

SPECIAL PAIRS OF PYTHAGOREAN TRIANGLES AND DHURUVA NUMBERS OF ORDERS 4, 5 AND 6

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Abstract

This paper concerns with the problem of obtaining pairs of pythagorean triangles, where, in each pair, the difference between their perimeters is represented by 6174(Dhuruva number of order 4),61974,82962,63954(Dhuruva number of order 5), 631764(Dhuruva number of order 6). Also, we present the number of pairs of primitive and non-primitive Pythagorean triangles.

Key words: Pairs of Pythagorean triangles, Dhuruva number, primitive and non-primitive Pythagorean triangles.

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1. INTRODUCTION

The fascinating branch of mathematics is the theory of numbers where in Pythagorean triangles have been a matter of interest to various mathematicians and to the lovers of mathematics, because it is a treasure house in which the search for many hidden connection is a treasure hunt. For a rich variety of fascinating problems one may refer [1-17]. A careful observer of patterns may note that there is a one to one correspondence between the polygonal numbers and the number of sides of the polygon. Apart from the above patterns we have some more fascinating patterns of numbers namely Jarasandha numbers, Nasty numbers and Dhuruva numbers. These numbers have been presented in [18-21].

In [22-24], special Pythagorean triangles connected with polygonal numbers and Nasty numbers are obtained. Recently in [25], special Pythagorean triangles in connection with Hardy Ramanujan number 1729 are exhibited. In [26], Pythagorean triangles in connections with 5-digit Dhuruva numbers are presented.

In this communication, we search for pairs of Pythagorean triangles, such that in each pair, the difference between their perimeters is the Dhuruva number.

Basic Definitons

Definition 1:

The ternary quadratic Diophantine equation given by $x^2 + y^2 = z^2$ is known as Pythagorean equation where x, y, z are natural numbers. The above equation is also referred to as Pythagorean triangle and denote it by T(x,y,z).

Also, in Pythagorean triangle T(x,y,z) : $x^2 + y^2 = z^2$, x and y are called its legs and z its hypotenuse.

Definition 2:

Most cited solution of the Pythagorean equation is $x = m^2 - n^2$, $y = 2mn$, $z = m^2 + n^2$, where $m > n > 0$. This solution is called primitive, if m,n are of opposite parity and $\gcd(m,n)=1$.

Definition 3: Dhuruva Numbers

The numbers which do not change when we perform a single operation or a sequence of operations are known as Dhuruva numbers.

2. METHOD OF ANALYSIS

Let PT_1 , PT_2 be two distinct Pythagorean triangles with generators m, q ($m > q > 0$), and p, q ($p > q > 0$) respectively. Let P_1 , P_2 be the perimeters of PT_1 , PT_2 such that $P_1 - P_2 = 4$ -digit Dhuruva number 6174

The above relation leads to the equation

$$(2m + q)^2 - (2p + q)^2 = 12348 \quad (1)$$

After performing numerical computations, it is noted that there are 514 distinct values for m, p and q satisfying (1). For simplicity and clear understanding, we have presented below in table 1 the values of m, p, q, P_1 and P_2 .

m	q	p	P1	P2
1030	1028	1029	4239480	4233306
1031	1026	1030	4241534	4235360

1032	1024	1031	4243584	4237410
1033	1022	1032	4245630	4239456
1034	1020	1033	4247672	4241498
1035	1018	1034	4249710	4243536
1036	1016	1035	4251744	4245570
1037	1014	1036	4253774	4247600
1038	1012	1037	4255800	4249626
1039	1010	1038	4257822	4251648
1040	1008	1039	4259840	4253666
1041	1006	1040	4261854	4255680
1042	1004	1041	4263864	4257690
1043	1002	1042	4265870	4259696
1044	1000	1043	4267872	4261698
1045	998	1044	4269870	4263696
1046	996	1045	4271864	4265690
1047	994	1046	4273854	4267680
1048	992	1047	4275840	4269666
1049	990	1048	4277822	4271648
1050	988	1049	4279800	4273626
1051	986	1050	4281774	4275600
1052	984	1051	4283744	4277570
1053	982	1052	4285710	4279536
1054	980	1053	4287672	4281498
1055	978	1054	4289630	4283456
1056	976	1055	4291584	4285410
1057	974	1056	4293534	4287360
1058	972	1057	4295480	4289306
1059	970	1058	4297422	4291248
1060	968	1059	4299360	4293186
1061	966	1060	4301294	4295120
1062	964	1061	4303224	4297050
1063	962	1062	4305150	4298976
1064	960	1063	4307072	4300898
1065	958	1064	4308990	4302816
1066	956	1065	4310904	4304730
1067	954	1066	4312814	4306640
1068	952	1067	4314720	4308546
1069	950	1068	4316622	4310448
1070	948	1069	4318520	4312346
1071	946	1070	4320414	4314240
1072	944	1071	4322304	4316130
1073	942	1072	4324190	4318016
1074	940	1073	4326072	4319898
1075	938	1074	4327950	4321776
1076	936	1075	4329824	4323650
1077	934	1076	4331694	4325520
1078	932	1077	4333560	4327386
1079	930	1078	4335422	4329248
1080	928	1079	4337280	4331106
1081	926	1080	4339134	4332960
1082	924	1081	4340984	4334810
1083	922	1082	4342830	4336656
1084	920	1083	4344672	4338498
1085	918	1084	4346510	4340336
1086	916	1085	4348344	4342170
1087	914	1086	4350174	4344000
1088	912	1087	4352000	4345826
1089	910	1088	4353822	4347648

1090	908	1089	4355640	4349466
1091	906	1090	4357454	4351280
1092	904	1091	4359264	4353090
1093	902	1092	4361070	4354896
1094	900	1093	4362872	4356698
1095	898	1094	4364670	4358496
1096	896	1095	4366464	4360290
1097	894	1096	4368254	4362080
1098	892	1097	4370040	4363866
1099	890	1098	4371822	4365648
1100	888	1099	4373600	4367426
1101	886	1100	4375374	4369200
1102	884	1101	4377144	4370970
1103	882	1102	4378910	4372736
1104	880	1103	4380672	4374498
1105	878	1104	4382430	4376256
1106	876	1105	4384184	4378010
1107	874	1106	4385934	4379760
1108	872	1107	4387680	4381506
1109	870	1108	4389422	4383248
1110	868	1109	4391160	4384986
1111	866	1110	4392894	4386720
1112	864	1111	4394624	4388450
1113	862	1112	4396350	4390176
1114	860	1113	4398072	4391898
1115	858	1114	4399790	4393616
1116	856	1115	4401504	4395330
1117	854	1116	4403214	4397040
1118	852	1117	4404920	4398746
1119	850	1118	4406622	4400448
1120	848	1119	4408320	4402146
1121	846	1120	4410014	4403840
1122	844	1121	4411704	4405530
1123	842	1122	4413390	4407216
1124	840	1123	4415072	4408898
1125	838	1124	4416750	4410576
1126	836	1125	4418424	4412250
1127	834	1126	4420094	4413920
1128	832	1127	4421760	4415586
1129	830	1128	4423422	4417248
1130	828	1129	4425080	4418906
1131	826	1130	4426734	4420560
1132	824	1131	4428384	4422210
1133	822	1132	4430030	4423856
1134	820	1133	4431672	4425498
1135	818	1134	4433310	4427136
1136	816	1135	4434944	4428770
1137	814	1136	4436574	4430400
1138	812	1137	4438200	4432026
1139	810	1138	4439822	4433648
1140	808	1139	4441440	4435266
1141	806	1140	4443054	4436880
1142	804	1141	4444664	4438490
1143	802	1142	4446270	4440096
1144	800	1143	4447872	4441698
1145	798	1144	4449470	4443296
1146	796	1145	4451064	4444890
1147	794	1146	4452654	4446480

1148	792	1147	4454240	4448066
1149	790	1148	4455822	4449648
1150	788	1149	4457400	4451226
1151	786	1150	4458974	4452800
1152	784	1151	4460544	4454370
1153	782	1152	4462110	4455936
1154	780	1153	4463672	4457498
1155	778	1154	4465230	4459056
1156	776	1155	4466784	4460610
1157	774	1156	4468334	4462160
1158	772	1157	4469880	4463706
1159	770	1158	4471422	4465248
1160	768	1159	4472960	4466786
1161	766	1160	4474494	4468320
1162	764	1161	4476024	4469850
1163	762	1162	4477550	4471376
1164	760	1163	4479072	4472898
1165	758	1164	4480590	4474416
1166	756	1165	4482104	4475930
1167	754	1166	4483614	4477440
1168	752	1167	4485120	4478946
1169	750	1168	4486622	4480448
1170	748	1169	4488120	4481946
1171	746	1170	4489614	4483440
1172	744	1171	4491104	4484930
1173	742	1172	4492590	4486416
1174	740	1173	4494072	4487898
1175	738	1174	4495550	4489376
1176	736	1175	4497024	4490850
1177	734	1176	4498494	4492320
1178	732	1177	4499960	4493786
1179	730	1178	4501422	4495248
1180	728	1179	4502880	4496706
1181	726	1180	4504334	4498160
1182	724	1181	4505784	4499610
1183	722	1182	4507230	4501056
1184	720	1183	4508672	4502498
1185	718	1184	4510110	4503936
1186	716	1185	4511544	4505370
1187	714	1186	4512974	4506800
1188	712	1187	4514400	4508226
1189	710	1188	4515822	4509648
1190	708	1189	4517240	4511066
1191	706	1190	4518654	4512480
1192	704	1191	4520064	4513890
1193	702	1192	4521470	4515296
1194	700	1193	4522872	4516698
1195	698	1194	4524270	4518096
1196	696	1195	4525664	4519490
1197	694	1196	4527054	4520880
1198	692	1197	4528440	4522266
1199	690	1198	4529822	4523648
1200	688	1199	4531200	4525026
1201	686	1200	4532574	4526400
1202	684	1201	4533944	4527770
1203	682	1202	4535310	4529136
1204	680	1203	4536672	4530498
1205	678	1204	4538030	4531856

1206	676	1205	4539384	4533210
1207	674	1206	4540734	4534560
1208	672	1207	4542080	4535906
1209	670	1208	4543422	4537248
1210	668	1209	4544760	4538586
1211	666	1210	4546094	4539920
1212	664	1211	4547424	4541250
1213	662	1212	4548750	4542576
1214	660	1213	4550072	4543898
1215	658	1214	4551390	4545216
1216	656	1215	4552704	4546530
1217	654	1216	4554014	4547840
1218	652	1217	4555320	4549146
1219	650	1218	4556622	4550448
1220	648	1219	4557920	4551746
1221	646	1220	4559214	4553040
1222	644	1221	4560504	4554330
1223	642	1222	4561790	4555616
1224	640	1223	4563072	4556898
1225	638	1224	4564350	4558176
1226	636	1225	4565624	4559450
1227	634	1226	4566894	4560720
1228	632	1227	4568160	4561986
1229	630	1228	4569422	4563248
1230	628	1229	4570680	4564506
1231	626	1230	4571934	4565760
1232	624	1231	4573184	4567010
1233	622	1232	4574430	4568256
1234	620	1233	4575672	4569498
1235	618	1234	4576910	4570736
1236	616	1235	4578144	4571970
1237	614	1236	4579374	4573200
1238	612	1237	4580600	4574426
1239	610	1238	4581822	4575648
1240	608	1239	4583040	4576866
1241	606	1240	4584254	4578080
1242	604	1241	4585464	4579290
1243	602	1242	4586670	4580496
1244	600	1243	4587872	4581698
1245	598	1244	4589070	4582896
1246	596	1245	4590264	4584090
1247	594	1246	4591454	4585280
1248	592	1247	4592640	4586466
1249	590	1248	4593822	4587648
1250	588	1249	4595000	4588826
1251	586	1250	4596174	4590000
1252	584	1251	4597344	4591170
1253	582	1252	4598510	4592336
1254	580	1253	4599672	4593498
1255	578	1254	4600830	4594656
1256	576	1255	4601984	4595810
1257	574	1256	4603134	4596960
1258	572	1257	4604280	4598106
1259	570	1258	4605422	4599248
1260	568	1259	4606560	4600386
1261	566	1260	4607694	4601520
1262	564	1261	4608824	4602650
1263	562	1262	4609950	4603776

1264	560	1263	4611072	4604898
1265	558	1264	4612190	4606016
1266	556	1265	4613304	4607130
1267	554	1266	4614414	4608240
1268	552	1267	4615520	4609346
1269	550	1268	4616622	4610448
1270	548	1269	4617720	4611546
1271	546	1270	4618814	4612640
1272	544	1271	4619904	4613730
1273	542	1272	4620990	4614816
1274	540	1273	4622072	4615898
1275	538	1274	4623150	4616976
1276	536	1275	4624224	4618050
1277	534	1276	4625294	4619120
1278	532	1277	4626360	4620186
1279	530	1278	4627422	4621248
1280	528	1279	4628480	4622306
1281	526	1280	4629534	4623360
1282	524	1281	4630584	4624410
1283	522	1282	4631630	4625456
1284	520	1283	4632672	4626498
1285	518	1284	4633710	4627536
1286	516	1285	4634744	4628570
1287	514	1286	4635774	4629600
1288	512	1287	4636800	4630626
1289	510	1288	4637822	4631648
1290	508	1289	4638840	4632666
1291	506	1290	4639854	4633680
1292	504	1291	4640864	4634690
1293	502	1292	4641870	4635696
1294	500	1293	4642872	4636698
1295	498	1294	4643870	4637696
1296	496	1295	4644864	4638690
1297	494	1296	4645854	4639680
1298	492	1297	4646840	4640666
1299	490	1298	4647822	4641648
1300	488	1299	4648800	4642626
1301	486	1300	4649774	4643600
1302	484	1301	4650744	4644570
1303	482	1302	4651710	4645536
1304	480	1303	4652672	4646498
1305	478	1304	4653630	4647456
1306	476	1305	4654584	4648410
1307	474	1306	4655534	4649360
1308	472	1307	4656480	4650306
1309	470	1308	4657422	4651248
1310	468	1309	4658360	4652186
1311	466	1310	4659294	4653120
1312	464	1311	4660224	4654050
1313	462	1312	4661150	4654976
1314	460	1313	4662072	4655898
1315	458	1314	4662990	4656816
1316	456	1315	4663904	4657730
1317	454	1316	4664814	4658640
1318	452	1317	4665720	4659546
1319	450	1318	4666622	4660448
1320	448	1319	4667520	4661346
1321	446	1320	4668414	4662240

1322	444	1321	4669304	4663130
1323	442	1322	4670190	4664016
1324	440	1323	4671072	4664898
1325	438	1324	4671950	4665776
1326	436	1325	4672824	4666650
1327	434	1326	4673694	4667520
1328	432	1327	4674560	4668386
1329	430	1328	4675422	4669248
1330	428	1329	4676280	4670106
1331	426	1330	4677134	4670960
1332	424	1331	4677984	4671810
1333	422	1332	4678830	4672656
1334	420	1333	4679672	4673498
1335	418	1334	4680510	4674336
1336	416	1335	4681344	4675170
1337	414	1336	4682174	4676000
1338	412	1337	4683000	4676826
1339	410	1338	4683822	4677648
1340	408	1339	4684640	4678466
1341	406	1340	4685454	4679280
1342	404	1341	4686264	4680090
1343	402	1342	4687070	4680896
1344	400	1343	4687872	4681698
1345	398	1344	4688670	4682496
1346	396	1345	4689464	4683290
1347	394	1346	4690254	4684080
1348	392	1347	4691040	4684866
1349	390	1348	4691822	4685648
1350	388	1349	4692600	4686426
1351	386	1350	4693374	4687200
1352	384	1351	4694144	4687970
1353	382	1352	4694910	4688736
1354	380	1353	4695672	4689498
1355	378	1354	4696430	4690256
1356	376	1355	4697184	4691010
1357	374	1356	4697934	4691760
1358	372	1357	4698680	4692506
1359	370	1358	4699422	4693248
1360	368	1359	4700160	4693986
1361	366	1360	4700894	4694720
1362	364	1361	4701624	4695450
1363	362	1362	4702350	4696176
1364	360	1363	4703072	4696898
1365	358	1364	4703790	4697616
1366	356	1365	4704504	4698330
1367	354	1366	4705214	4699040
1368	352	1367	4705920	4699746
1369	350	1368	4706622	4700448
1370	348	1369	4707320	4701146
1371	346	1370	4708014	4701840
1372	344	1371	4708704	4702530
1373	342	1372	4709390	4703216
1374	340	1373	4710072	4703898
1375	338	1374	4710750	4704576
1376	336	1375	4711424	4705250
1377	334	1376	4712094	4705920
1378	332	1377	4712760	4706586
1379	330	1378	4713422	4707248

1380	328	1379	4714080	4707906
1381	326	1380	4714734	4708560
1382	324	1381	4715384	4709210
1383	322	1382	4716030	4709856
1384	320	1383	4716672	4710498
1385	318	1384	4717310	4711136
1386	316	1385	4717944	4711770
1387	314	1386	4718574	4712400
1388	312	1387	4719200	4713026
1389	310	1388	4719822	4713648
1390	308	1389	4720440	4714266
1391	306	1390	4721054	4714880
1392	304	1391	4721664	4715490
1393	302	1392	4722270	4716096
1394	300	1393	4722872	4716698
1395	298	1394	4723470	4717296
1396	296	1395	4724064	4717890
1397	294	1396	4724654	4718480
1398	292	1397	4725240	4719066
1399	290	1398	4725822	4719648
1400	288	1399	4726400	4720226
1401	286	1400	4726974	4720800
1402	284	1401	4727544	4721370
1403	282	1402	4728110	4721936
1404	280	1403	4728672	4722498
1405	278	1404	4729230	4723056
1406	276	1405	4729784	4723610
1407	274	1406	4730334	4724160
1408	272	1407	4730880	4724706
1409	270	1408	4731422	4725248
1410	268	1409	4731960	4725786
1411	266	1410	4732494	4726320
1412	264	1411	4733024	4726850
1413	262	1412	4733550	4727376
1414	260	1413	4734072	4727898
1415	258	1414	4734590	4728416
1416	256	1415	4735104	4728930
1417	254	1416	4735614	4729440
1418	252	1417	4736120	4729946
1419	250	1418	4736622	4730448
1420	248	1419	4737120	4730946
1421	246	1420	4737614	4731440
1422	244	1421	4738104	4731930
1423	242	1422	4738590	4732416
1424	240	1423	4739072	4732898
1425	238	1424	4739550	4733376
1426	236	1425	4740024	4733850
1427	234	1426	4740494	4734320
1428	232	1427	4740960	4734786
1429	230	1428	4741422	4735248
1430	228	1429	4741880	4735706
1431	226	1430	4742334	4736160
1432	224	1431	4742784	4736610
1433	222	1432	4743230	4737056
1434	220	1433	4743672	4737498
1435	218	1434	4744110	4737936
1436	216	1435	4744544	4738370
1437	214	1436	4744974	4738800

1438	212	1437	4745400	4739226
1439	210	1438	4745822	4739648
1440	208	1439	4746240	4740066
1441	206	1440	4746654	4740480
1442	204	1441	4747064	4740890
1443	202	1442	4747470	4741296
1444	200	1443	4747872	4741698
1445	198	1444	4748270	4742096
1446	196	1445	4748664	4742490
1447	194	1446	4749054	4742880
1448	192	1447	4749440	4743266
1449	190	1448	4749822	4743648
1450	188	1449	4750200	4744026
1451	186	1450	4750574	4744400
1452	184	1451	4750944	4744770
1453	182	1452	4751310	4745136
1454	180	1453	4751672	4745498
1455	178	1454	4752030	4745856
1456	176	1455	4752384	4746210
1457	174	1456	4752734	4746560
1458	172	1457	4753080	4746906
1459	170	1458	4753422	4747248
1460	168	1459	4753760	4747586
1461	166	1460	4754094	4747920
1462	164	1461	4754424	4748250
1463	162	1462	4754750	4748576
1464	160	1463	4755072	4748898
1465	158	1464	4755390	4749216
1466	156	1465	4755704	4749530
1467	154	1466	4756014	4749840
1468	152	1467	4756320	4750146
1469	150	1468	4756622	4750448
1470	148	1469	4756920	4750746
1471	146	1470	4757214	4751040
1472	144	1471	4757504	4751330
1473	142	1472	4757790	4751616
1474	140	1473	4758072	4751898
1475	138	1474	4758350	4752176
1476	136	1475	4758624	4752450
1477	134	1476	4758894	4752720
1478	132	1477	4759160	4752986
1479	130	1478	4759422	4753248
1480	128	1479	4759680	4753506
1481	126	1480	4759934	4753760
1482	124	1481	4760184	4754010
1483	122	1482	4760430	4754256
1484	120	1483	4760672	4754498
1485	118	1484	4760910	4754736
1486	116	1485	4761144	4754970
1487	114	1486	4761374	4755200
1488	112	1487	4761600	4755426
1489	110	1488	4761822	4755648
1490	108	1489	4762040	4755866
1491	106	1490	4762254	4756080
1492	104	1491	4762464	4756290
1493	102	1492	4762670	4756496
1494	100	1493	4762872	4756698
1495	98	1494	4763070	4756896

1496	96	1495	4763264	4757090
1497	94	1496	4763454	4757280
1498	92	1497	4763640	4757466
1499	90	1498	4763822	4757648
1500	88	1499	4764000	4757826
1501	86	1500	4764174	4758000
1502	84	1501	4764344	4758170
1503	82	1502	4764510	4758336
1504	80	1503	4764672	4758498
1505	78	1504	4764830	4758656
1506	76	1505	4764984	4758810
1507	74	1506	4765134	4758960
1508	72	1507	4765280	4759106
1509	70	1508	4765422	4759248
1510	68	1509	4765560	4759386
1511	66	1510	4765694	4759520
1512	64	1511	4765824	4759650
1513	62	1512	4765950	4759776
1514	60	1513	4766072	4759898
1515	58	1514	4766190	4760016
1516	56	1515	4766304	4760130
1517	54	1516	4766414	4760240
1518	52	1517	4766520	4760346
1519	50	1518	4766622	4760448
1520	48	1519	4766720	4760546
1521	46	1520	4766814	4760640
1522	44	1521	4766904	4760730
1523	42	1522	4766990	4760816
1524	40	1523	4767072	4760898
1525	38	1524	4767150	4760976
1526	36	1525	4767224	4761050
1527	34	1526	4767294	4761120
1528	32	1527	4767360	4761186
1529	30	1528	4767422	4761248
1530	28	1529	4767480	4761306
1531	26	1530	4767534	4761360
1532	24	1531	4767584	4761410
1533	22	1532	4767630	4761456
1534	20	1533	4767672	4761498
1535	18	1534	4767710	4761536
1536	16	1535	4767744	4761570
1537	14	1536	4767774	4761600
1538	12	1537	4767800	4761626
1539	10	1538	4767822	4761648
1540	8	1539	4767840	4761666
1541	6	1540	4767854	4761680
1542	4	1541	4767864	4761690
1543	2	1542	4767870	4761696

Thus, it is seen that there are 514 pairs of Pythagorean triangles such that for each pair the difference in the perimeters is 4- digit Dhuruva number 6174.

Out of these 6174 pairs of Pythagorean triangles 1-pair is non-primitive and in each of the remaining pairs, one of the triangles is primitive and the other is non-primitive triangle. A similar observation, regarding 5- digit and 6- digit dhuruva numbers are exhibited in the table2 below.

Dhuruva number	pairs of Pythagorean triangles	pairs of non-primitive Pythagorean triangles	pairs of primitive and non-primitive Pythagorean triangles
61974	5164	62	5102
82962	6913	1391	5522
63954	5329	439	4890
631764	52647	-	52647

3. CONCLUSION

In this paper, we have presented pairs of Pythagorean triangles such that, in each pair, the difference between their perimeters is represented by Dhuruva numbers of orders 4,5 and 6. It is observed that there are only finitely many Pythagorean triangles satisfying the property under consideration. Also we have given the total number of pairs of Primitive and non-primitive Pythagorean triangles.

To conclude, One may search for the connections between the pairs of Pythagorean triangles, higher order Dhuruva numbers, Special polygonal and pyramidal numbers. Also one may attempt to determine pairs of Pythagorean triangles, where, in each pair, the difference between their areas is represented by Dhuruva numbers, figurate numbers and other special number patterns, namely, Star numbers, Jacobstal numbers, Kynea numbers and so on.

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