

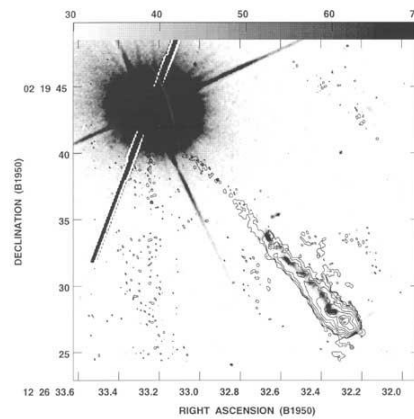
A.

i. Who first moved Earth from the center of the universe?

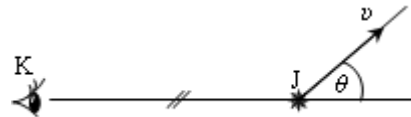
1. Galileo
2. Aristarchus
3. Copernicus
4. Cassini
5. Zhang Heng
6. al-Biruni
7. Kepler
8. Brahe
9. Aryabhatta

ii. The obliquity of the ecliptic in degrees. (one decimal)

iii. The first known and brightest quasar is 3C__.



iv. A relativistic jet moves at $0.83c$. If no Doppler shift is observed, how many degrees is the angle between the jet and the line of sight, assuming that the source has negligible velocity? (integer)

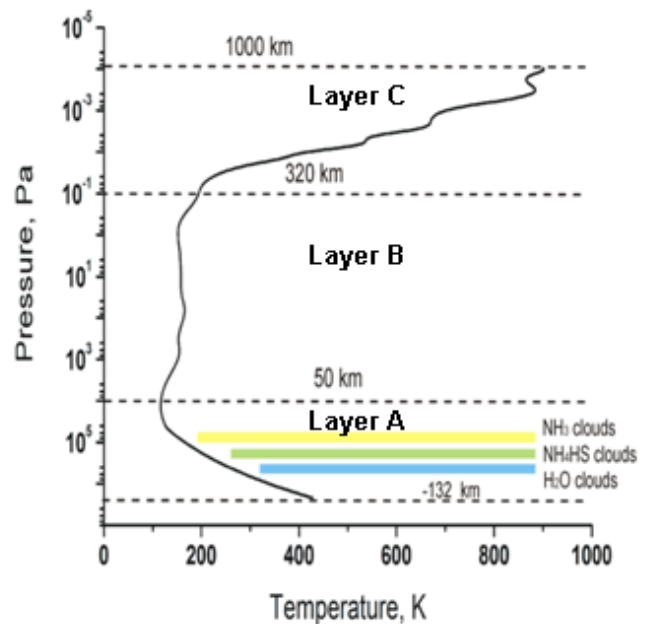


v. This nebula is NGC__.



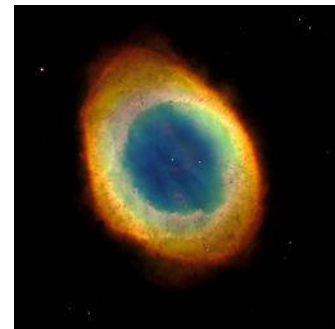
- vi. Choose the names of the layers A, B and C of the Jovian atmosphere, beginning from Layer A.

1. Troposphere
2. Magnetosphere
3. Ionosphere
4. Ozone layer
5. Thermosphere
6. Lithosphere
7. Chromosphere
8. Photosphere



B.

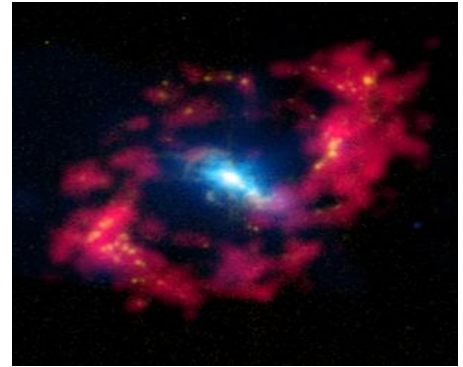
- i. How many AU is one parsec? (integer)
- ii. Jupiter-Sun-Trojan Asteroids angle (degrees). (integer)
- iii. This nebula is M__.



- iv. On the 25th of August, at a latitude of $\varphi > 0$ and longitude $\lambda_L = 37^\circ W$, we observe a star with Declination $\delta > 0$ complementary to the latitude and Right Ascension $\alpha = 67.5^\circ$. What is the local civil time in hh:mm during the rising and set of the star? It is given that $T_{o\ 24/8} = 21^h 58^m$.
- v. During a Meteor Shower, in a radius of 100km, an observer counted 600 meteors/min. If the velocity of the meteors was 10km/s with opposite direction to that of the Earth's orbital velocity, what is the mean distance between two meteors in km? (integer)
- vi. The photon's spin.

C.

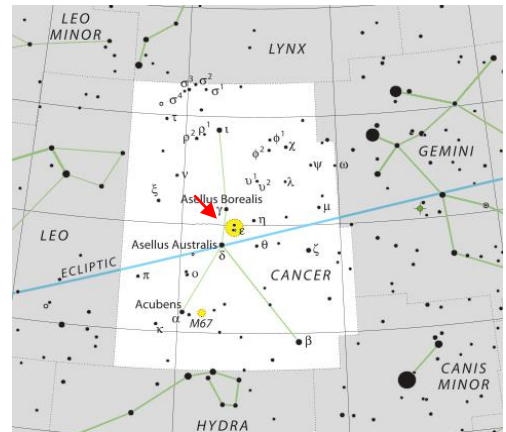
- i. This image shows the centre of one of the first known Seyfert galaxies, dubbed the "Eye of Sauron". It is NGC__.



- ii. A galaxy in the constellation Triangulum is M__.

- iii. Pluto's moons.

- iv. The Beehive Cluster is M__.

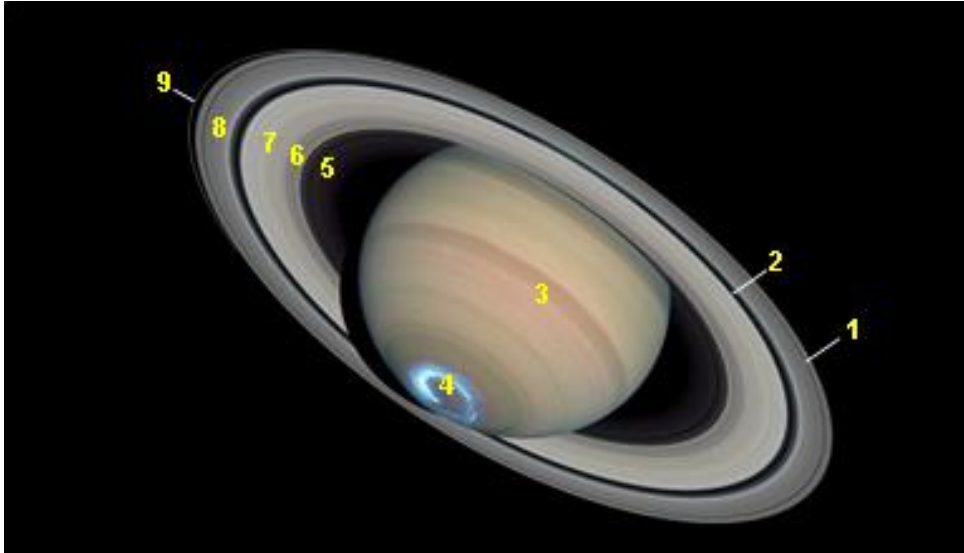


- v. Extinction in the interstellar medium is mainly due to __ scattering.

1. Compton
2. Rayleigh
3. Mie
4. Bragg
5. Brillouin
6. Mott
7. Thompson
8. Rutherford

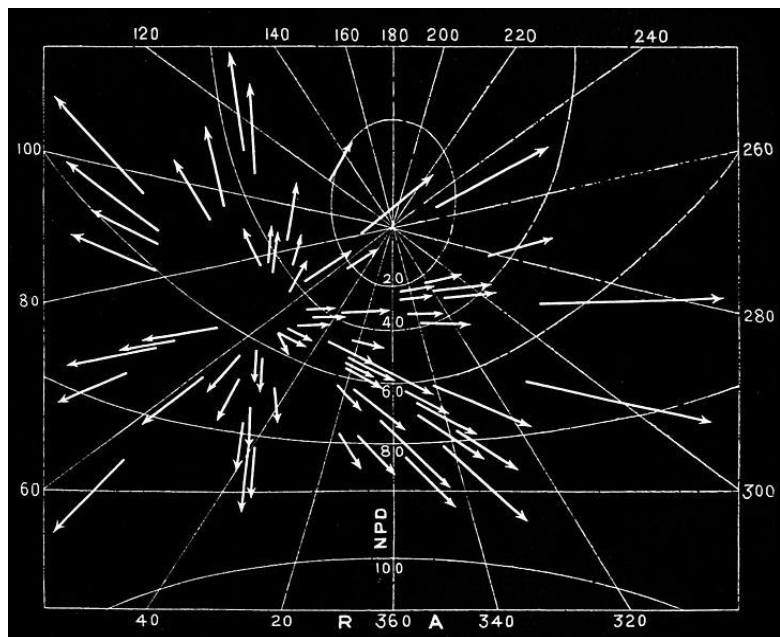
- vi. Proxima Centauri is 4.243ly distant. It has apparent magnitude of 11.5mag and approaches Earth at 21.7km/s. After how many thousands of years will it be visible to the naked eye? (integer)

vii. Cassini Division, D Ring, Encke Gap, A Ring



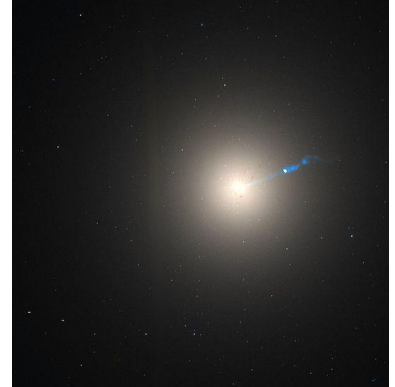
viii. The radiant point of this meteor shower lies in:

1. Cygnus
2. Gemini
3. Leo
4. Perseus
5. Cetus
6. Orion



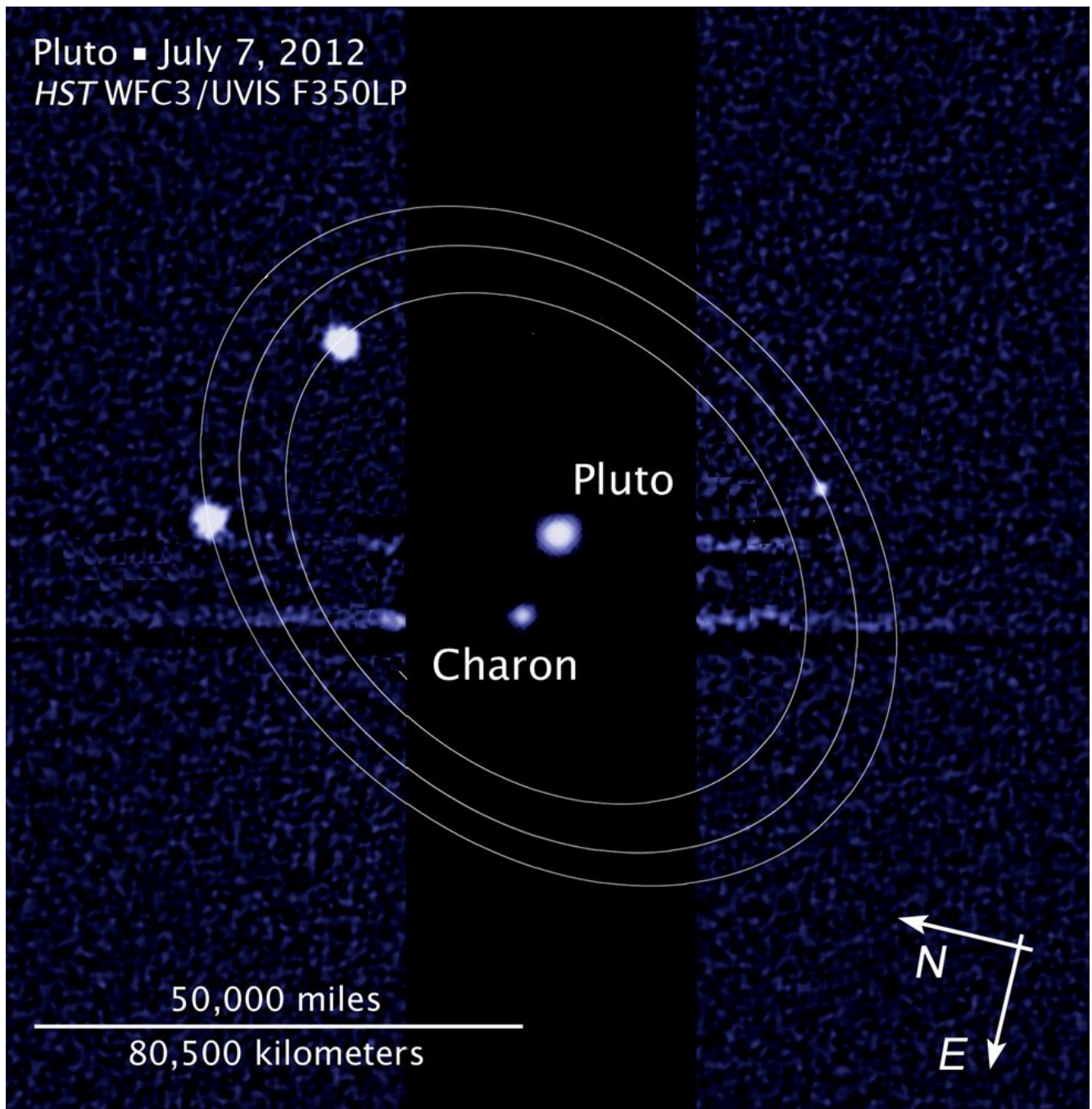
D.

- i. At this Lagrange point on the orbit of Jupiter lies a Trojan camp!
- ii. Kiloparsec to light-years. (integer)
- iii. The mean distance of Venus from Sun (AU). (two decimals)
- iv. The supergiant elliptical galaxy near the centre of the Virgo Galaxy Cluster is M__.



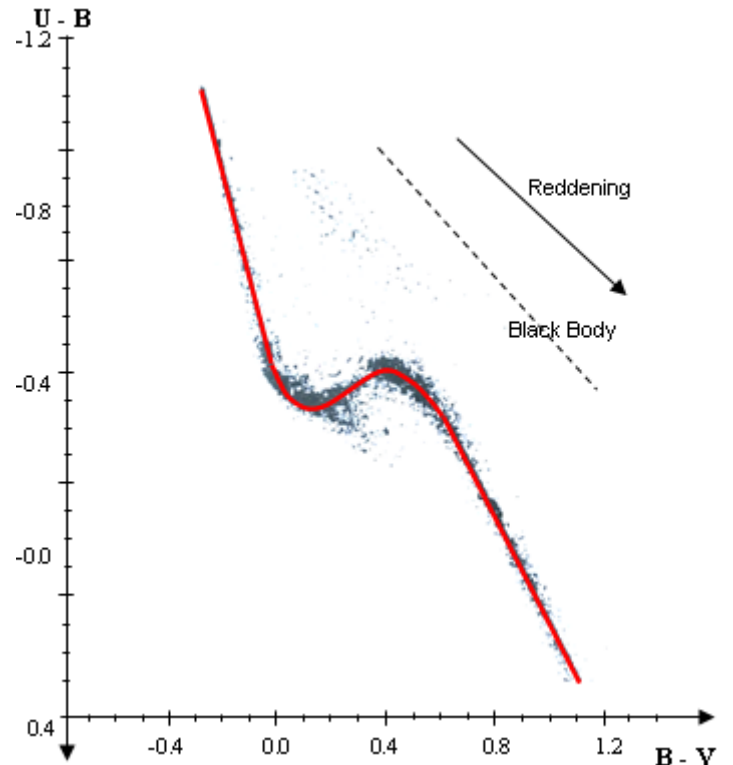
- v. The molar mass of the substance that forms clouds in the upper atmosphere of Venus.
- vi. Gordian starships are spherical, while Ozata ships are ellipsoids of revolution with small semi-major axes $a=b$ (the corresponding semi-minor axis of the appropriate ellipse) equal to the radius of the Gordian starships and flattening equal to 0.159664 . With what speed (relative to the speed of light) do the Ozata starships have to travel in order to look like the starships of the Gordian? (two decimals)

- vii. The orbital period of Charon is $T=6.387\text{days}$. Find the order of magnitude of the mass of the Pluto-Charon system (kg), ignoring the masses of other bodies. Assume that the major-axis of each ellipse is perpendicular to the line of sight.

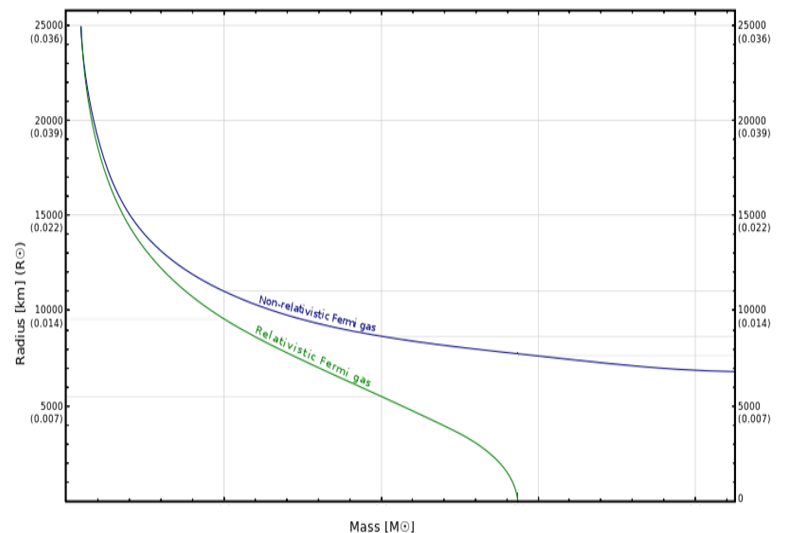


E.

- i. A A_0V star has observed Colour Index $B-V=0.70$. How many times brighter would the star look if there was no interstellar extinction? Consider that $A_V=3 \cdot E_{B-V}$, where E_{B-V} is the Colour Excess and A_V is the Visual Absorption. (integer)
- ii. The sidereal rotation period at the equator of the Sun (days). At the spectrum of the Sun, the line H_α ($\lambda=6,563\text{\AA}$) has a broadening of $0.089\text{\AA}$. (integer)
- iii. One star has a $B-V$ colour index of 0.2mag and a $U-B$ colour index of -0.1mag . What is its Colour Excess E_{B-V} ? (one decimal)



- iv. A limit to the mass of a specific class of stars. (two decimals)

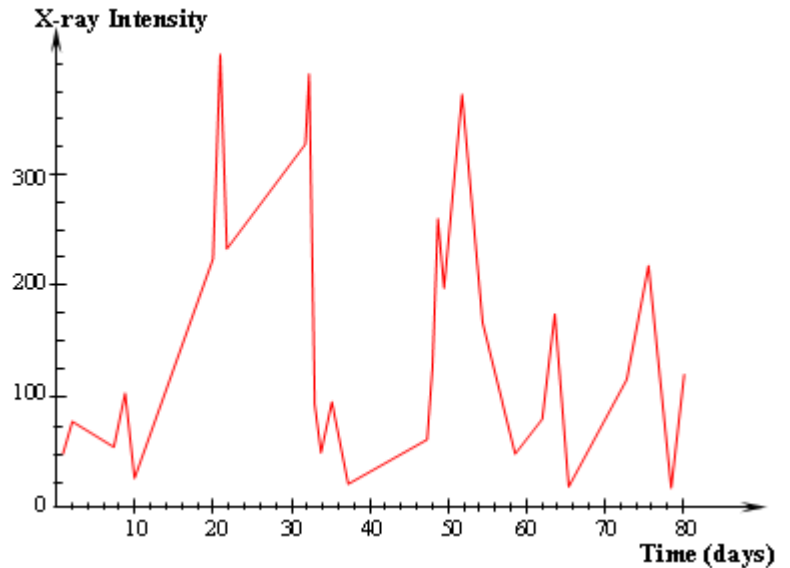


v. The orbital period of Mercury (days). (integer)

vi. The axial tilt of an exoplanet without atmosphere is 0° . Its orbital period is really long. How many times greater is the temperature of the illuminated (by the corresponding star) hemisphere when the planet spins really slowly compared to when it spins really quickly? (one decimal)

vii. The atomic mass of the heaviest element which can be produced in a star, before it meets its end.

viii. An AGN shows rapid variations in X-ray intensity because of the existence of X-ray emitting regions with various sizes. What is the minimum size possible of the greatest X-ray-emitting region (light days)?

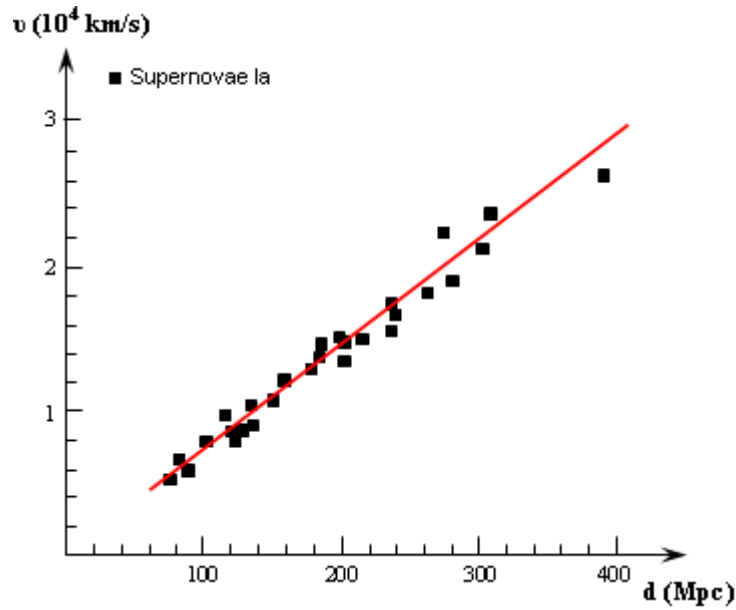


ix. The inventor of the telescope.

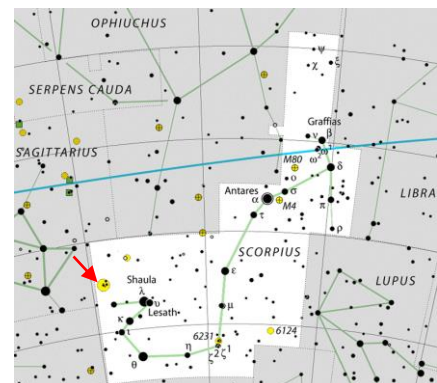
1. Demisianos
2. Brache
3. Ibn Sahl
4. Lippershey
5. Huygens
6. Harriot
7. Marius
8. Newton
9. Galileo

F

- i. The value of the constant that still troubles the astronomers. (integer)



- ii. Ptolemy's Cluster is M__.



- iii. What is the critical radius in parsec over which a spherical, homogeneous and isothermal interstellar nebula of atomic hydrogen with temperature $T=30K$ and numerical density $n=30 \times 10^6 \text{ particles/m}^3$ becomes unstable and starts collapsing under the influence of its own gravity? (one decimal)

- iv. Castor is a multiple star of how many components?

- v. M1 was recorded in __AD.



vi. In the spectral classification system, what is the number representing subdwarfs?

vii. Alcyone, Taygeta, Maia, Electra, Atlas



viii. In the spectral classification system, what is the number representing stars like the Sun?

G

i. Bode's Galaxy is M__.

ii. Cigar Galaxy is M__.

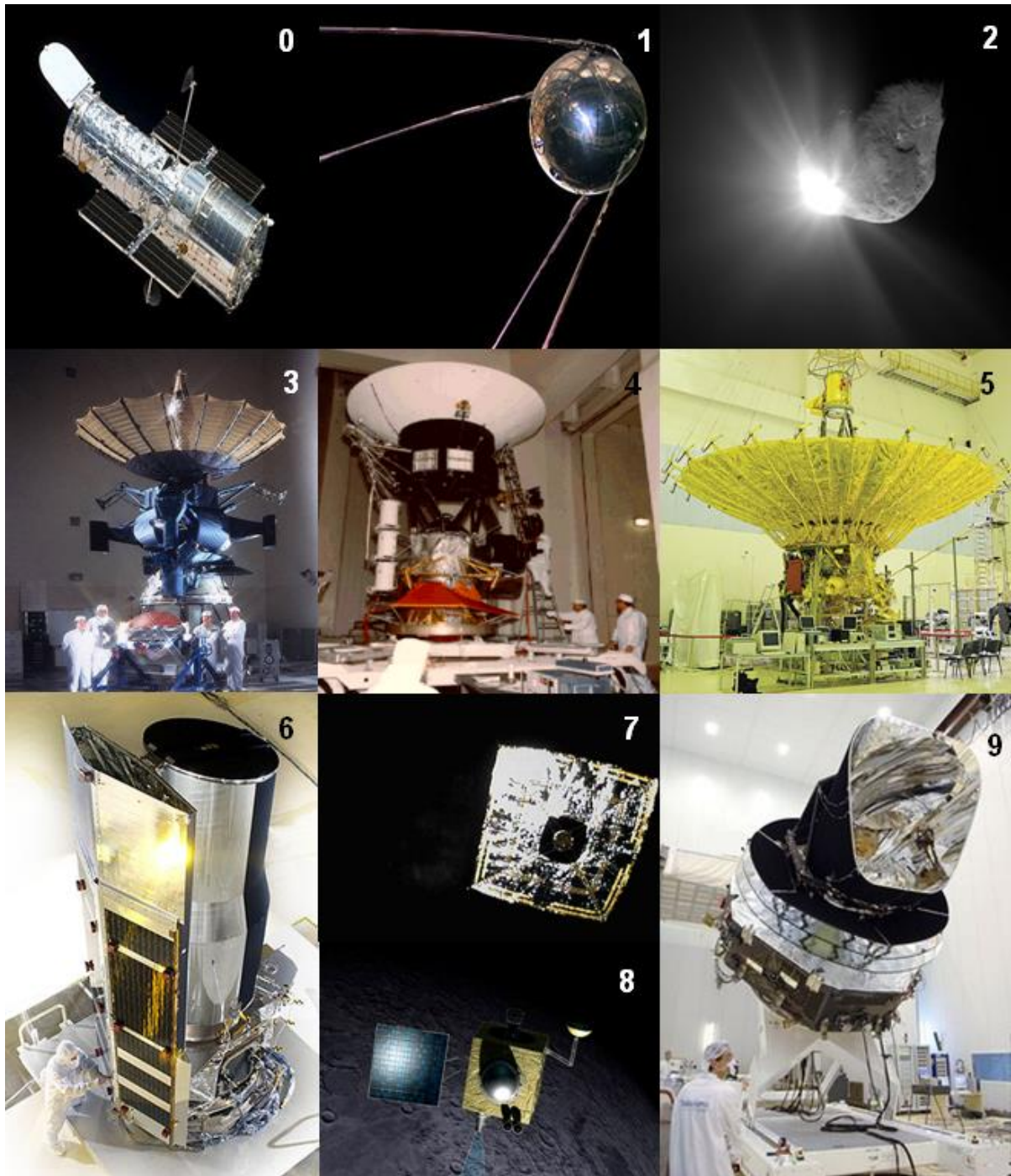


iii. How many times fainter will a star become if its magnitude is increased by 1mag? (three decimals)

iv. A Globular Cluster near the nostril of Pegasus is M__.

v. Hipparchus described a Solar Eclipse which was seen as Total in the Hellespont ($40^{\circ}25'N$, $29^{\circ}43'E$) but Partial in Alexandria ($31^{\circ}12'N$, $29^{\circ}55'E$), where at maximum $4/5$ of the Sun was hidden. Hipparchus calculated the parallax of the limb of the Moon between the Hellespont and Alexandria, assuming that the parallax of the Sun is 0. He also knew that the Moon has the same apparent angular diameter as the Sun, with a value of $1/650$ of the circle. Finally, by applying simple trigonometry, he calculated the approximate distance between the Earth and the Moon in Earth radii. How many Earth radii is the Earth-Moon distance? (integer)

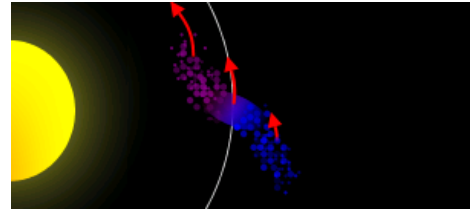
vi. Chandrayan-1, Deep Impact, Planck Telescope, Hubble Space Telescope



vii. If the mass of a star is 5 solar masses, and its initial radius and rotation period is $21 \times 10^5 \text{ km}$ and 4,083 days respectively, how many milliseconds will be its period when it turns into a Pulsar with a radius of 10 km? Assume the star is a homogenous sphere and does not lose mass.

H.

- i. How many planets of the Solar System have rings?
- ii. Which is the numerical factor that is related to the Roche limit in the case of a rigid spherical satellite and primary? (two decimals)



- iii. The Saros in ___y ___d.
- iv. If a more accurate indicator existed for the latitude scale of the telescopes you are going to use during the observational part, it would show ___°__'.
- v. The “width” of the Zodiac (degrees).
- vi. An asteroid is $2.8AU$ away from the Sun. At opposition, its visual brightness was $2.96 \times 10^{-16} \text{Watt/m}^2$, while its infrared brightness was the $1/4$ of this. What is its radius in metres? (integer)

I

i. On 11th December 2117 a Venus Transit will take place. How many years later is the next one?

ii. An Open Cluster in Canis Major is M__.

iii. Write the numbers of the three brightest stars:

1. Betelgeuse
2. Vega
3. Canopus
4. Rigel-Kentaurus
5. Capella
6. Procyon
7. Altair
8. Rigel
9. Arcturus

iv. The IC number of this dark nebula.



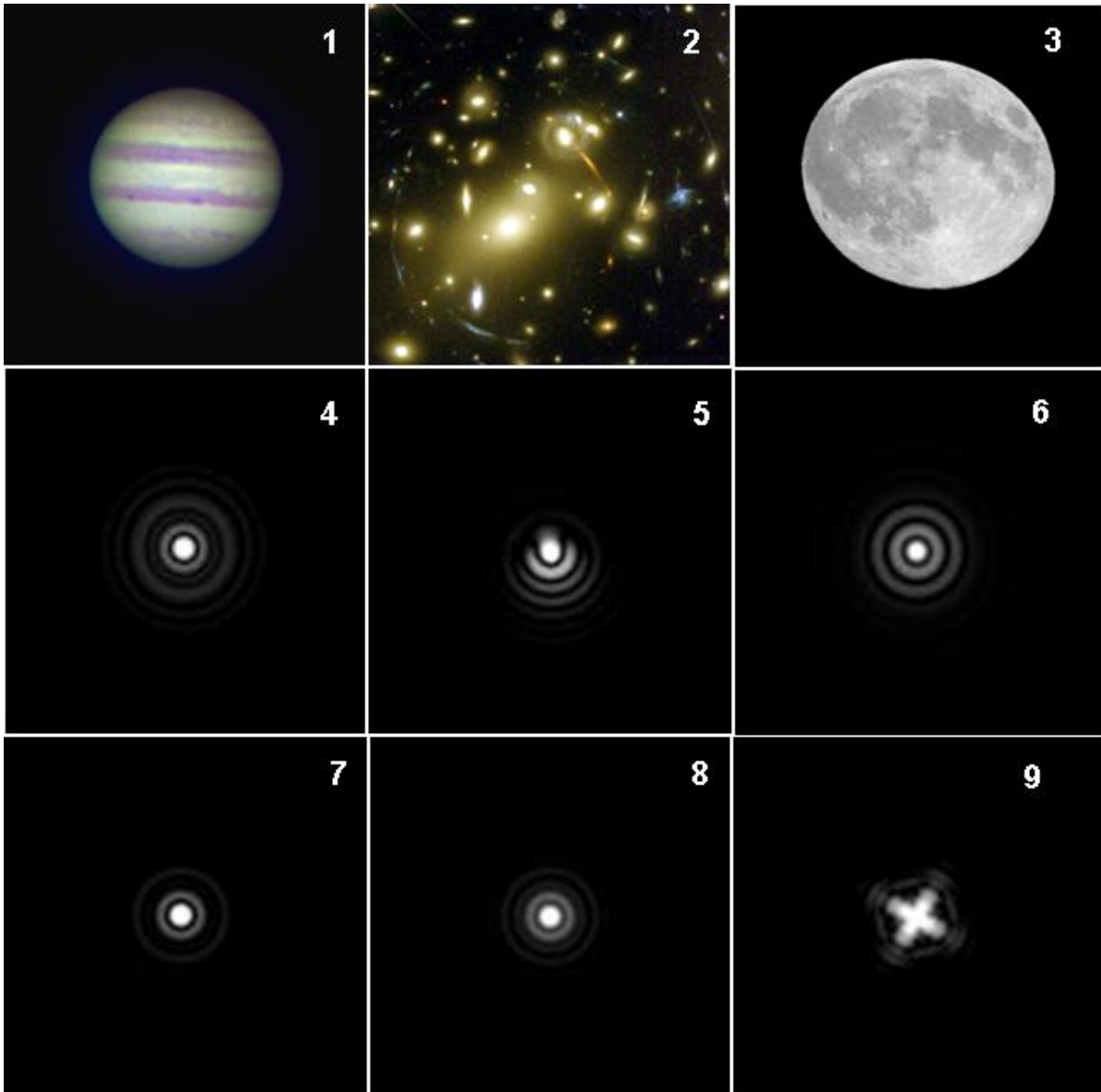
v. CaXIII is abundant in the solar corona. If the ionization potential of this element is 655eV, what is at least the temperature at the Corona (millions of K)? (integer)

vi. The Solar System lies within this arm of the Milky Way:

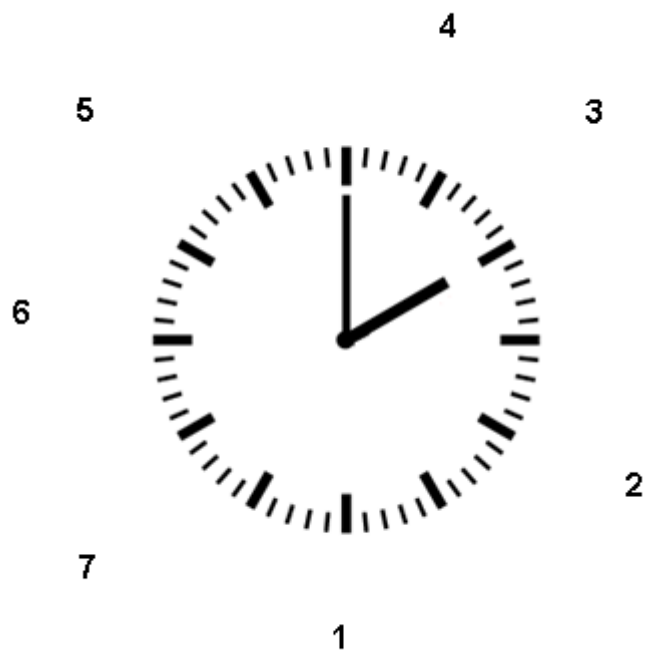
1. Sagittarius-Carina
2. Scutum-Crux
3. Norma
4. Orion
5. Perseus
6. Cygnus
7. Outer

vii. The resonance between Pluto and Neptune is __:__.

viii. Distortion, Coma, Astigmatism

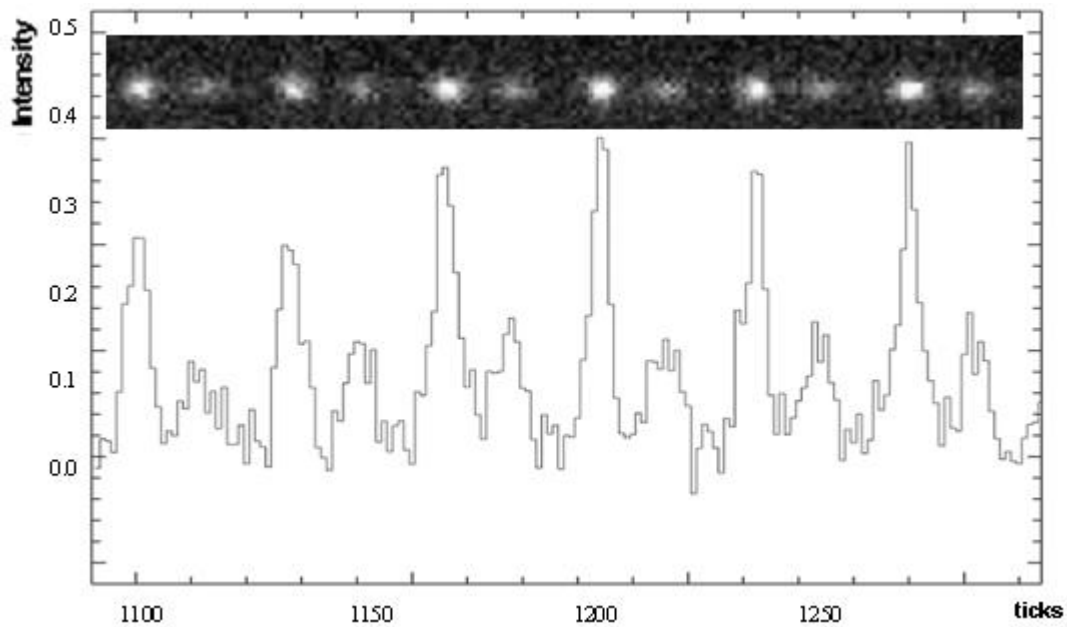


- ix. On 16th December you visit a country of the Southern Hemisphere which uses Daylight Saving Time. When it is 2 o' clock, you place your watch so as the hour hand points to the projection of the Sun to the horizon. Which number indicates North (approximately)?



J.

- i. Each Zodiacal Sign extends for that many degrees along the ecliptic.
- ii. You are given the light curve of a pulsar. What is its rotation period (ms) if the time interval between two “ticks” is 1.1965ms? (one decimal)



- iii. Pipe Nebula, Trifid Nebula, Lagoon Nebula, Cat's Paw Nebula, Eagle Nebula

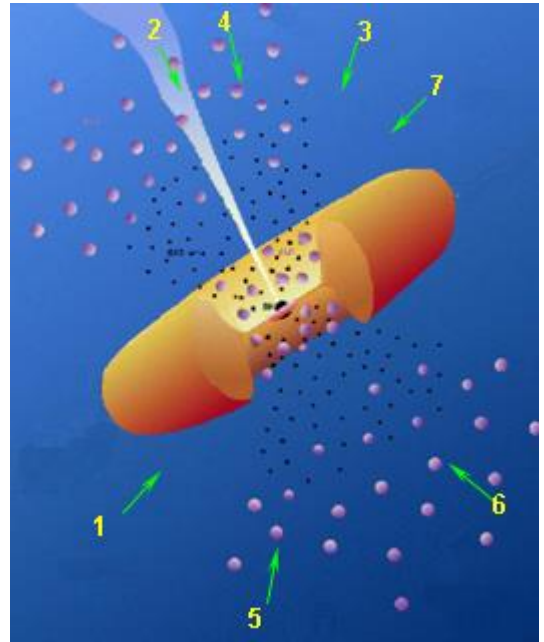


iv. Write the corresponding numbers of the three biggest asteroids:

1. Hygiea
2. Ceres
3. Eugenia
4. Pallas
5. Fortuna
6. Aurora
7. Nemesis
8. Vesta
9. Psyche

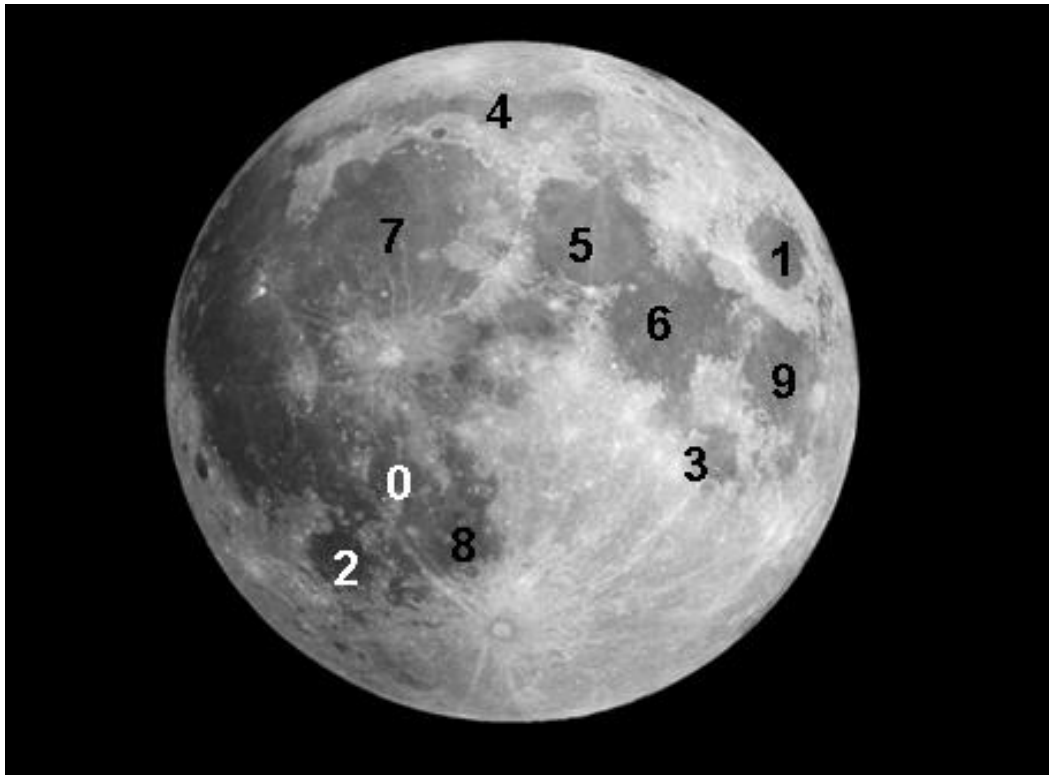
v. Unified models propose that different classes of AGN are really a one type of object seen from different directions. From which direction an observer can detect a:

- ÷ BL Lac
- ÷ Seyfert II
- ÷ BLR
- ÷ NLR

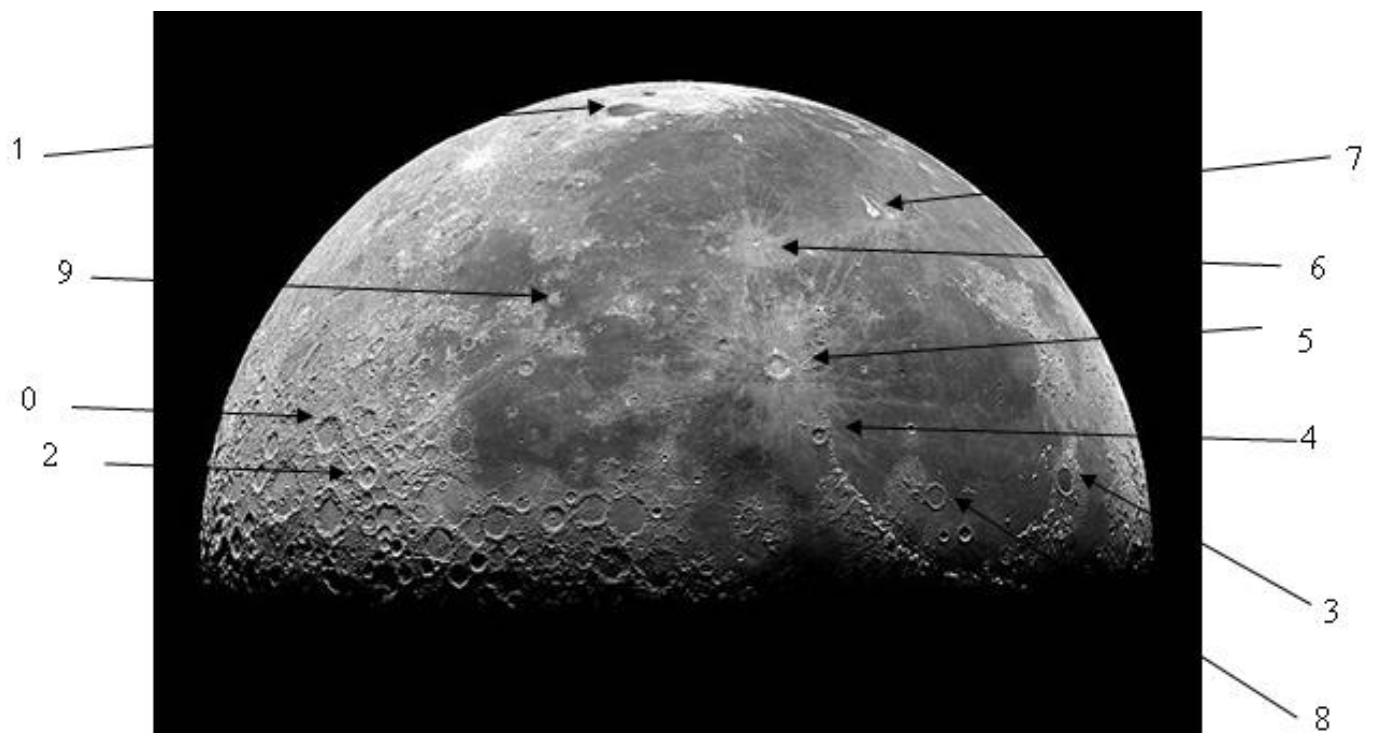


K.

- i. Mare Crisium, Mare Nectaris, Mare Frigoris, Mare Humorum



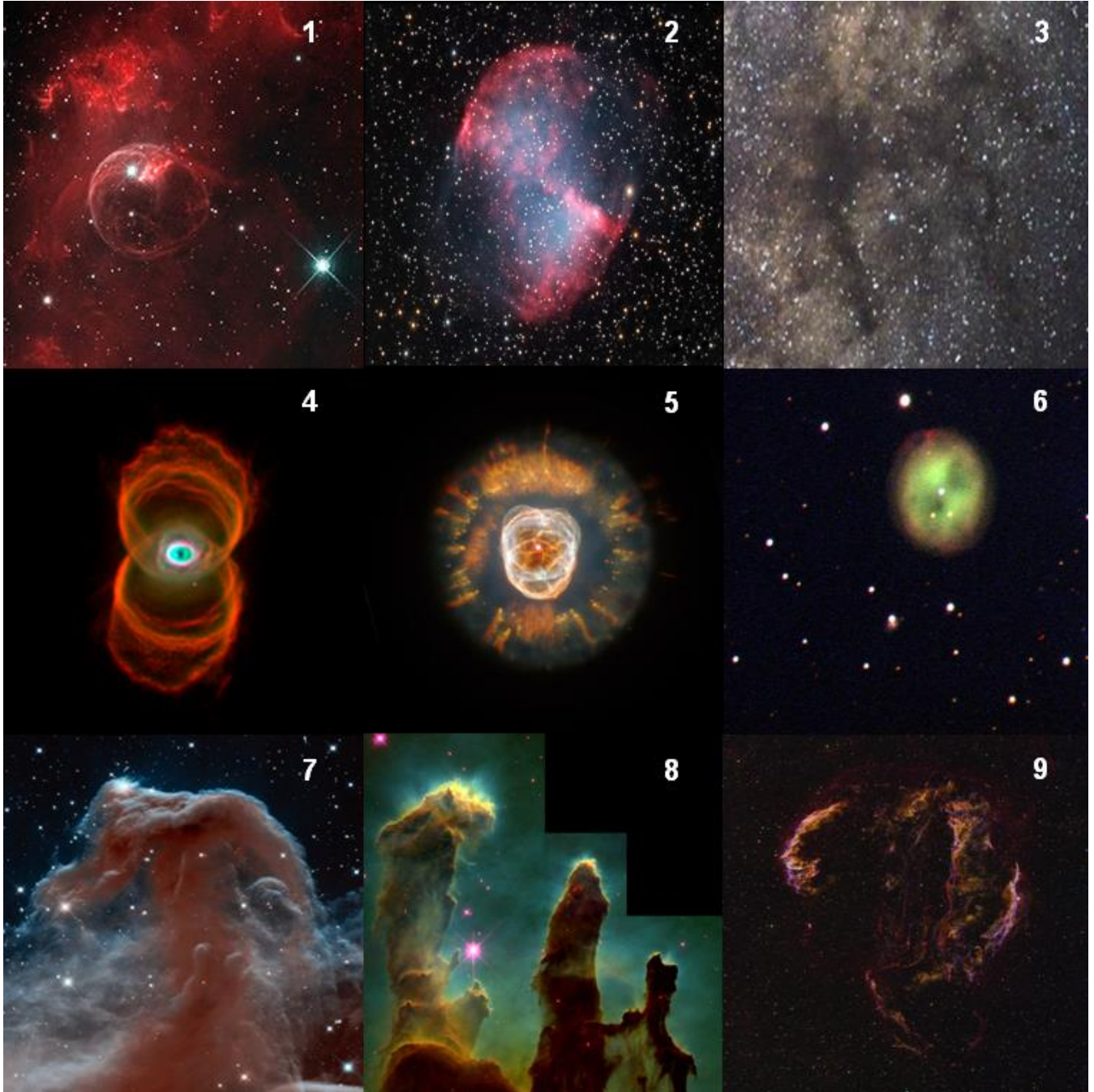
- ii. Grimaldi, Plato, Tycho, Eratosthenes



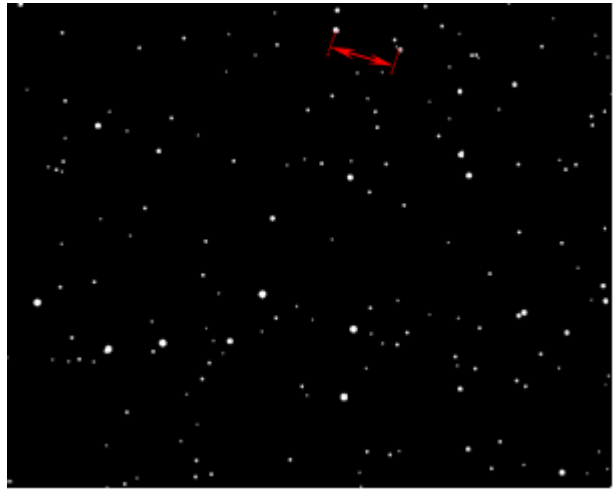
- iii. How many degrees under the horizon is the centre of the Sun when the Astronomical Twilight ends?
- iv. The mission of Apollo ____ was aborted after an oxygen tank exploded on the way to the Moon.
- v. If the Observatory Factor is 0.95 , what is the Wolf Number if the number of sunspot groups is 13 and the number of individual spots is 14 ? (integer)
- vi. A star is $100pc$ away. Its Apparent Visual Magnitude is $m_V=13.0mag$, its Apparent Photographic Magnitude is $m_{pg}=14.6mag$ and its Absolute Visual Magnitude is $M_V=4.7mag$. What is its Colour Excess? Consider that $A_V=3 \cdot E_{B-V}$, where E_{B-V} is the Colour Excess and A_V is the Visual Absorption. (one decimal)

L.

- i. Pillars of Creation, Dumbbell Nebula, Dark Horse Nebula (Great Dark Horse), Bubble Nebula, Engraved Hourglass Nebula



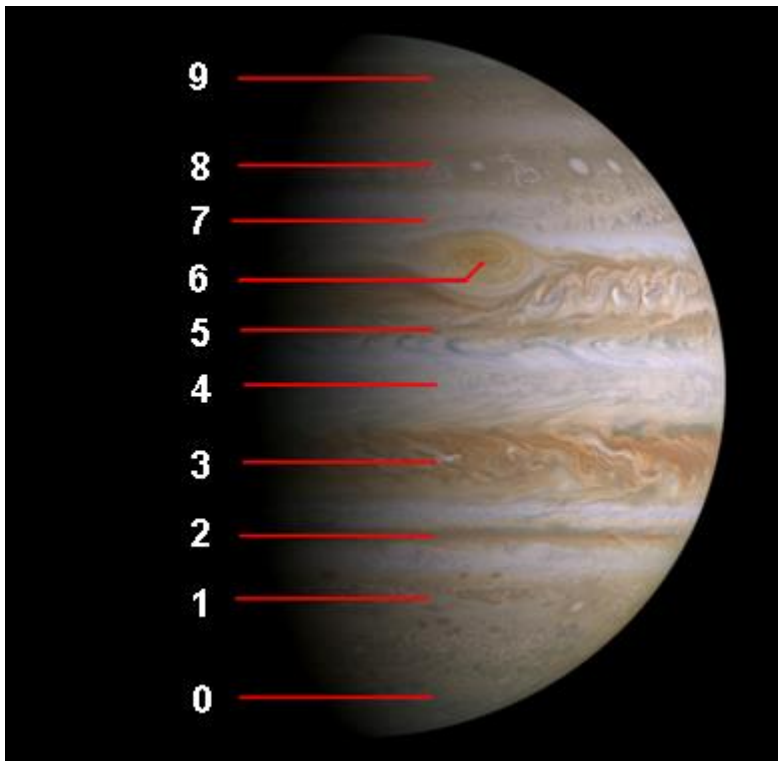
- ii. What is the wavelength of the spectral line $H\beta$? (integer)
- iii. Numbering the planets from the closest to the Sun to the farthest, which planet has the longest day and night?
- iv. What is the angular distance between the two stars (degrees)? (integer)



- v. The final Apollo lunar mission is Apollo ____.
- vi. How many times greater is the escape velocity of a satellite compared to the velocity that is required for an orbit with radius equal to the celestial body's radius? (one decimal)
- vii. A star is behind the Coalsack Nebula in a distance of $200pc$. If its apparent magnitude is $m=18mag$ and its optical depth $\tau=1.38$, what is its Absolute Magnitude? (integer)

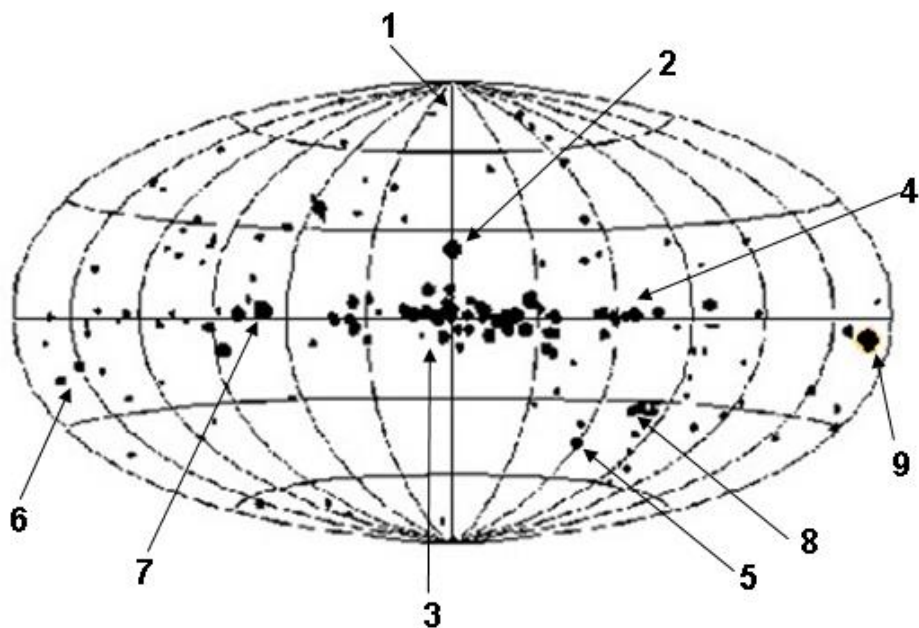
M.

- i. Great Red Spot, North Polar Region, South Equatorial Belt, Equatorial Zone



- ii. This is a map of the sky in X-rays using galactic coordinates.

- ÷ Large Magellanic Cloud
- ÷ Scorpio X-1
- ÷ Cancer Nebula
- ÷ Cygnus X-1
- ÷ Coma



- iii. The table shows the composition of the atmosphere of Mars, Earth, Jupiter, Neptune and Venus. Find Jupiter, Venus, Neptune.

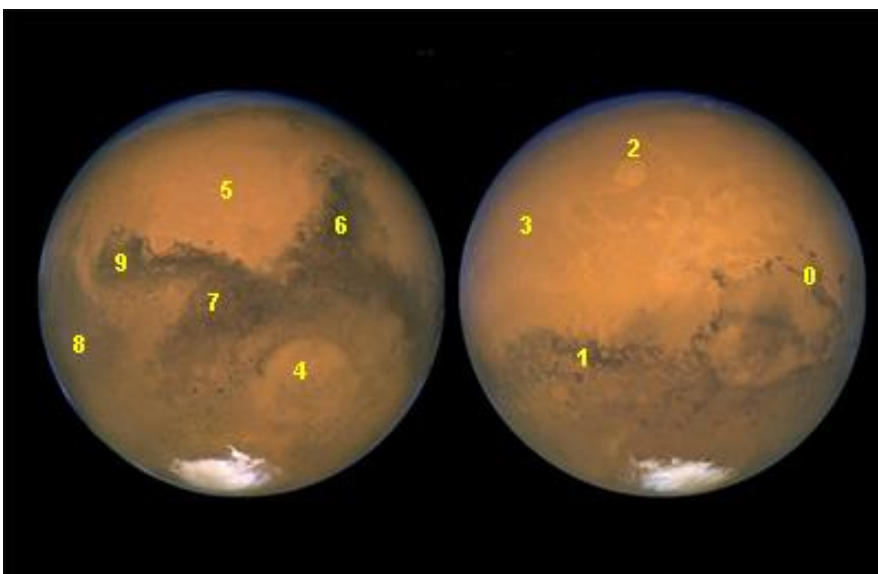
	1	2	3	4	5
H ₂	0.000055%	80.0	-	-	86.4
He	0.000524%	19.0	12 ppm	-	13.6
CH ₄	0.000179%	2	-	10.5 ppb	0.0018
NH ₃	trace	<600 ppb	-	-	0.0006
H ₂ O	locally 0.001%–5%	-	20 ppm	210 ppm	520 ppm
H ₂ S	-	<3 ppm	-	-	70 ppm
CO ₂	0.0397%	0.3 ppb	96.5%	95.32%	30 ppb
HCN	-	60 ppb	-	-	60 ppb
N ₂	78.084%	-	3.5%	2.7%	-
O ₂	20.946%	-	-	1300 ppm	-
Ar	0.9340%	-	70 ppm	1.6%	-
H ₂ SO ₄ *	-	-	150 ppm	-	-

- iv. The distance of this nebula from Earth is 6,100pc. The Field of View is 202"x202".

Calculate the ratio v/c , where v is the apparent velocity with which the nebula expands. (one significant figure)



- v. Hellas Basin, Olympus Mons, Arabia Terra, Amazonis Planitia



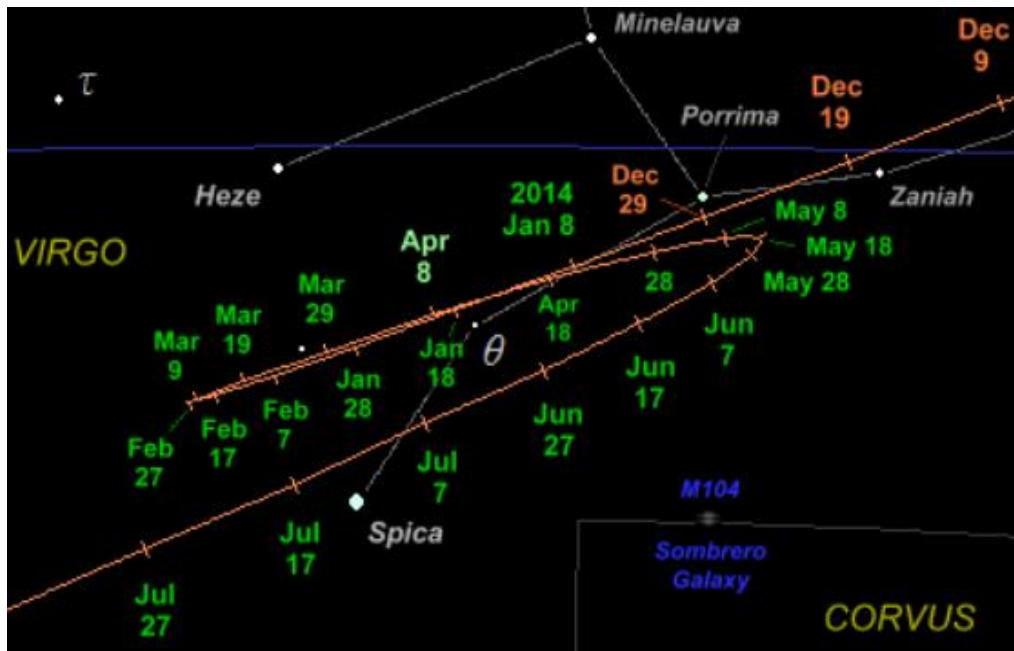
A.

- i. M31 is NGC__.

- ii. The effective temperature of the solar surface (Kelvin). Use the table of constants. (integer)

- iii. Sun's Absolute Visual Magnitude. (two decimals)

- iv. The orbital radius of Mars is $1.52AU$. Consider circular and coplanar orbits. Ignore the martian orbital inclination. Find the angle between Earth and Mars as seen from the Sun on the 18th of May in degrees. (integer)



- v. A geostationary satellite as seen from Athens ($\phi=37^{\circ}58'N$, $g=9.80m/s^2$) is on the celestial meridian. The angular distance of the satellite from the celestial equator in degrees as seen from Athens is __. (integer)

B.

- i. The Trifid Nebula is M__.

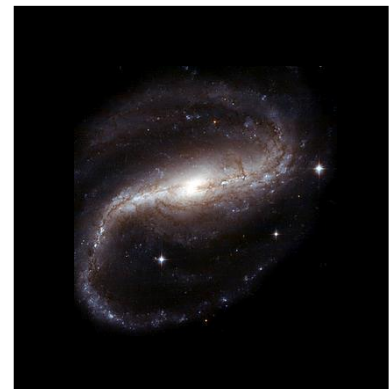


- ii. The temperature at an exoplanet's atmosphere is 336K . The mean speed of the nitrogen molecules ($m=4.7\times 10^{-26}\text{kg}$) in the same temperature is 0.5km/s . The mean speed (km/s) that the nitrogen molecules acquire when the temperature becomes four times greater is ____.

- iii. The spectral line $H\alpha$ is the result of the transition of an electron between energy levels $_\rightarrow_\$.

- iv.** The morphological class of this galaxy.

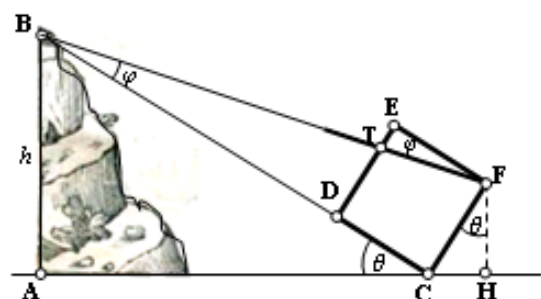
1. SBa
2. SBb
3. SBc
4. S0
5. SB0
6. Irr
7. Sa
8. Sb
9. Sc



- v. Io, Europa and Ganymede revolve in a 4 : 2 : 1 resonance.

- vi. Vega's B-V Colour Index.**

- vii.** Find the height of the mountain (metres).
 $FE/TE=800$ and $CH=0.4m$. EFCD is a square and FH is vertical to CH.



C.

- i. The Julian century has ___ days.
- ii. The first to measure Earth's radius, "without travelling long distances".

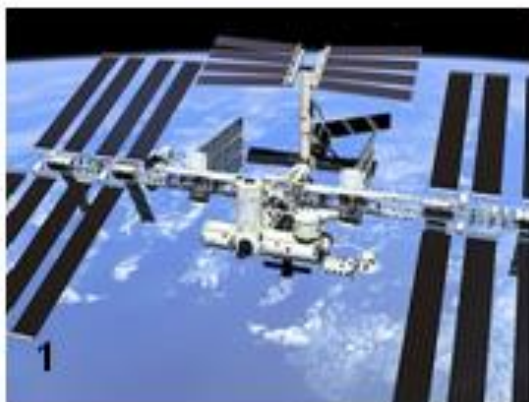
- 1. Posidonius
- 2. Picard
- 3. al-Ma'mun
- 4. Eratosthenes
- 5. al-Farghani
- 6. Snell
- 7. al-Biruni
- 8. Cassini
- 9. Gauss

- iii. This image shows a part of the Virgo Galaxy Cluster. At the bottom left you can see the dominant cD of the cluster. The long chain of galaxies is known as Markarian's Chain. The pointer shows a giant elliptical galaxy (a really powerful radio source). This galaxy is M__.



- iv. A star cluster which lies between η and ζ Herculis is M__.

vi. Tiangong-1, Skylab, Salyut-7

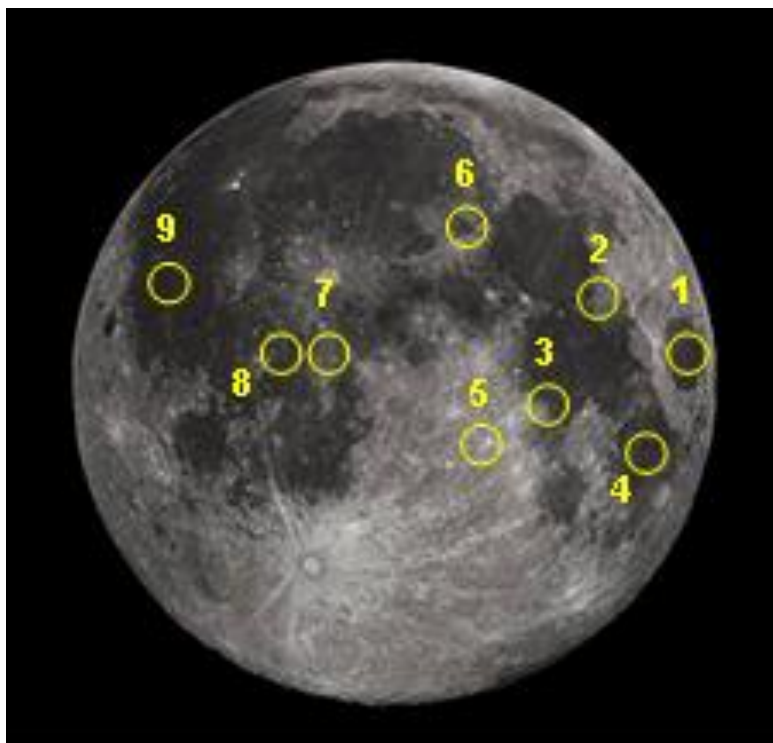


D.

- i. The Orion Nebula is M__.



- ii. This year Galileo observed the sky with a telescope for the first time.
- iii. The period of repetition of the Venus Transits in Julian years. The venusian synodic period is 583.92days.
- iv. The region where Neil Armstrong set foot.



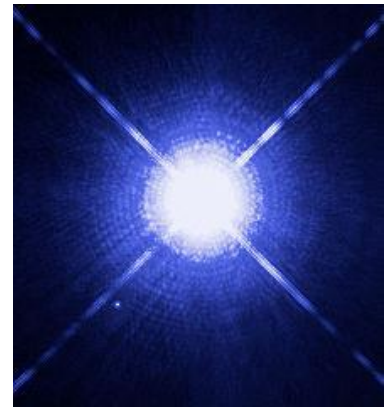
v. Comet McNaught, Comet Shoemaker–Levy 9, Comet Hale–Bopp



E.

- i. What is the distance of the star in the photo (parsecs)? (two decimals)

	Parallax (mas)
Proxima Centauri	769
α -Centauri	747
Barnard's star	547
Wolf 359	419
Sirius	380
Ross 154	337
ϵ -Eri	310
61 Cygni	286



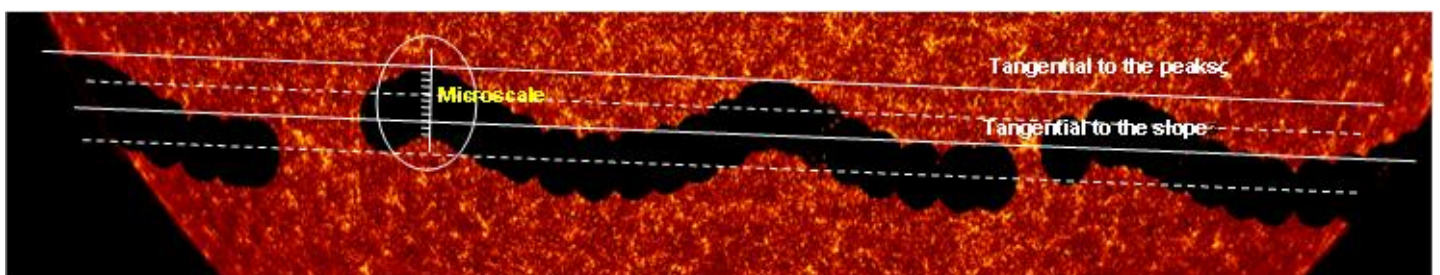
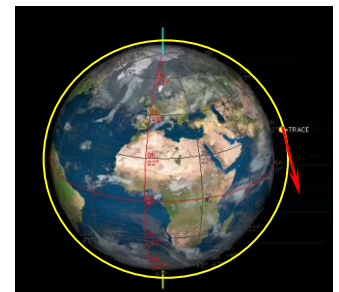
- ii. The number of chromosomes that the human egg cell has.

- iii. That many planets of the Solar System have moons.

- iv. The wavelength used to chart the Milky Way.

- v. Pleiades is M__.

- vi. In 2004, space telescope TRACE pulled off a series of photos during the transit of Venus. The picture that emerged presented snapshots of the transit on the solar disk as a black wavy chord. The TRACE was in a polar orbit, at a distance of 6,698km from the centre of the Earth. On that date, the Earth-Sun distance was $r_{\oplus}=1.0150949AU$ and the Sun-Venus distance was $r_{\odot}=0.7262039AU$. The venusian angular diameter was $57.8''$. Calculate the AU (millions of kilometres). (integer)



F.

- i. Every __ years (integer), Halley's comet appears!
- ii. The relative error of the spectroscopic parallax is 15% and the absolute error of the trigonometric parallax is 0.005". Over which distance (pc) the spectroscopic parallax becomes more accurate than the trigonometric? (integer)
- iii. Titan's atmosphere is dominated by nitrogen. The other main component of the atmosphere is a gas that at the temperature of -180°C on the surface of the moon has become liquid. What is its molar mass?
- iv. What is the critical radius (tens of nanometers) of ice particles "escaping" from a comet so as to not get ejected out of the Solar System by the solar radiation? Density=1000 kg/m³.
- v. In the beginning of July it stopped its retrograde motion. How many AU is its mean orbital radius? (one decimal)

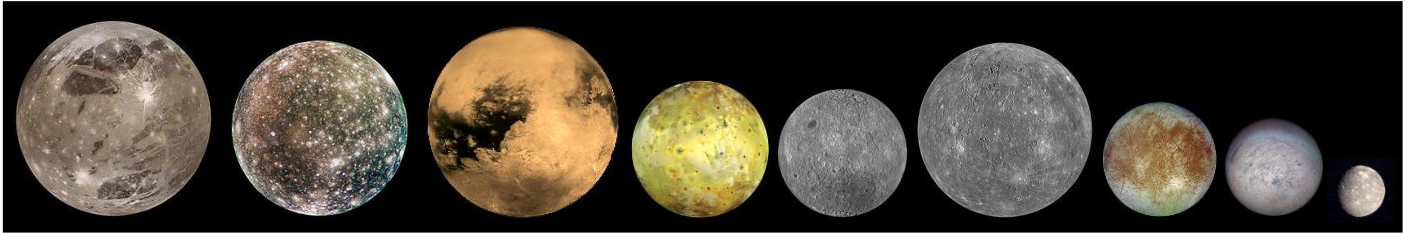
vi. Sojourner, Lunokhold 1, Curiosity



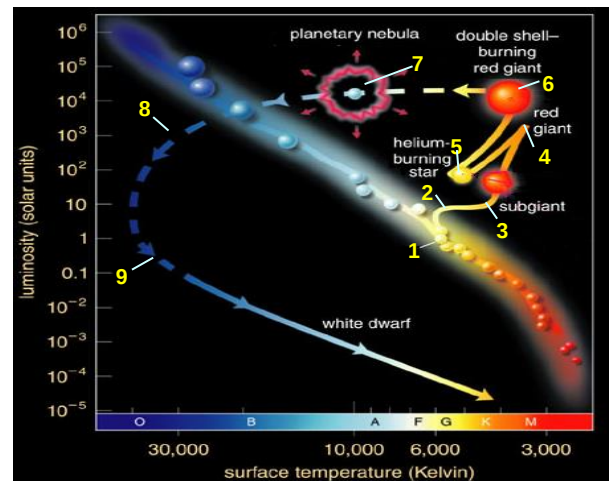
G.

i. The four greatest celestial objects in descending order of size:

1. Moon
2. Europa
3. Ganymede
4. Io
5. Mercury
6. Titan
7. Callisto
8. Triton
9. Titania

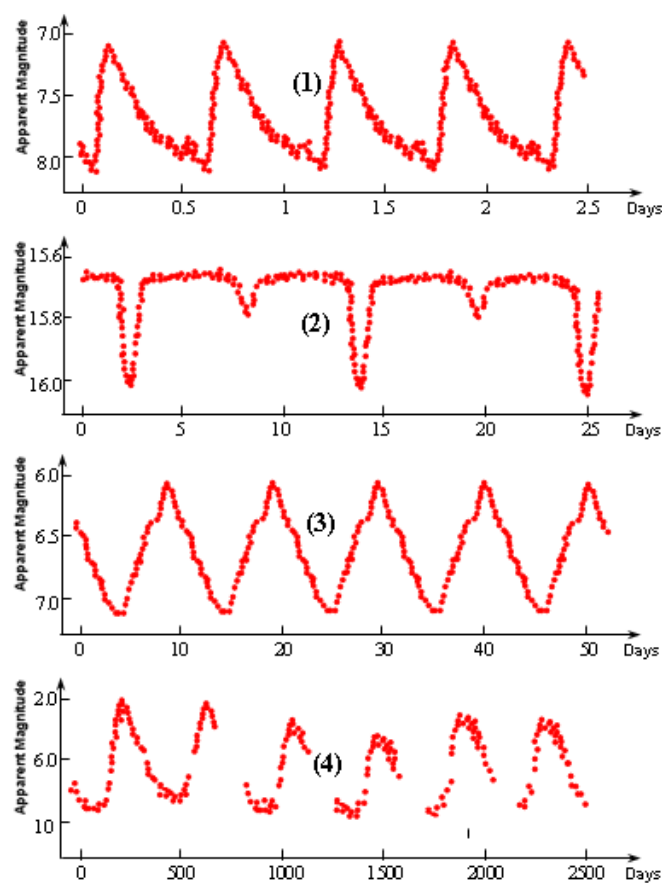


ii. At which point does the Helium Flash occur?



iii. The polarity of the solar magnetic field is reversed every __years. (integer)

iv. RR Lyrae, Mira, Classical Cepheid, Ecliptic Binary



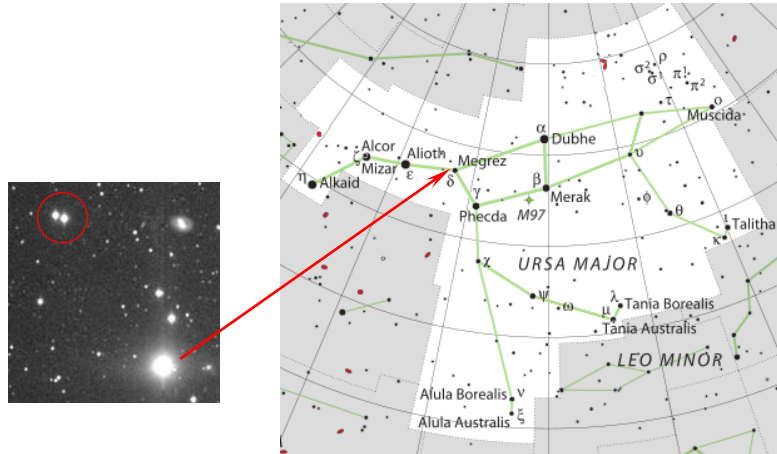
v. That many days lasts the summer at the Southern Hemisphere. (integer)

H.

i. Sombrero galaxy is M__.

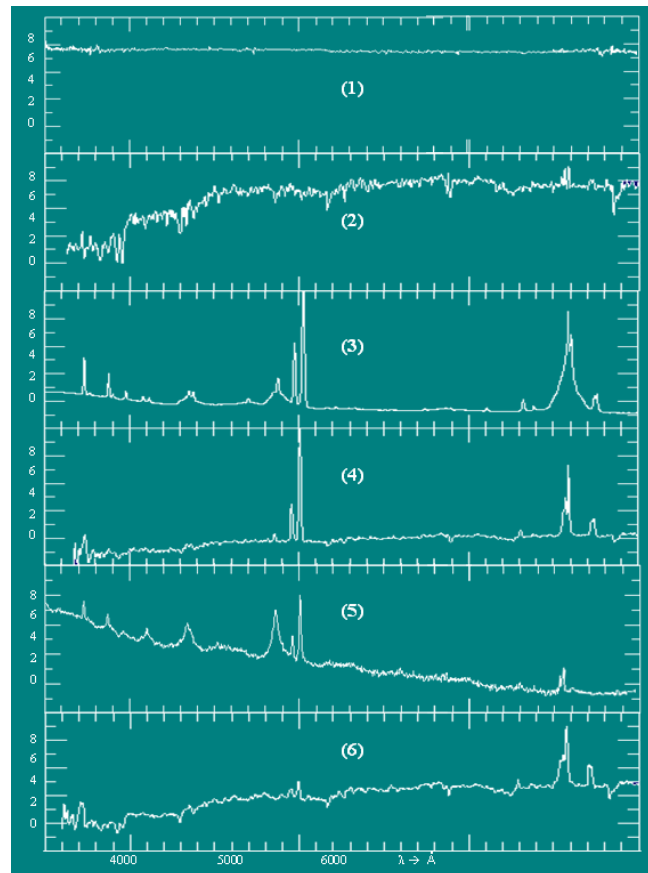
ii. That many venusian days lasts the venusian year. The synodic period of Venus is 583.92days and its rotation period is 243.02 *earthian solar days*. (integer)

iii. This is M__.



iv.

- ÷ Normal Galaxy
- + BL Lac
- + Seyfert I
- + Quasar
- + Seyfert II
- + LINER



v. At this planet the greatest day and night occurs. It is the __ planet farthest from the Sun.

I.

- i. How many days have passed since the last New Moon? (integer).



- ii. Causes the continuum of the solar spectrum?

1. Metals
2. H_2
3. H
4. H^+
5. H^-
6. He
7. He^+
8. He^{++}
9. He^-

- iii. The number related to the celestial sphere that was set by the IAU in 1922.

- iv. The Whirlpool Galaxy is M__.

- v. The four closest galaxies to the Milky Way in ascending order:

- 1.SMC
- 2.Andromeda
- 3.Canis Major Irregular Dwarf
- 4.SagDEG
- 5.Triangulum galaxy
- 6.Fornax Dwarf Spheroidal
- 7.Barnard's galaxy
- 8.Maffei I
- 9.LMC

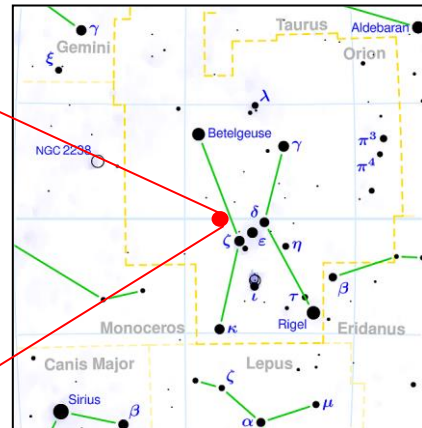
- vi. That many are the Van Allen Radiation Belts.

- vii. The L point through which matter from one star of a binary system escapes to the other.

J.

i. The CMBR has a thermal black body spectrum at a temperature of __Kelvin. (two decimals)

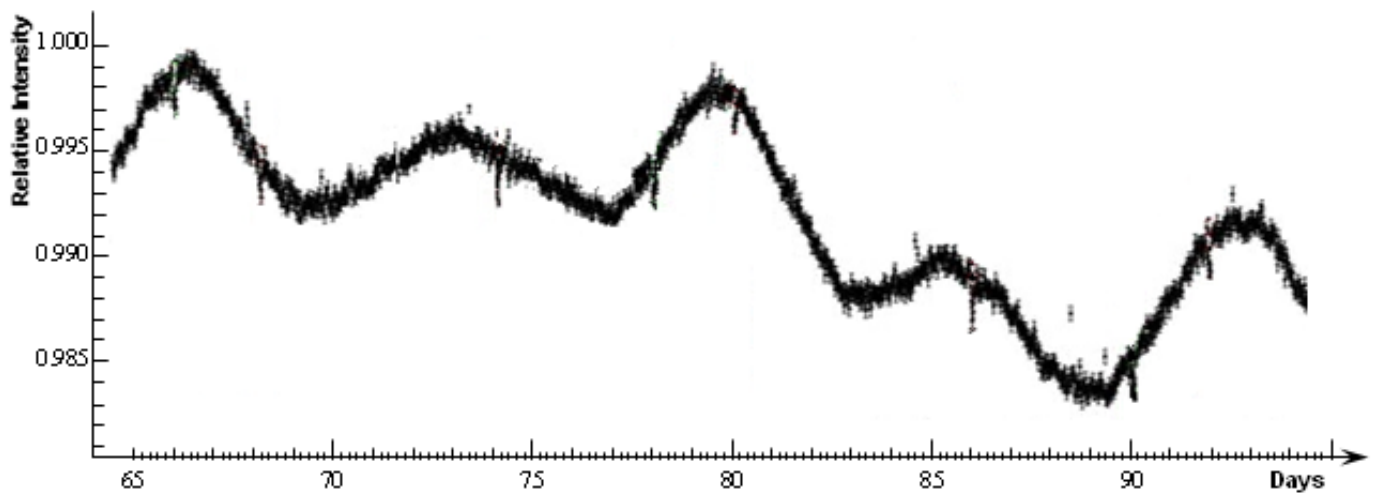
ii. This nebula is M__.



iii. Radiation with an energy of 4eV.

1. gamma-ray
2. X-ray
3. Ultraviolet
4. Visible
5. Infrared
6. Far Infrared
7. Microwave
8. Radio
9. Super Low Frequency

iv. Two exoplanets with a radius five times the radius of Earth rotate around a star (radius equal to this of the Sun). Find the greatest orbital period (days). (two decimals)

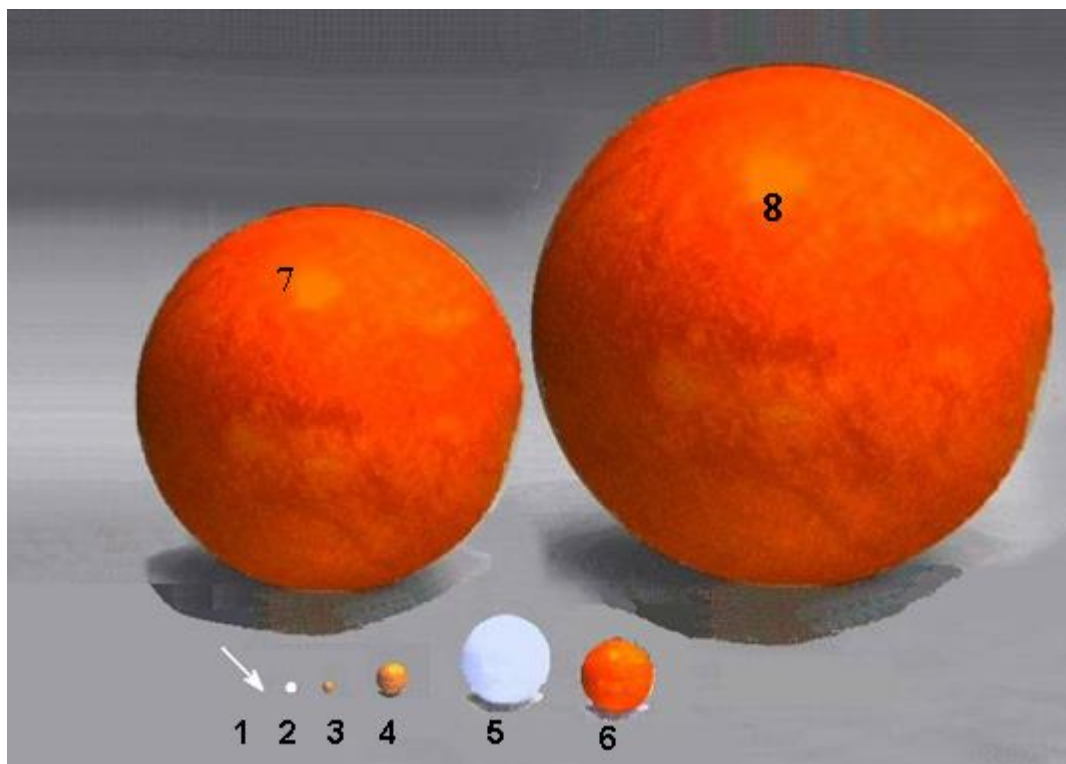


v. The first to calculate the AU by measuring the parallax of a planet:

- 1.Cassini
- 2.Aristachus
- 3.Hipparchus
- 4.Horrocks
- 5.Halley
- 6.Bayly
- 7.Euler
- 8.Lomonosov
- 9.Newcomp

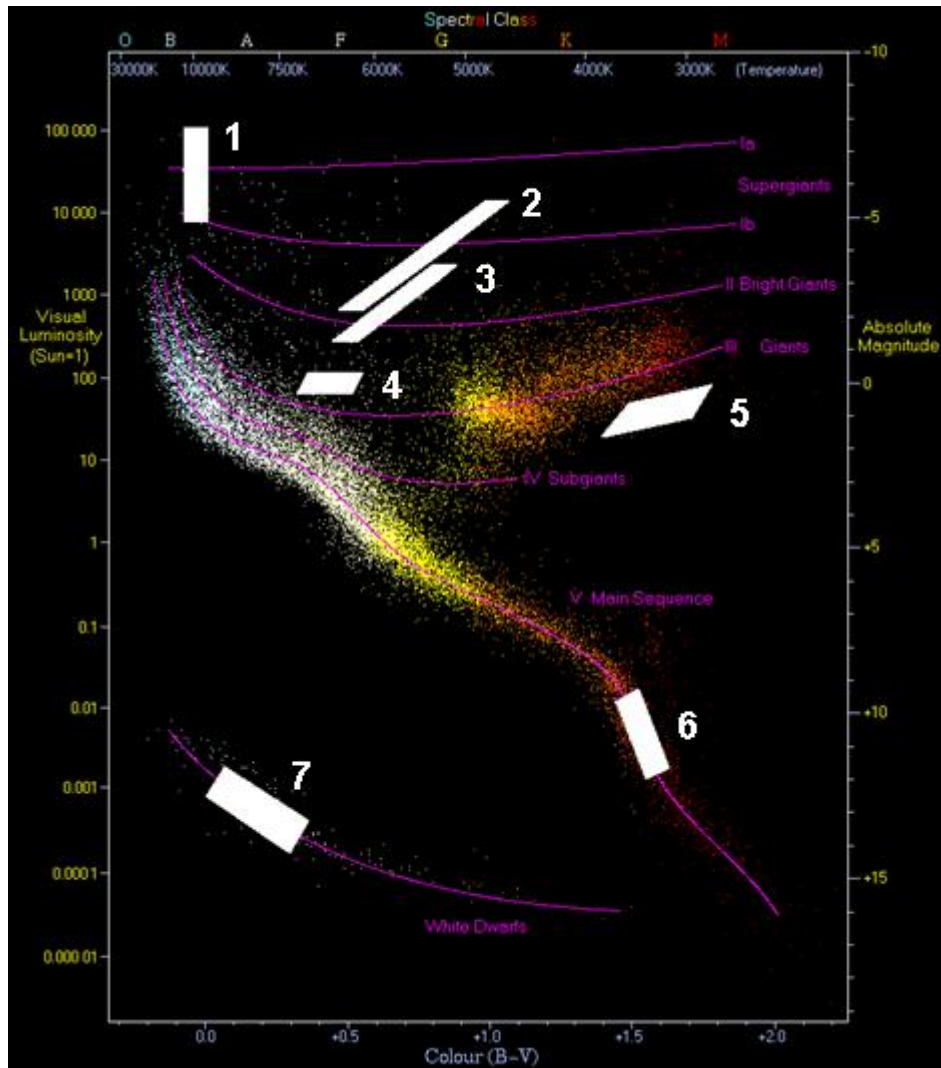
vi. The diametres of the stars (Sirius, Betlegeuse, Aldebaran, Antares, Rigel, Pollux, Arcturus, Sun) are to scale.

Betlegeuse, Antares, Rigel



K.

- i. Every that many years, the orientation of Earth's axial tilt shifts by 1° . (two decimals)
- ii. When we swim in the sea, the height of our eyes from its level is 20cm . How many kilometres away can we look on the surface of the Earth? (one decimal)
- iii. Flare Stars, Type I Cepheids, RR Lyrae Variables



- iv. The first Pulsar discovered was nicknamed LGM-1. Its official name is now PSR J1921 +2153. Its declination is $__^\circ __'$.

L.

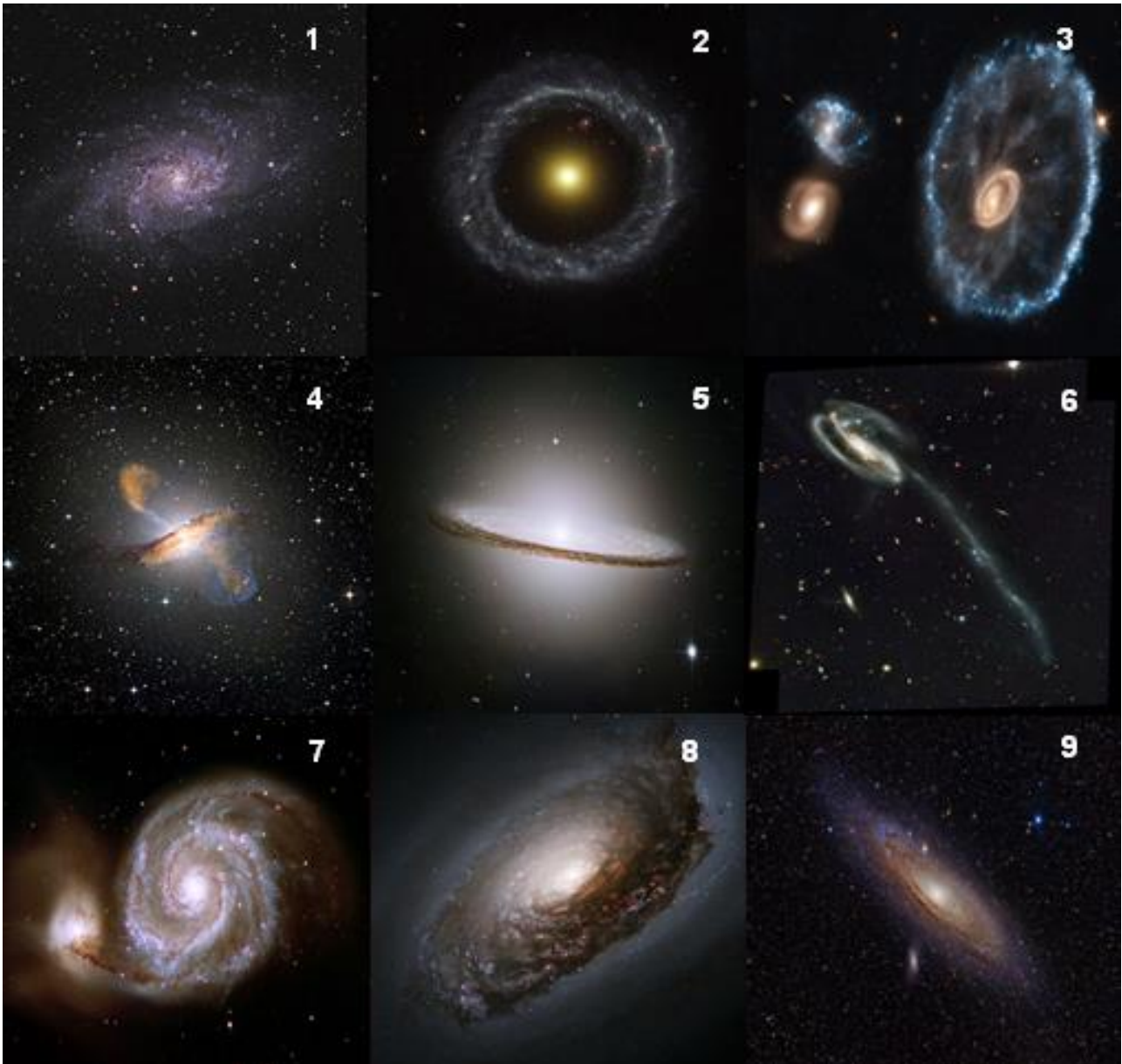
- i. What time (hh:mm) is shown at the watches at a place with latitude $\varphi=0^\circ$ and longitude $\lambda_L=18^\circ E$ on the 22nd of September, the moment that the Sun has an altitude of 30° before its upper culmination? The GMST at midnight is $T_o=23^h58^m32^s$.
- ii. The axial tilt of Mars. (integer)
- iii. How many images of the same distant quasar appear at the Einstein Cross?
- iv. A white dwarf has a mass of 0.6 solar masses, a temperature of $2 \times 10^7 K$ and luminosity equal to 5.5×10^{-4} times the solar one. The mean mass of its particles is $2m_p$. How many billions of years will its cooling last if its luminosity is not going to change? (integer)
- v. Put in the right order the meteor showers according to when their peak occurs, starting from the earlier one:
 - 1.Perseids
 - 2.Orionids
 - 3.Eta Aquarids
 - 4.Quadrantids

M.

- i. Two white dwarfs have the same effective temperature. The one dwarf has an Absolute Bolometric Magnitude of $M_{bolA}=10.5mag$ and a mass $m_A=1$ solar mass, while the other has $M_{bolB}=10mag$. What is the second dwarf's mass in solar masses? The mass-radius relationship of a white dwarf is $R^3 \sim 1/M$. (one decimal)
- ii. The value of the Constant of Aberration (arcseconds). (one decimal)
- iii. Because of the solar parallax, the time the Sun stays below the horizon of the North Pole is longer. How many minutes is this increase in time? (integer)
- iv. How many billions of years is the age of the Universe? (one decimal)
- v. What is the maximum ecliptic latitude that can be acquired by Pluto? Pluto's aphelion is $49.30AU$, its perihelion is $29.58AU$ and its orbital inclination is 17.17° . Earth's aphelion is $1.017AU$ and its perihelion is $0.983AU$. (one decimal)

N.

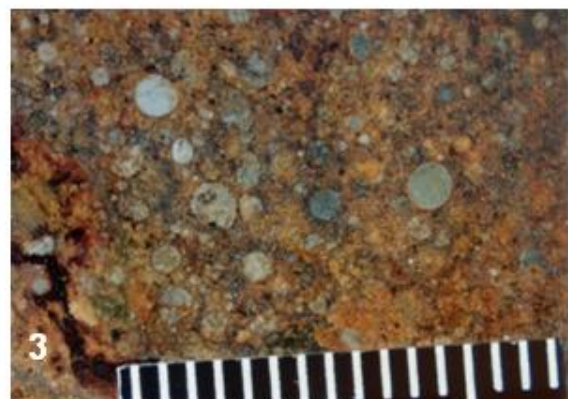
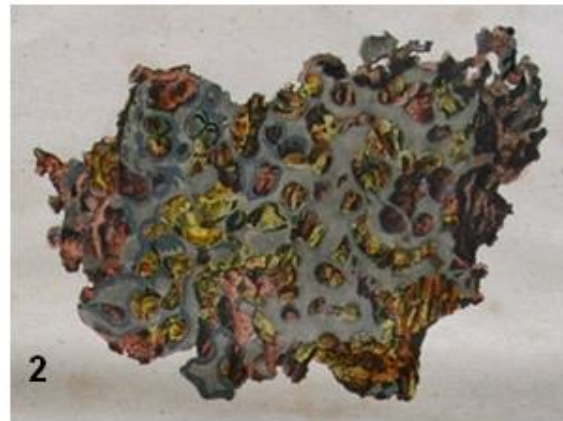
- i. By how many magnitudes will the magnitude of the faintest stars that can be detected by a CCD increase, if the exposure time is doubled? (two decimals)
- ii. Sombrero Galaxy, Tadpole Galaxy, Black Eye Galaxy, Hoag's Object



iii. How many flavours do the quarks have?

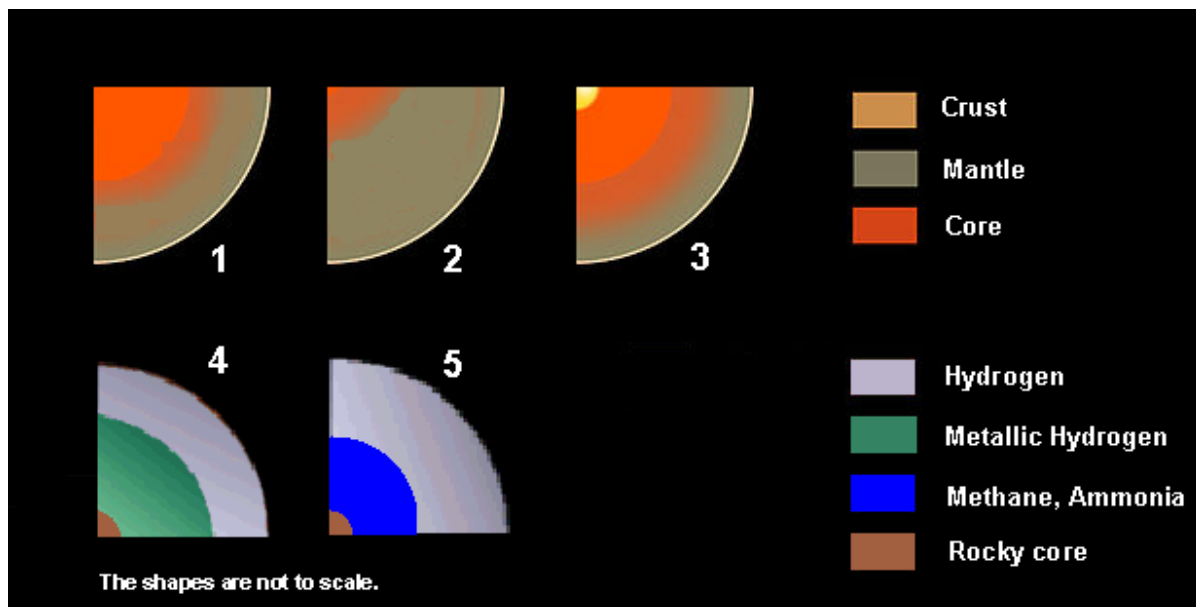
iv. How many colours do the quarks have?

v. Pallasite, Chondrite, Achondrite, Iron meteorite



O.

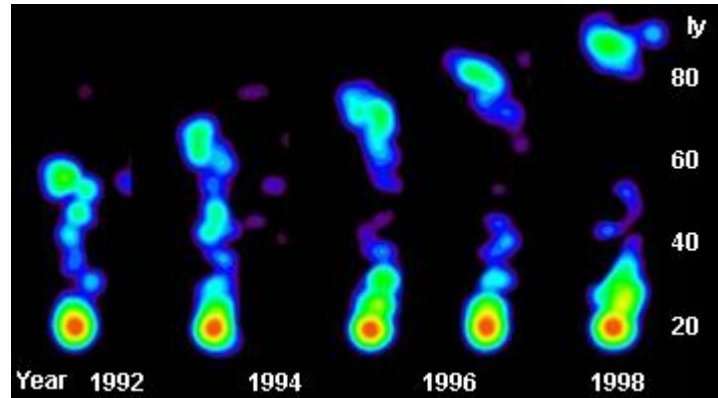
- i. The maximum effective temperature of the surface of a Cepheid is $9,000K$ and the minimum is $7,000K$. The difference between its brightness maximum and minimum is 2.0 Absolute Bolometric Magnitudes. How many times bigger is the maximum radius of the Cepheid than its minimum radius? (one decimal)
- ii. In 2013, after how many days after the Summer Solstice did the Earth reach Aphelion? (integer)
- iii. The Sun belongs to the Population ___ stars.
- iv. The parallax of Barnard's star is $\pi=0.545''$, its proper motion is $\mu=10''.25/year$ and its radial velocity is $u_r=110.8\text{ km/s}$. At its spectrum, a blueshift occurs. How many degrees is its angular distance from its convergence point? (integer)
- v. Identify the following planets by recognizing their internal structure: Jupiter, Neptune, Mercury



- vi. What was the angular speed in rpm of the furnace which was used to make a parabolic reflector with a diameter of $6.5m$ and focal ratio of $f/1.25$ in a place with $g=9.80m/s^2$? (two decimals)

P.

- i. What is the Azimuth of the point γ (degrees) at the 18th Sidereal Hour? (integer)
- ii. Analemma
- iii. A homogeneous and spherical protostar of mass $2.284 \times 10^{30} \text{ kg}$ shrinks from a radius of 120 solar radii to a radius of 100 solar radii in 100 years. Calculate the ratio of its mean luminosity to the solar luminosity. (integer)
- iv. The apparent speed of this active galaxy's jet is $3.6c$! If the angle of the jet with the line of sight is 1.5° , what is the true speed of the jet?

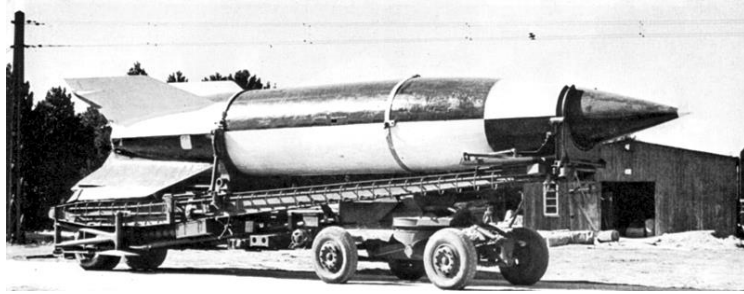


- v. On the 21st of March, at a place with latitude $\phi = 30^\circ$, during the sunset, a star of the ecliptic is at its upper culmination. What is the altitude of the star (degrees) at the 12th Sidereal Hour? (one decimal)

Q.

i. What is the inclination of the Moon to the ecliptic? (truncate to two decimals)

ii. The first photo from space was taken from a V-__.



iii. A mission is sent to Mars by following a Hohmann-Vetchinkin orbit. How many days is the minimum time interval that the mission's members will have to stay on Mars before they find the first opportunity to come back to Earth by following once more a Hohmann-Vetchinkin orbit? Consider that the orbits of Earth and Mars are circular and coplanar and that the distance of Mars from the Sun is $1.52AU$. (two decimals)

iv. During half moon, the projection of the shadow cast by Mons Penck on the surface of the Moon (the distance between the mountain's top and the shadow's edge) is $10km$. The selenographic coordinates of this peak are $10.0^{\circ}S, 21.6^{\circ}E$. Calculate its height (km). (one decimal)

v. When a star is at its upper culmination, its altitude is $40^{\circ}38'$ south of the zenith at an altitude of $39^{\circ}22'N$. How many degrees is the star away from the cardinal point of the North when it rises? (integer)