	0.49946	0.49948	0.49950
3.3	0.49952	0.49953	0.49955	0.49957	0.49958	0.49960	0.49961	0.49962	0.49964	0.49965
3.4	0.49966	0.49968	0.49969	0.49970	0.49971	0.49972	0.49973	0.49974	0.49975	0.49976
3.5	0.49977	0.49978	0.49978	0.49979	0.49980	0.49981	0.49981	0.49982	0.49983	0.49983
3.6	0.49984	0.49985	0.49985	0.49986	0.49986	0.49987	0.49987	0.49988	0.49988	0.49989
3.7	0.49989	0.49990	0.49990	0.49990	0.49991	0.49991	0.49992	0.49992	0.49992	0.49992
3.8	0.49993	0.49993	0.49993	0.49994	0.49994	0.49994	0.49994	0.49995	0.49995	0.49995
3.9	0.49995	0.49995	0.49996	0.49996	0.49996	0.49996	0.49996	0.49996	0.49997	0.49997
4.0	0.49997	0.49997	0.49997	0.49997	0.49997	0.49997	0.49998	0.49998	0.49998	0.49998