Explore the Universe Observing Certificate

Welcome to the Explore the Universe Observing Certificate Program. This program is designed to provide the observer with a well-rounded introduction to the night sky visible from North America. Using this observing program is an excellent way to gain knowledge and experience in astronomy. Experienced observers find that a planned observing session results in a more satisfying and interesting experience. This program will help introduce you to amateur astronomy and prepare you for other more challenging certificate programs such as the *Messier* and *Finest NGC*.

The program covers the full range of astronomical objects. Here is a summary:

Observing Objective	Requirement	Available
Constellations and Bright Stars	12	24
The Moon	16	32
Solar System	5	10
Deep-Sky Objects	12	24
Double Stars	10	20
Total	**55**	**110**

In each category a choice of objects is provided so that you can begin the certificate at any time of the year. **In order to receive your certificate you need to observe a total of 55 of the 110 objects available**. Here is a summary of some of the abbreviations used in this program

Instrument	**V** – Visual (unaided eye) **B** – Binocular **T** – Telescope **V/B** – Visual/Binocular **B/T** – Binocular/Telescope
Season	Season when the object can be best seen in the evening sky between dusk. and midnight. Objects may also be seen in other seasons.
Description	Brief description of the target object, its common name and other details.
Cons	Constellation where object can be found (if applicable)
BOG Ref	Refers to corresponding references in the RASC's *The Beginner's Observing Guide* highlighting this object.
Seen?	Mark each item with a check mark when you have observed it.
Log Page	Cross reference to your Visual Observing Log or other logbook entry where you have recorded your observations.

Binoculars are an ideal first observing instrument and this program has been designed so that it can be completed using binoculars alone. By mounting your binoculars on a tripod you will find that you can see more detail and observe more comfortably. While a telescope can show many objects on this list in more detail, experienced observers always have a pair of binoculars handy. For more information see *The Beginner's Observing Guide* p. 86.

The Bayer Catalogue

First published in 1603, the Bayer Catalogue was based solely on bright visual stars that could be seen with the unaided eye in each constellation. Using the Greek alphabet, starting with Alpha, stars are labelled mainly (with certain exceptions) according to how bright they are. Thus the brightest star in Ursa Minor is called "Alpha Ursae Minoris" and written α UMi. Here is a list of all the 24 Greek letters used in astronomy:

α - Alpha	β - Beta	γ - Gamma	δ - Delta	ε - Epsilon	ζ - Zeta	η - Eta	ϑ - Theta (θ)
ι - Iota	κ - Kappa	λ - Lambda	μ - Mu	ν - Nu	ξ - Xi	o - Omicron	π - Pi
ρ - Rho	σ - Sigma	τ - Tau	υ - Upsilon	ϕ - Phi	χ - Chi	ψ - Psi	ϖ - Omega

The Flamsteed Catalogue

Another major catalogue is the Flamsteed Catalogue compiled in 1725. This catalogue lists stars visible to the unaided eye by constellation in Right Ascension order from west to east. Thus the higher the number, the further east in a constellation is a given star. For more information on the Bayer and Flamsteed catalogues see *The Beginner's Observing Guide* page 23.

Reference Sources

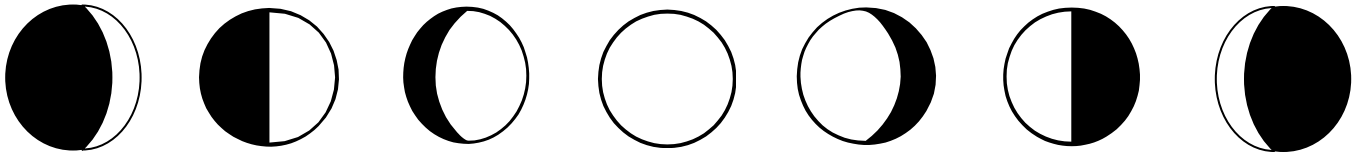
The Explore the Universe Observing Certificate program can be used in conjunction with *The Beginner's Observing Guide*. This publication of the Royal Astronomical Society of Canada provides a clear introduction to the observation of astronomical phenomena and appropriate observing techniques. In addition to this type of guide you will need a **star map** or **atlas** to assist you with locating a number of the objects in this program. For specific recommendations refer to *The Beginner's Observing Guide* pages 134-135.

Constellations and Bright Stars (12 of 24)

Season	Name	Abbr.	Observing Notes	Bright Star (s)	Mag.	Bayer	Flamsteed	BOG?	Seen? ✓	Log Page
Spr	**Ursa Major** The Great Bear	UMa	Ursa Major has important pointer stars leading to Polaris, Arcturus.	Dubhe Merak	1.81 2.34	Alpha (α) Beta (β)	50 UMa 48 UMa	14	☐	
Spr	**Leo** The Lion	Leo	Prominent constellation includes the bright star Regulus.	Regulus Denebola	1.36 2.14	Alpha (α) Beta (β)	32 Leo 94 Leo	33	☐	
Spr	**Virgo** The Maiden	Vir	Virgo contains the giant Virgo cluster of galaxies, visible in telescopes.	Spica	0.98	Alpha (α)	67 Vir	42	☐	
Spr	**Libra** The Scales	Lib	Alpha & Beta Librae are prominent but other stars need darker skies.	Zuben El Genubi Zuben Eschamali	2.75 2.61	Alpha (α) Beta (β)	9 Lib 27 Lib	49-50	☐	
Spr	**Bootes** The Herdsman	Boo	Arcturus is the 4th brightest star. Take the arc to Arcturus from UMa.	Arcturus	- 0.05	Alpha (α)	16 Boo	41-42	☐	
Spr	**Ursa Minor** The Lesser Bear	UMi	Contains Polaris the Pole Star. Needs darker skies to stand out.	Polaris Kochab	1.97 2.07	Alpha (α) Beta (β)	1 UMi 7 UMi	27	☐	
Sum	**Scorpius** The Scorpion	Sco	Runs roughtly north to south with bright red Antares at its heart.	Antares	1.06	Alpha (α)	21 Sco	50	☐	
Sum	**Hercules** Hero of Greek Myth	Her	Ras Algethi is south of Hercules' distinctive four star polygon.	Ras Algethi	2.78	Alpha (α)	64 Her	47-48	☐	
Sum	**Sagittarius** The Archer	Sgr	Distinctive teapot pattern, marks the centre of the Milky Way.	Nunki	2.05	Sigma (σ)	34 Sgr	57	☐	
Sum	**Lyra** The Lyre or Harp	Lyr	Beautiful star fields in binoculars, Vega is the 5th brightest star.	Vega	0.03	Alpha (α)	3 Lyr	48	☐	
Sum	**Aquila** The Eagle	Aql	Look for a diamond-shaped pattern; Altair is the 12th brightest star.	Altair	0.76	Alpha (α)	53 Aql	49	☐	
Sum	**Capricornus** The Sea Goat	Cap	A wide V-shaped star field, Alpha Cap is a wide visual double star.	Al Giedi Dabih	3.60 3.05	Alpha (α) Beta (β)	6 Cap 9 Cap	58	☐	
Sum	**Cygnus** The Swan	Cyg	Rich in Milky Way stars, look for the outline of a bird in flight.	Deneb Albireo	1.25 3.36	Alpha (α) Beta (β)	50 Cyg 6 Cyg	56-57	☐	
Aut	**Pegasus** Winged Horse	Peg	Look for the Great Square of Pegasus w/ Markab opp. Alpheratz.	Markab	2.49	Alpha (α)	54 Peg	29	☐	
Aut	**Andromeda** Cassiopeia's child	And	Look for two lines of stars extending from Alpheratz.	Alpheratz	2.07	Alpha (α)	21 And	28	☐	
Aut	**Cassiopeia** The Queen	Cas	Cassiopeia has a distinctive "W" shaped pattern in the N. Milky Way.	Schedar	2.24	Alpha (α)	18 Cas	28-29	☐	
Aut	**Aries** The Ram	Ari	Look for Alpha & Beta Arietis between Andromeda & Taurus.	Hamal Sheratan	2.01 2.64	Alpha (α) Beta (β)	13 Ari 6 Ari	31-32	☐	
Aut	**Perseus** Rescuer of Andromeda	Per	The rich starfield near Mirfak is great in binoculars.	Mirfak	1.79	Alpha (α)	33 Per	29	☐	
Win	**Taurus** The Bull	Tau	The wide open cluster, the Hyades, is the head of Taurus the Bull.	Aldebaran	0.87	Alpha (α)	87 Tau	31	☐	
Win	**Auriga** The Charioteer	Aur	Look for a Pentagon-shaped asterism. Capella is the 6th brightest.	Capella	0.08	Alpha (α)	13 Aur	30	☐	
Win	**Orion** The Hunter	Ori	Prominent constellation with a rich starfield around the 3 Belt Stars.	Betelgeuse Rigel	0.45 0.18	Alpha (α) Beta (β)	58 Ori 19 Ori	30	☐	
Win	**Canis Major** The Big Dog	CMa	Located southeast of Orion, Canis Major contains the brightest star.	Sirius	- 1.44	Alpha (α)	9 CMa	30-31	☐	
Win	**Canis Minor** The Little Dog	CMi	A small constellation with the star Procyon as its mascot.	Procyon Gomeisa	0.41 2.89	Alpha (α) Beta (β)	10 CMi 3 CMi	34	☐	
Win	**Gemini** The Twins	Gem	The stars Castor and Pollux are the twins.	Castor Pollux	1.58 1.16	Alpha (α) Beta (β)	66 Gem 78 Gem	32-33	☐	

Observing the Moon (16 of 32)

As the closest major celestial object to the earth, the moon reveals more detail to observers than any other object. So much so, in fact, that a large number of lunar features can be clearly identified in binoculars. To observe the moon successfully requires a good Moon map, an understanding of lunar phases and sturdy tripod-mounted binoculars. East and West on the Moon are opposite from our earthly viewpoint, so the western hemisphere of the Moon will appear to face east and the eastern hemisphere will appear to face west, while north and south remain the same. Binoculars with 10X magnification will work best although observers can easily complete this phase with 7X magnification.



Lunar Phases (4 of 8 observations are required)

The RASC *Observer's Calendar* and other observing resources provide detailed information on the daily phase of the Moon and exact times of first quarter, full, third quarter, and new Moon.

Season	Approx Day	Object	Inst.	Observing Notes	BOG?	Seen? ✓	Log Page
Any	3	**Waxing Crescent ①**	V	Visible within 3 hours of sunset.	107	☐	
Any	7	**First Quarter ②**	V	Within 18 hours before or after exact time of phase.	107	☐	
Any	11	**Waxing Gibbous ③**	V	Visible 3-4 days after first quarter.	107	☐	
Any	14	**Full Moon ④**	V	Within 18 hours before or after exact time of phase.	107	☐	
Any	17	**Waning Gibbous ⑤**	V	Visible 3-4 days after full Moon.	107	☐	
Any	21	**Third Quarter ⑥**	V	Within 18 hours before or after exact time of phase.	107	☐	
Any	26	**Waning Crescent ⑦**	V	Visible within 3 hours of sunrise.	107	☐	
Any	Any	**Orbital Motion**	V	Over 1-2 days, track the Moon's orbital motion against background stars.		☐	

Lunar Basins / Maria (6 of 12 observations are required)

The dark lava plains known as lunar basins or *maria* are the most easily visible feature on the Moon. The following features are listed in order from east to west and will become visible as they rise each night during a lunar cycle, and all maria can be seen at full Moon. Note the relative sizes ranging from 55,000 km² to over 2 million km².

Season	Best Phase	Object	B/T/T	Size km²	Lat	Long	Observing Notes	BOG?	Seen? ✓	Log Page
Any	④	**Mare Crisium**	B/T	176,000	17ºN	59ºE	Sea of Crises. Size of Great Britain, Large impact basin 570 km in diameter.	113-114	☐	
Any	④	**Mare Fecunditatis**	B/T	326,000	4ºS	50ºE	Sea of Fertility	113-114	☐	
Any	④	**Mare Nectaris**	B/T	100,000	15ºS	35ºE	Sea of Nectar, 350 km in diameter.	113-114	☐	
Any	④	**Mare Tranquillitatis**	B/T	421,000	8ºN	32ºE	Sea of Tranquillity, Size of Black Sea, Apollo 11 landing site.	113-114	☐	
Any	④	**Mare Serenitatis**	B/T	370,000	28ºN	22ºE	Sea of Serenity bordered by Lacus Somniorum & Lacus Mortis	113-114	☐	
Any	④	**Mare Vaporum**	B/T	55,000	13ºN	3ºE	Sea of Vapours; circular basin 230 km in diameter located SE of the Apennine Mountains.	113-114	☐	
Any	④	**Mare Frigoris**	B/T	436,000	58ºN	45ºW-45ºE	Sea of Cold, northmost mare near the crater Plato.	113-114	☐	
Any	④	**Mare Imbrium**	B/T	830,000	51ºN-14ºN	40ºW-6ºE	Sea of Rains, large impact basin, 1250 km in diameter.	113-114	☐	

Sea-son	Best Phase	Object	B/T/T	Size km²	Lat	Long	Observing Notes	BOG?	Seen? ✓	Log Page
Any	④	**Mare Nubium**	B/T	254,000	20ºS	15ºW	Sea of Clouds	113-114	☐	
Any	④	**Sinus Iridum**	B/T	53,000	45ºN	32ºW	Bay of Rainbows flooded partial crater 260 km in diameter extending into Mare Imbrium.	113-114	☐	
Any	④	**Mare Humorum**	B/T	113,000	24ºS	39ºW	Sea of Moisture; 380km in diameter, nicely paired with Mare Nubium	113-114	☐	
Any	④	**Oceanus Procellarum**	B/T	2,102,000	42ºN-14ºS	68ºW-27ºW	Ocean of Storms, largest continuous feature covers the southeastern part of the Moon.	113-114	☐	

Impact Craters (6 of 12 observations are required)

For many years, the craters on the Moon were thought to be volcanic in nature. Our understanding of them now indicates that most of them are a result of major impacts by asteroids and comets. This has contributed greatly to our understanding of the formation and evolution of the Solar System.

"Best Phase" shows approximately when the objects will be near to the terminator and thus easiest to see with detail. Note that there is a complementary phase during the waning period when the same object will also be on the terminator but lit at sunset instead of at sunrise.

Sea-son	Best Phase	Object	V/B/T	Dia-meter	Lat	Long	Observing Notes	BOG?	Seen? ✓	Log Page
Any	3-4	**Petavius**	B/T	177 km	25ºS	60ºE	Prominent crater with central peak; look for Wrottesley nearby	111-113	☐	
Any	3-4	**Cleomedes**	B/T	126 km	28º N	56º E	Located near Mare Crisium; easily seen in binoculars	111-113	☐	
Any	4-5	**Posidonius**	B/T	95 km	32º N	30º E	Located on the edge of Mare Serenitatis; Crater walls 2300m high	111-113	☐	
Any	5-6	**Theophilus**	B/T	100 km	11º S	26º E	Prominent crater with 1400m central peak; Cyrillus and Catharina nearby	111-113	☐	
Any	5-6	**Aristoteles**	B/T	87 km	50º N	17º E	In Mare Frigoris; has deep terraced walls; look for Eudoxus nearby at the border of Frigoris	111-113	☐	
Any	8-9	**Ptolemaeus**	B/T	153 km	09º S	02º W	Prominent walled plain; Alphonsus and Arzachel to the south	111-113	☐	
Any	8-9	**Plato**	B/T	101 km	52º N	09º W	Outstanding crater that is easy to spot due to its dark floor	111-113	☐	
Any	8-9	**Tycho**	B/T	85 km	43º S	11º W	Famous crater featuring spectacular rays that are best observed at or near full Moon	111-113	☐	
Any	9-10	**Clavius**	B/T	225 km	58º S	14º W	Very large crater encompassing several smaller craters	111-113	☐	
Any	8-9	**Copernicus**	B/T	93 km	10º N	20º W	Spectacular crater with 3760m deep terraced walls; also features prominent rays at or near full Moon	111-113	☐	
Any	11-12	**Gassendi**	B/T	110 km	18º S	40º W	Prominent crater on the northern edge of Mare Humorum	111-113	☐	
Any	13-14	**Grimaldi**	B/T	222 km	05º S	67º W	Very large dark-floored crater located near the western edge of the Moon	111-113	☐	

The Solar System (5 of 10)

Our Solar System contains the planets, asteroids, comets, the Sun, and other wonders.

Season	Object	V/B/T	Observing Notes	BOG Ref	Seen? ✓	Log Page
†	**Mercury**	V/B/T	Mercury is the closest planet to the Sun. Unlike other planets, Mercury is visible only for a few weeks at a time; so check an annual guide such as the *Observer's Handbook* for the best times to spot this fast-moving, elusive object.	117-118	☐	
†	**Venus**	V/B/T	The brightest planet. Telescope users can see Venus go through phases similar to those of the Moon.	11-119	☐	
†	**Mars**	V/B/T	Known as the "Red Planet," it is best observed at opposition about every 26 months, although it can be seen often at other points of its orbit.	125-126	☐	
†	**Jupiter**	V/B/T	The largest planet in the Solar System with four bright moons nearby that can be seen in binoculars. Each moon can be identified by name using the *Observer's Handbook* but this is not mandatory.	126	☐	
†	**Saturn**	V/B/T	Any astronomical telescope will show Saturn's rings. Saturn has one bright moon named Titan and several fainter ones visible in telescopes.	126-127	☐	
Sum	**Uranus**	B/T	This planet can be seen clearly in binoculars, particularly when they are mounted on a tripod. A detailed finder chart is published annually in the *Observer's Handbook*. Telescopes will reveal the small round disc of this far away world.	127	☐	
Sum	**Neptune**	B/T	Neptune is similar to Uranus, but even further away and fainter. It also can be seen in binoculars using the same method as for Uranus. Seeing the disc of Neptune is more difficult but well within the reach of good amateur telescopes.	128	☐	
Any	**Orbital Motion**	V	Plot the orbital motion of a planet: This can be done easily by drawing the star field around a planet on two or more separate nights and recording the movement of the planet against the background stars, which do not move. Orbital motion can be plotted visually, through binoculars or telescopes, with the outer planets being the easiest to plot.		☐	
Any	**Artificial Satellites & Meteors**	V	Observe at least 3 Earth-orbiting artificial satellites (including spacecraft and the *International Space Station*) and 3 meteors (either sporadics or from a meteor shower).	144-148	☐	
Any	**Sunspots**	T (Filtered)	WARNING! Use properly filtered telescopes or binoculars. USE OF A GOOD QUALITY FULL-APERTURE SOLAR FILTER REQUIRED! This observation may best be done through the telescope of an experienced solar observer who has one set up for public viewing or club events.	154-156	☐	

† Mercury, Venus, Mars, Jupiter, and Saturn have relatively short orbital periods and their visibility varies from one year to the next. Consult the *Observer's Handbook* or *The Beginner's Observing Guide* for details on current positions and visibility.

Optional Observations

Sea-son	Object	V/B/T	Observing Notes	BOG Ref	Seen? ✓	Log Page
Any	**Eclipses**	V	Eclipses occur when one Solar System object passes in front of and hides another Solar System object. A **solar eclipse** occurs when, on passing between the Sun and the Earth, the Moon is closely enough aligned to hide at least part of the Sun, as viewed from the Earth. A **lunar eclipse** occurs when, on passing between the Sun and the Moon, the Earth is closely enough aligned for its shadow to fall upon at least some of the Moon. For both solar and lunar eclipses, use the predictions listed in *The Beginner's Observing Guide* or the *Observer's Handbook* to plan your observations.	110-114		
Any	**Conjunctions**	V	When two or more celestial objects appear close together in the sky, it is called a conjunction. These are regular occurrences that are listed in *The Beginner's Observing Guide*, the *Observer's Handbook*, and in popular astronomy magazines.	115		
Any	**Meteor Showers**	V	**Sporadic meteors** can be seen on most dark, clear nights. **Meteor showers** are regular events occurring at different times throughout the year with high rates of meteors appearing to come from a specific zone or **radiant** in the sky. Look for a dark moonless night and be prepared to stay up late, as the best observing is usually after midnight.	116-119		
Any	**Aurorae**	V	Aurorae borealis (or the Northern Lights) are caused by streams of solar particles striking the upper atmosphere and causing it to glow. Best in dark skies.	120-122		
Any	**Comets**	V/B/T	Small bodies left over from the birth of the Solar System, comets are usually quite faint and require a medium- to large-sized telescope to observe. Occasionally a comet will appear that is bright enough to be seen through binoculars or even visually.	123-124		
Win Fall	**Zodiacal Light**	V	For mid-northern observers the best time to view this pyramid of light is after dusk in the western sky during February and March or in the pre-dawn eastern sky during September and October.	125		
Any	**Asteroids**	B/T	Several asteroids are bright enough to be seen in small instruments. You can locate these objects by using a finder chart in the *Observer's Handbook* or by using the co-ordinates listed there.	OH		

Deep-Sky Objects (12 of 24)

"Deep-Sky Objects" is the catch-all description applied to some of astronomy's most interesting sights including:

Open Clusters – Loose agglomerations of stars, recently emerged from the giant molecular clouds that gave them birth.
Globular Clusters – Ancient spherical clusters of stars, often containing hundreds of thousands of stars.
Emission/Reflection Nebulae – Glowing clouds of interstellar gas or dust, often marking the birth or death of stars.
Planetary Nebulae / Supernova Remnants – Glowing clouds of gas and dust marking the death of stars.
Galaxies – Huge "Island Universes," like the Milky Way, containing hundreds of billions of stars but so distant that they are merely hazy patches of light.

All of the deep-sky objects on this list can be observed with binoculars and many can be sighted visually. Larger telescopes will reveal more detail. The Season indicates best viewing during the evening hours, but many objects can also be sighted before and after the suggested time.

Sea-son	Cons	Object	Mag.	RA	Dec	Observing Notes	BOG?	Seen? ✓	Log Page
Spr	Cnc	**M44** The Beehive	3.10	08:40.1	+19:59	Open cluster. 95', With a magnitude of 3.1, this cluster is bright enough to be quite easily seen with the unaided eye from a dark sky. To locate it, try scanning along an imaginary line from Regulus in Leo to Pollux in Gemini.	38	☐	
Spr	Com	**Coma Cluster** Melotte 111	1.80	12:25.0	+26:00	Open cluster. 275', This rather large group of stars lies between Leo and Boötes. It is made up of several chains of mag. 5-6 stars that are said to be the amber tresses of Queen Berenice's hair offered to the god Aphrodite for the safe return of her beloved king from battle.	40 (Map)	☐	
Spr	Ser	**M5** NGC 5904	5.70	15:18.6	+02:05	Globular cluster, 17.4' : A globular that is as big and bright as the more famous M13. It is located about 2½ binocular fields north of Beta Librae, the northernmost bright star in Libra.	52	☐	
Sum	Her	**M13** Hercules Cluster	5.70	16:41.7	+36:28	Globular cluster, 17', This well-known globular cluster contains hundreds of thousands of stars. Look for an out of focus star below Eta, the upper-right Keystone star in Hercules. Note the two 7th magnitude stars lying on either side.	59	☐	
Sum	Sco	**M4** NGC 6121	5.80	16:23.6	-26:32	Globular cluster, 26', Located a degree west of Antares in Scorpius, this globular cluster is easily found under a dark sky. However, because most of its individual stars are quite dim, it can prove difficult from light-polluted skies.	59	☐	
Sum	Ser	**M16** Eagle Nebula	6.00	18:18.6	-13:58	Emission nebula & open cluster 35'x28', Located 4 degrees north of the M24 (see below) this nebulous open cluster contains between 20 and 30 stars ranging from magnitude 8 to 10.		☐	
Sum	Sgr	**M8** Lagoon Nebula	~3.00	18:03.8	-24:23	Emission nebula, 45' x 30', This huge cloud of gas is bisected at one end by a dark lane. To find this deep-sky object, first locate the spout of the Sagittarius "teapot" and simply slew your binoculars upward 6 degrees.	59	☐	
Sum	Sgr	**M17** Swan Nebula	6.00	18:20.8	-16.11	Emission nebula, 20' x 15', also known as the Omega Nebula. It is located about halfway between M24 & M16. You may also note the open cluster M18 just below it.	59	☐	
Sum	Sgr	**M22** NGC 6656	5.10	18:36.4	-23.54	Globular cluster, 24', This globular cluster is almost a magnitude brighter than the well-known M13. Look for a nebulous disk two degrees north-east from the top of the teapot lid.	59	☐	
Sum	Sgr	**M23** NGC 6494	5.50	17:56.8	-19.01	Open cluster, 27', Nearly 5 degrees west of M24 (see below) lies this rich open cluster made up of over 120 faint stars. Under dark skies, you may be able to resolve some of them with a pair of 10x50 binoculars.		☐	
Sum	Sgr	**M24** Sagittarius Starcloud	4.60	18:16.5	-18:50	Star cloud, 95' x 35', The small Sagittarius star cloud lies a little over 7 degrees north of the teapot lid. On some charts it is mislabelled as the small open cluster NGC 6603. It's actually the large cloud surrounding NGC 6603.		☐	
Sum	Sgr	**M25** IC 4725	4.60	18:31.6	-19:15	Open cluster, 32', Slew your binoculars about 3 degrees eastward of M24, and you'll be rewarded with a view of this attractive little cluster containing several bright stars.		☐	

Sea-son	Cons	Object	Mag.	RA	Dec	Observing Notes	BOG?	Seen? ✓	Log Page
Sum	Sct	**M11** Wild Duck Cluster	5.80	18:51.1	-06:16	Open cluster, 13', You can find the "wild duck" cluster, as Admiral Smyth called it, nearly three degrees west of Aquila's beak lying in one of the densest parts of the summer Milky Way: the Scutum Star Cloud.	59	☐	
Sum	Vul	**Collinder 399** The Coathanger	3.60	19:25.4	+20.11	aka Brocchi's Cluster, 60', Popularly known as The Coathanger this unmistakable collection of 10 stars lies a little over 7 degrees below Beta Cygni, the head of the swan.		☐	
Aut	And	**M31** Andromeda Galaxy	3.40	00:42.7	+41.16	Nearest major galaxy, 185' x 75', How easy or difficult this object is to observe will depend mostly on the darkness of the sky. Follow the outline of Andromeda to the second pair of stars and scan the area just to the north for an elongated fuzzy patch of light.	73	☐	
Aut	Per	**Alpha Persei Group**	1.20	03:22.0	+49.00	Open cluster, 185', Also known as Melotte 20, this large, beautiful group of stars is located near Alpha Persei (proper name Mirfak) and is best seen in binoculars.		☐	
Aut	Per	**Double Cluster** NGC 869/884	5.30	02:19.0	+57.09	Double open cluster, 29' ea. If you scan the Milky Way between Cassiopeia and Perseus under a dark sky, these two beauties will be hard to miss. Even without binoculars, you'll probably see a misty patch that betrays the presence of one of the northern sky's grandest sights.	60, 73	☐	
Win	Tau	**M45** Pleiades	1.20	03:47.0	+24:07	Visual open cluster, 110'. Known since ancient times, this spectacular cluster is best viewed through binoculars or a wide-field telescope.	73	☐	
Win	Tau	**Hyades**	0.50	04:27.0	+16:00	Unaided-eye open cluster, 330'. This is the group of stars that forms the V-shaped head of Taurus the bull. Although it's easily visible with the unaided eye, take a closer look with binoculars and you'll see the beautiful and colourful double stars Theta (1&2) and Delta (1&2).	36	☐	
Win	Cam	**Kemble's Cascade**	4.00	03:57.0	+63:00	String of stars, 180'. From Alpha Persei, go two binocular fields towards Polaris and you will see a long string of stars resembling a waterfall. The asterism is named after the late Fr. Lucian Kemble, of the RASC's Regina Centre. You may also see the small open cluster NGC1502 at the end of the string.		☐	
Win	Aur	**M37** NGC 2099	5.60	05:52.4	+32:33	Open cluster, 20', If you follow an imaginary line northward along the feet of Gemini for a couple of fields of view, you should see this cluster. Although you won't be able to resolve many of this cluster's faint stars with binoculars, if you look closely, you should notice how much more concentrated it becomes toward the centre. You may see M36 & M38 nearby.	73	☐	
Win	Ori	**M42** Orion Nebula	4.60	05:35.4	-05:27	Great Nebula in Orion, 65' x60', The brightest nebula visible in the northern hemisphere. Appears as a bright green cloud surrounding Theta 1 and Theta 2 Orionis, the middle stars in Orion's sword. Once you find M42, just look at the top of the field of your binoculars and you'll see an attractive little group of 7 stars shaped like an aardvark; this is NGC 1981.	36	☐	
Win	Gem	**M35** NGC 2168	5.10	06:08.9	+24:20	Open cluster, 28', Another open cluster, this one lies at the feet of Gemini. Its appearance is best under dark skies, but it can be seen fairly well with 10x50 binoculars from a suburban location.	36	☐	
Win	Pup	**M47** NGC 2422	4.40	07:36.6	-14:30	Open cluster, 29', Starting from Sirius, look about two binocular fields eastward for a little splash of stars. In dark skies, you may also see the faint wisp of M46 (NGC 2437) in the same field.	37	☐	

Magnitude: Magnitudes are expressed in the same way as stars but deep-sky objects often appear fainter because they are diffuse or spread out over the sky.
Size: Measured in arc-minutes. Once you have identified the object, make a note of its relative size in arc-minutes. This will help you gain a feel for angular measurements used in astronomy. Deep-Sky Objects are often extended in nature and can cover significant areas in the sky. For comparison, the full Moon is about 30' in diameter or ½º.
Right Ascension – "RA" is the equivalent of longitude used on maps of the Earth. The 360 degrees of sky, measured around the celestial sphere, is used as the basis for 24 hourly sections of Right Ascension as seen on star maps.
Declination – The 90 degrees of sky measured north and south of the celestial equator, is written on star maps as +1 to +90 (degrees north) and -1 to -90 (degrees south) with 0 degrees marking the celestial equator.

Double & Multiple Stars (10 of 20)

Double stars appear to the unaided eye as a single star, but when viewed through binoculars or a telescope they can be split into two components. **Optical doubles** are a chance alignment in space that are adjacent to one another when viewed from Earth. **Physical doubles** are near one another (as part of an open cluster), while **binaries** are known to orbit around a common centre of mass. For certain double stars, you can detect this orbital motion over a period of a few years.

Double stars offer interesting colour contrasts, magnitude differences, and separations, and many can be viewed easily from locations with moderate to heavy light pollution. To complete this section, it is suggested that you work with binoculars mounted on a tripod. To find the stars listed, you will need a good star atlas where you can plot their location using the co-ordinates listed for each one. A good way to confirm that you are observing the double star you are looking for is to check the magnitude, separation, and position angle.

Note: **Separation** is measured in arc-seconds. The larger the separation, the more easily you can discern the split between the stars. The **Position Angle** is the apparent angle measured from the brighter star to the dimmer one where due north is 0º and 90º is measured counter-clockwise from 0 degrees north as seen on a star atlas. The north point can be found on a star map by using the lines of Right Ascension (RA) that always point north. Be sure to carefully orient the map when checking your position angles to match your eyepiece view.

Season	Cons	Object	Mag.	Sep.	Pos. Angle	RA	Dec	Observing Notes	BOG?	Seen? ✓	Log Page
Spr	Leo	**Zeta-36**	3.5 & 5.8	325.9"	340º	10:16.7	+23:25	Proper name; Aldhafera. Secondary is 35 Leonis; Optical pair.		☐	
Spr	Com	**17 Com**	5.3 & 6.6	145.4"	251º	12:28.9	+25:55	In Coma Cluster; Common proper-motion pair.		☐	
Spr	Com	**32 & 33 Com**	6.3 & 6.7	95.2"	49º	12:52.2	+17:04	Located south of the Coma Cluster near the star Alpha Comae Berenices.			
Spr	CVn	**15 & 17**	6.3 & 6.0	284.0"	277º	13:09.6	+38:32	Nice even-magnitude pair located near Alpha CVn.		☐	
Spr	UMa	**Zeta 79&80**	2.4 & 4.0	708.7"	71º	13:23.9	+54:56	Middle star in the Big Dipper handle; Zeta 79 is also a telescopic double.		☐	
Spr	Lib	**Alpha 2&1**	2.8 & 5.2	231.0"	314º	14:50.9	-16:02	Proper name Zuben El Genubi. Common proper-motion pair. Look for colour.		☐	
Spr	Boo	**Mu 51**	4.3 & 7.0	108.3"	171º	15:24.5	+37.23	Located near Beta and Delta Bootis, a nice contrast of magnitudes.			
Spr	CrB	**Nu-1&2**	5.4 & 5.3	364.4"	165º	16:22.4	+33:48	Look for the half circle of CrB then starhop from 13-Epsilon.		☐	
Spr	Dra	**17&16**	5.4 & 5.5	90.3"	194º	16:36.2	+52:55	Find the 4 star "Head of the Dragon" pattern then use 23-Beta and 33-Gamma as pointers.		☐	
Spr	Dra	**Nu-24&25**	4.9 & 4.9	61.9"	312º	17:32.2	+55:11	Located in the 4 star "Head of the Dragon" pattern. An outstanding even-magnitude double!		☐	
Sum	Lyr	**Epsilon**	5.4 & 5.1	207.7"	173º	18:44.3	+39:40	Wide easy binocular pair. Telescope users can try splitting each star again to see the Double-Double.		☐	
Sum	Lyr	**Zeta 6&7**	4.3 & 5.9	43.7"	150º	18:44.8	+37:36	Zeta, Epsilon, and Vega form a wide triangle. Use tripod-mounted binoculars or a telescope.		☐	
Sum	Lyr	**Delta 11&12**	5.6 & 4.5	630.0"	n/a	18:53.7	+36:58	Very wide, easy binocular double with colour. From Vega, go to Zeta, then on to Delta.		☐	
Sum	Cap	**Alpha 2&1**	3.6 & 4.2	377.7"	291º	20:18.1	-12:33	Wide visual or binocular double in nice starfield.		☐	
Sum	Cap	**Beta 1&2**	3.4 & 6.2	205.3"	267º	20:21.0	-14:47	Look for Beta just below Alpha. Nice magnitude contrast with secondary star.		☐	
Sum	Cyg	**Omicron 31 (Triple!)**	3.8 - 6.7 4.8	107.0" - 337.5"	173º - 323º	20:13.6	+46:44	Beautiful triple star for binoculars. Look for colour.		☐	

Sea-son	Cons	Object	Mag.	Sep.	Pos. Angle	RA	Dec	Observing Notes	BOG?	Seen? ✓	Log Page
Sum	Cyg	**Albireo (Beta Cygni)**	3.1 & 5.1	34.3"	54º	19:30.7	+27:58	Albireo is one of the most beautiful double stars in the sky. Use tripod-mounted binoculars or a telescope.		☐	
Aut	Cyg	**16 Cygni**	6.0 & 6.2	39.5"	133º	19:41.8	+50:32	Impressive pair located in the area of 10-Iota Cyg (3.8m) and just next to 13-Theta (4.5m). Use tripod-mounted binoculars or a telescope.		☐	
Win	Tau	**78&77 Tauri**	3.4 & 3.8	337.4"	346º	04:28.7	+15:52	Located in the beautiful Hyades star cluster.		☐	
Win	Cep	**Delta 27**	3.4 & 7.5	40.7"	191º	22:29.2	+58:25	This famous Cepheid variable is also a very pretty double star. Use tripod-mounted binoculars or a telescope.		☐	

Variable Stars (Supplementary)

Observing variable stars is one of the ways that backyard astronomers can contribute information that is helpful to professional astronomers. Because of the great number of observations required for variable stars, large observatories cannot provide enough observing time for experts to monitor them all. Many of these stars are among the most interesting and beautiful stars in the night sky, and it is well worth the effort to find them. There are four main categories of variable stars including **Pulsating**, **Eruptive**, **Eclipsing** and **Rotating**. Each major category has several specific groups within it.

The **Pulsating** category includes Cepheid variables, RR Lyrae-type stars, RV Tauri-type stars, Omicron Ceti (Mira)-type stars that are also known as Long-Period Variables (LPV). Also included in the Pulsating group are Semi-Regular and Irregular variable stars. The **Eruptive** category includes Supernovae, Novae, Recurrent Novae, U Geminorum type stars, Z Camelopardalis type stars, SU Ursae Majoris type stars, R Coronae Borealis type stars, and Symbiotic stars. The **Eclipsing** category (two or more stars passing in front of one another from our point of view) includes Beta Persei (Algol) type stars, Zeta Aurigae type stars, Beta Lyrae type stars, W Ursae Majoris type stars and Ellipsoidal variables. The **Rotating** category includes RS Canum Venaticorum type stars that undergo small amplitude changes. More information about these specific groups of stars can be found in the *Observer's Handbook* or in other fine observing guides. Another excellent source of information is the American Association of Variable Star Observers (AAVSO). Variable star charts are available from the AAVSO on their Web site.

All of the stars listed here are from the Pulsating and Eclipsing categories. It is important when recording variable star magnitudes to observe the star regularly and to make a note of the date and time of each observation. Magnitude information includes "Ex" magnitudes that are extreme variations and "Av" which are long-term average variations. If your time is limited, it is recommended that you make better observations of a moderate number of variable stars regularly than trying to observe a large number sporadically.

For more information on Variable Stars and Variable Star observing, consult the *Observer's Handbook* and the American Association of Variable Star Observers (AAVSO) at www.aavso.org.

Visual / Binocular Objects

Sea-son	Cons	Star	Variable Type	Magnitude Range	Period (days)	Spectral Range	RA	Dec	Notes
Sum	Lyr	Beta 10 Lyrae	E (Eclipsing Binary)	3.3-4.3	12.94	B8-A8	18:50.1	+33:22	Bright EB; Proper name Sheliak; use Gamma Lyrae (Mag.3.3) for comparison.
Sum	Aql	Eta 55 Aquilae	DCEP (Delta Cepheid)	3.5-4.4	7.17	F6-G4	19:52.5	+01:00	Bright Cepheid; use Beta Aquilae (Mag.3.7) for comparison.
Aut	Cep	Mu Cephei	SR (Semi-Regular)	3.4-5.1	730	M2	21:43.5	+58:47	Known as Herschel's "Garnet Star." Compare colour to the white star Alpha Cephei.
Aut	Cep	Delta 27Cephei	DCEP (Delta Cepheid)	3.5-4.4	5.36	F5-G2	22:29.2	+58:25	First Cepheid discovered; use Epsilon Cephei (Mag. 4.2) and Zeta Cephei (Mag.3.4) for comparison.
Aut	Per	Beta 26 Persei (Algol)	E (Eclipsing Binary)	2.1-3.4	2.86	B8+G5	03:08.2	+40:57	Proper name Algol; use Epsilon Per (Mag. 2.9), Delta Per (Mag.3.1), Kappa Per (Mag.3.8), and Gamma And (Mag.2.2) for comparison.
Win	Tau	Lambda-35 Tauri	E (Eclipsing Binary)	3.5-4.0	3.95	B3+A4	04:00.7	+12:29	Bright eclipsing binary; use Gamma Tauri (Mag. 3.6) and Xi Tauri (Mag. 3.7) for comparison.
Win	Gem	Zeta 43 Geminorum	DCEP (Delta Cepheid)	3.6-4.2	10.15	F7-G3	07:04.1	+20:34	Bright Cepheid; use Kappa Gem (Mag. 3.6) and Upsilon Gem (Mag. 4.2) for comparison.

Binocular / Small Telescope Objects

Season	Cons	Star	Variable Type	Magnitude Range	Period (days)	Spectral Range	R.A.	Dec.	Notes
Spr	CVn	Y Canum Venaticorum	SR (Semi-regular)	4.8-6.4	157	C5-4J (N3)	12:45.1	+45:26	Known as "La Superba," it is a deep-red carbon star with a semi-regular period.
Sum	Oph	X Ophiuchi	M (Mira, Long Period Variable)	6.8-8.8 (Av) 5.9-9.2 (Ex)	334	M6-K1	18:38.3	+08:50	Good example of a long-period variable for small instruments; variable-star chart recommended.
Sum	Scu	R Scuti	RV (RV Tauri)	5.0-7.0 (Av) 4.5-8.6 (Ex)	140	G0-K0	18:47.5	-05:42	RV Tauri type variable with cycles of shallow and deep minima.
Sum	Lyr	RR Lyrae	RR (RR Lyrae)	6.9-8.1	0.56	A8-F7	19:25.5	+42:47	Interesting short-period variable that goes through a complete cycle in less than one day.
Aut	Cet	Omicron 68Ceti (Mira)	M (Mira, Long Period Variable)	3.4-9.5 (Av) 2.0-10.1 (Ex)	332	M5-M9	02:19.3	-02:59	Proper name Mira; has the brightest maxima of all LPV's and is the prototype of its class.
Win	Mon	T Monocerotis	DCEP (Delta Cepheid)	5.6-6.6	27.02	F7-K1	06:25.2	+07:05	Located near the Rosette Nebula, just north of the star Epsilon Monocerotis.

Small/Medium Telescope

Sea-son	Cons	Star	Variable Type	Magnitude Range	Period (days)	Spectral Range	RA	Dec	Notes
Spr	Leo	R Leonis	M (Mira, LPV)	5.8-10.0 (Av) 4.4-11.3 (Ex)	313	M8	09:47.6	+11:26	Bright LPV that is well placed for observing in the spring season.
Spr	Vir	R Virginis	M (Mira, LPV)	6.9-11.5 (Av) 6.0-12.1 (Ex)	146	M4.5	12:38.5	+06:59	LPV with a shorter-than-average period of just 145 days.
Sum	Aql	R Aquilae	M (Mira, LPV)	6.1-11.5 (Av) 5.5-12.1 (Ex)	284	M5-M9	19:06.4	+08:14	The brightest LPV in Aquila. Its red colour intensifies around minima.
Aut	Cep	S Cephei	M (Mira, LPV)	8.3-11.2 (Av) 7.4-12.9 (Ex)	486	C7(N8)	21:35.2	+78:37	A carbon star that is one of the reddest known. Look for it between Kappa and Gamma Cephei. It will be reddest around minima.
Win	Tau	RW Tauri	E (Eclipsing Binary)	7.9-11.4	2.76	B8+K0	04:03.9	+28:08	An interesting EB that drops 3.5 magnitudes during eclipse. It is located near the star 41 Tauri.
Win	Lep	R Leporis	M (Mira, LPV)	6.8-9.6 (Av) 5.5-11.7 (Ex)	432	C6	04:59.6	-14:48	Known as Hind's "Crimson Star," it is a red carbon star that displays a deep red crimson hue around minima.
Win	Ori	U Orionis	M (Mira, LPV)	6.3-12.0 (Av) 4.8-12.6 (Ex)	372	M6.5	05:55.8	+20:10	An excellent LPV that features a large range in brightness. Find it near 54 and 57 Orionis.