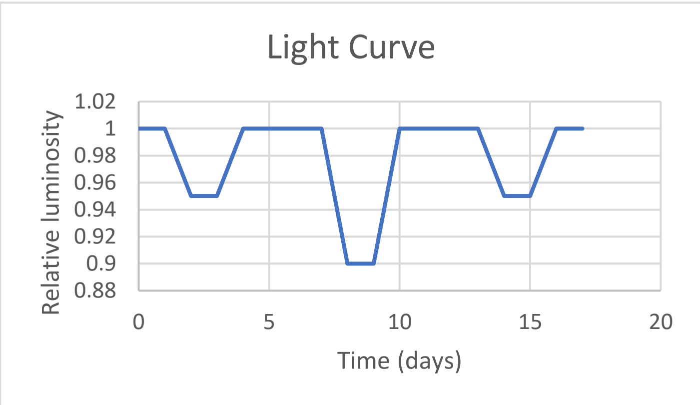
	Question	Answer
1	Which of the following stellar spectral classes have the highest surface temperature? A. A B. B C. F D. G E. K	Answer: B. In order from hottest to coolest: O, B, A, F, G, K, M
2	For a stargazer who is interested in looking at celestial objects other than the Moon, the best time to stargaze is during New Moon compared to the Full Moon. Why? A. The glare of the moon washes out the fainter objects in the sky B. The Moon will pass in front of several objects in the sky C. The objects only align in place with star charts during New Moon D. Telescopes can only function during New Moon but not Full Moon E. All celestial objects are only visible in the sky during New Moon	Answer: A The glare of the moon interferes with telescopic views of deep sky objects
3	During an astronomy outreach event, a member of the public asked "How do you visually tell a star apart from a planet?" What could be an accurate response? A. Planets always appear brighter than stars B. Stars "twinkle" but not planets C. Planets appear significantly bigger than stars to the naked eye D. Stars are of a different colour from the planets E. Planets are only visible through a telescope	Answer: B. Although stars are enormous, they are very far away from the Earth as compared to planets, and hence appear very small. Light from stars gets refracted as it passes through the atmosphere of the Earth, causing them to twinkle. The planets are much closer to Earth, hence appearing larger to us. Thus, the displacement due to refraction is much smaller relative to their apparent size and therefore there is no twinkle.
4	What is the ratio of a man's weight on Earth to his weight on Saturn? A. 1:1 B. 2:1 C. 3:1 D. 5:1	Answer: A. Compute the gravitational acceleration on both planets.

	E. 6:1	
5	How much brighter is a magnitude 1 star than a magnitude 3 star? A. 6.31 times brighter B. 4 times brighter C. 2 times brighter D. 0.50 times brighter E. 0.16 times brighter	Answer: A. Repurpose the Luminosity-Absolute magnitude relationship in the Formula Book, and we get that the magnitude 1 star is 10^(2/2.5)=6.31 times brighter.
6	In 1838, Friedrich Bessel first measured the distance between Earth and 61 Cygni using its parallax, which was 0.31”. The actual distance between Earth and it is approximately: A. 1 ly B. 3 ly C. 10 ly D. 32 ly E. 100 ly	Answer: C. Using the formula d = 1/p where d is distance in parsecs and parallax angle p measured in arc seconds, we can get that the distance is roughly 3.23 parsecs, which is about 10 ly.
7	What is the Roche limit? A. The minimum radius for a body to be classified as a star. B. The maximum mass of a stable white dwarf star C. The minimum distance an orbiting satellite can be from a primary body and yet remain intact due to self-gravity. D. The distance from the centre of a black hole at which the strong gravity allows photons to orbit it circularly. E. The minimum mass for a main sequence star to evolve into a red giant	Answer: C. The distance at which tidal forces are exactly balanced out by the satellite’s own gravitational forces so that the satellite can stay intact via self-gravity
8	Which of these celestial objects could possibly serve as a stable anchor point for modern measurement of magnitudes? A. Algol B. Vega C. Saturn D. Jupiter E. Mars	Answer: B. The other objects in this list are all significantly variable in brightness. In fact, Vega was the original reference point of the magnitude scale, where it is defined to have an apparent magnitude of zero as measured through all filters .

9	Saturn is famously known for its stunning ring system. Which of the following setups will allow one to easily discern its rings? A. 7 x 50 binoculars B. Naked eye C. 3 inch telescope of 50x D. A and C only E. A, B and C	Answer: C A good 3-inch telescope of 50x can show Saturn's rings as separate structure detached from the planet itself.
10	What is the solar wind? A. The stream of electromagnetic radiation emitted from the surface of the Sun B. Areas of magnetic activity on the surface of the Sun C. Kinetic energy possessed by the Sun D. A stream of charged particles released from the atmosphere of the Sun E. Dark spots on the Sun	Answer: D The solar wind is a stream of charged particles released from the upper atmosphere of the Sun, called the corona.
11	The following chart is a hypothetical light curve for a star and associated bodies.  Which of the following statements are plausible explanations for this observation? I. The star is part of a binary-star system, and this curve is a result of eclipses. II. The star is likely a small red dwarf with at least two massive exoplanets. III. The star is a classical Cepheid variable. IV. The star is a RR Lyrae variable. A. I. and II. B. II. only. C. III. and IV. D. III. only. E. I., II., III., and IV. (All of the above) .	Answer: A. I. and II. are correct. Cepheids and RR Lyrae show very different light curves.

12	Contrary to what one might expect, the latest sunrise of the year does not occur during the respective hemisphere's winter solstice. Why is this so? You may assume this location does not lie within equatorial latitudes without loss of generality. A. The Earth is significantly oblate and this leads to variations in the time of sunrise due to horizon effects. B. The Sun is significantly oblate, and this leads to variations in the time of sunrise as our perspective of the Sun's shape changes across time C. As Earth's orbit is elliptical, the Sun appears to drift across the night sky at different rates across the year. D. Milankovitch cycles affect the Earth's axial tilt, causing a large constant drift in sunrise timing. E. The question statement is false.	Answer: C. A and B are clearly false, and while Milankovitch cycles do affect Earth's axial tilt, it takes place over long timescales and thus is too small to be easily noticeable.
13	One fine day, Brian noticed two satellites that are passing directly overhead in opposite directions. He decided to label the satellite moving from west to east A, and the satellite moving from east to west C. Turns out, he noticed the same two satellites passing directly over his head again exactly 8 hours later! Suppose the satellites are in circular orbit and assume that Brian is on the equator (well, close enough since he stays in Singapore). What is the ratio of the orbital radius of satellite A to that of satellite B? A. 0.481 B. 0.630 C. 1 D. 1.587 E. 2.080	Answer: B Note - Direction of rotation of the Earth: West to East Notice that for satellite **A**, since it is orbiting in the same direction as the direction of rotation of the Earth, he must have covered an angle equivalent to one entire round, and the angle rotated by the Earth during these 8 hours. Hence, $\theta_A = 360^o + 120^o = 480^o$ (8 hours amount to 120^o) A similar logic can be applied to satellite **C**. However, since it is orbiting in the **opposite** direction, the total angle covered is one entire round, but with the angle rotated by the Earth during these 8 hours being subtracted off.

<table>
<tr><td></td><td></td><td>Hence, $\theta_B = 360^o - 120^o = 240^o$.
Now, these angles are covered in the same amount of time, 8 hours. Hence, we can deduce that the angular velocity of A is twice of C, i.e, $\frac{\omega_C}{\omega_A} = \frac{1}{2}$. This is equivalent to saying that the orbital period of A is half that of C.
From Kepler's 3rd Law of Orbital Motion, we can obtain the following equation: $\omega^2 = \frac{GM}{r^3}$
Hence,
$$\frac{r_A}{r_C} = \left(\frac{\omega_C}{\omega_A}\right)^{\frac{2}{3}}$$
Therefore, the required ratio is $(0.5)^{\frac{2}{3}} = 0.630$</td></tr>
<tr><td>14</td><td>While Clarence was reading a book on telescopes, he came across an equation which seems interesting. The equation suggested that for a night sky object with a declination of δ, if we want an object to stay within the field of view (FOV) for a certain amount of time t, the required FOV would be given by the equation:
$$FOV = k\ t \cos\delta$$
This is provided that we position the object to one side of the eyepiece (along the edge of the field of view) and turn off the telescope drive.
Which of the following could be a possible value of the constant k?

A. 1.04×10^{-3}
B. 2.09×10^{-3}
C. 4.18×10^{-3}
D. 6.25×10^{-3}
E. 8.33×10^{-3}</td><td>Answer: C

Since this equation must work for all declination values, we can easily set it to be at $\delta = 0^o$. Hence, these objects will tend to drift across the diameter in the field of view. Thus, to determine the FOV, ie angular displacement, we know that the angle travelled (ie. "FOV") of 360^o is done through 24 hours (well, that's because that is the total angle rotated by the Earth about its own axis).
Hence, $FOV = 360^o$, $t = 86164\ s$, $\delta = 0^o$ gives $k = 4.18 \times 10^{-3}$ (Note that it does not matter if we use a sidereal day or a solar day. The answers will round off to be around this value)</td></tr>
<tr><td>15</td><td><table><tr><td>Star</td><td>Vega</td><td>Aldebaran</td><td>10 Lacertae</td></tr><tr><td>Spectral type</td><td>A0V</td><td>K5III</td><td>O9V</td></tr></table></td><td>Answer: D.

While Aldebaran lies in the northern half of the celestial</td></tr>
</table>

Declination	– 38° 47′ 01″	+ 16° 30′ 33″	–39° 03′ 00″
Apparent magnitude	+0.026	+0.86	+4.88
Distance from Earth	25.04 ly	65.3 ly	2,330.9 ly
Colour index (B–V)	+0.00	+1.44	-0.21

Given the information above, which of the following statement is incorrect?
A. 10 Lacertae is the hottest star
B. All three stars are in the Milky Way
C. Only two of the three stars are in their main sequence stage
D. Aldebaran cannot be seen in the southern hemisphere
E. Vega is the dimmest in terms of absolute magnitude

sphere, that does not imply that its invisible to all southern hemisphere observers

16 What does it mean for an object to have a redshift of z=1.2?

A. The object has a luminosity distance of 1.2 megaparsecs
B. The object has a co-moving distance of 1.2 megaparsecs
C. The object emits 1.2 times more red light (600nm) as a proportion of its total emission than our reference star, the Sun
D. The wavelengths of the object's emitted light are all increased by 1.2 times compared to the original wavelength
E. The object's observed velocity is 1.2 times greater than the velocity generated by the Hubble Flow at that distance

Answer: D.

The formula for z in the Formula Book is given: simply translate the math.

17 The following is a list of solar system objects and their respective deity according to an ancient Vedic (Indian) astrology text dated ~700 BCE

Object	Deity
Sun	Surya
Mercury	Budha
Mars	Mangala
Saturn	Shani
Neptune	Rahu

Which of the five pairs is wrong?

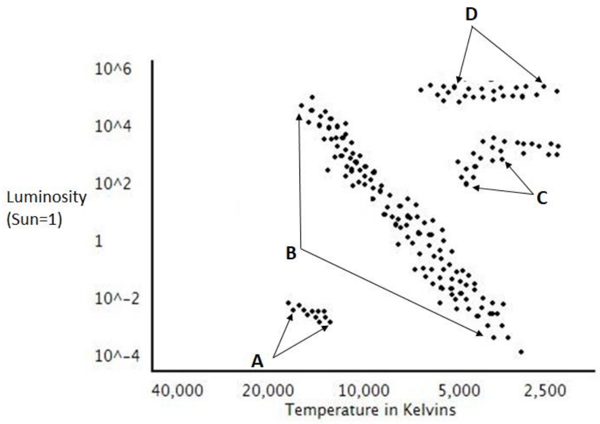
A. Neptune-Rahu
B. Saturn-Shani

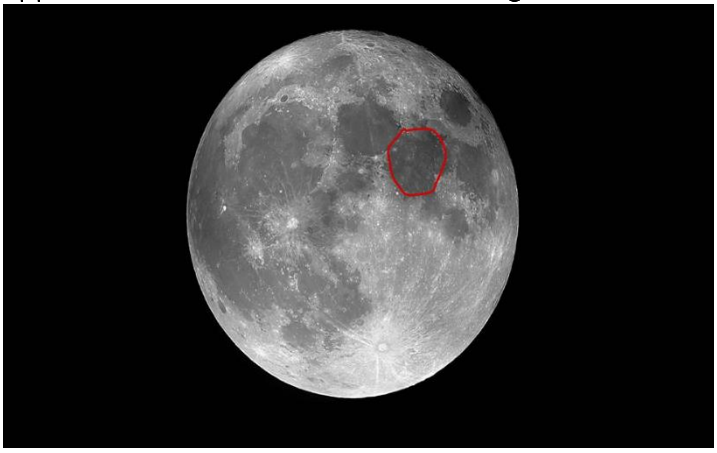
Answer: A.

As Neptune is not visible to the naked eye, ancient Indians do not have any known means to observe Neptune and thus did not know of its existence.

	C. Mars-Mangala D. Mercury-Budha E. Sun-Surya	
18	Question 18 & 19 refer to the same object. 2015 TG387 is a recently discovered Sednoid, nicknamed 'The Goblin'. At Perihelion it is 65.082 AU away from the sun, but at Aphelion it is 1955.69 AU away from the Sun. Which of these statements about it Is true: I. It has an Eccentricity of 0.064. II. It has an Eccentricity of 0.936. III. It has an Eccentricity of 1.936. IV. It has a Semi-major axis of about 101 AU. V. It has a Semi-major axis of about 1010 AU. A. I. and IV. B. I. and V. C. II. and IV. D. III. and V. E. None of the above.	Answer: E. II. and V. are correct. Calculations can be made from formula book.
19	The discovery of 'The Goblin' led to plenty of excitement in the scientific community. This is because: A. The strange, highly perturbed orbit is potential evidence for a massive, unobserved 'Planet Nine'. B. It is the first-ever interstellar body that does not orbit the sun, given its huge Aphelion. C. It is the smallest dwarf planet ever discovered, measuring only 300 km in diameter. D. It has an albedo of 0.15, making it the first object in the Solar System with a greenish hue. E. The name is controversial as it was named after a TV show, thus making several people upset.	Answer: A. Reality is stranger than fiction here. B. is False; if it was an interstellar body that did not orbit the Sun, it would not have a finite aphelion. C. The smallest Dwarf Planet is Ceres, measuring around 1000 km; 'The Goblin' is unlikely to be in hydrostatic equilibrium. D. Bullshit detector test. E. Bullshit detector test.
20	The helium flash is a phenomenon where large amounts of helium in the core of a solar-mass star suddenly fuses into carbon through the triple-alpha process. This releases a large amount of energy (0.3% the energy of a Type 1a supernova). However, the star does not expand significantly, and the phenomenon is not optically visible. This is because A. The released energy is used to fuse the hydrogen layer above. B. The released energy is used to overcome degeneracy pressure	Answer: B Before the helium flash occurs, the helium core of the star is degenerate. Thus, while the energy released in the helium flash is significant, nearly all of it is used to lift the degeneracy of the core, leading to core expansion. Meanwhile, the outer layers remain largely unperturbed

	C. The released energy is used to sustain ongoing helium fusion D. The energy results in pair-production, reducing the energy available to support the star. E. The energy produced is consumed to produce heavy elements like iron and silicon.	(and in fact slowly shrink after the helium flash)
21	A school astronomy club held a discussion on whether to purchase a reflector or a refractor 10’’ telescope. Which of the following 5 comments recorded is accurate? A. A refractor uses convex lens while a reflector uses parabolic mirrors. B. A sealed tube on refractors means little maintenance is required C. Images seen in reflectors do not suffer from astigmatism while refractors do D. Chromatic aberrations found in reflectors require expensive apochromatic modifications. E. All of the statements above are accurate.	Answer: B This question demands knowledge on the differences between a refractor and a reflector. A refractor uses concave lens (A) and is prone to chromatic aberrations (D). C is false. B is true and relevant for a small-scale telescope.
22	During the summer months, polar regions may experience “white night”, which is the phenomenon where twilight persists even during local midnight, when the night is supposedly at its darkest. What is approximately the southernmost latitude in the Northern hemisphere in which the phenomenon of “white night” can be observed? (Note: twilight here refers to civil twilight where the Sun is less than 6 degrees below the horizon) A. 23 degrees N B. 29 degrees N C. 61 degrees N D. 67 degrees N E. 90 degrees N	Answer: C Start off by considering the solution to a simpler problem: what is the southernmost possible latitude in the northern hemisphere where the center of the sun appears to touch the horizon during local midnight on the summer solstice? That is clearly the Arctic Circle at 66.5 degrees N. Deduct 6 degrees and round your answer to get C.
23	Which pair of stars are most likely to have the same radius?	Answer: A Using the Stefan Boltzman law, we can show that: $\frac{R_1}{R_2} = (\frac{T_1}{T_2})^2 \times (\frac{L_1}{L_2})^{0.5}$ Under a radius ratio of 1, L is proportional to the 4th power

	 A. A B. B C. C D. D E. It is impossible to compare stellar radius via a HR diagram	of T. It becomes clear that the relationship is downward sloping (temperature is plot in reverse). Hence eliminating C and D. With respect to A and B, a quick graphical check shows that B’s luminosity ratio is much larger than the temperature ratio.
24	An Earth-like planet is orbiting its star at 1 AU. If the star is determined to have a mass double that of the Sun. What is the orbital period of the planet in Earth years? A. 1.6 B. 1.2 C. 0.7 D. 0.5 E. 0.3	Answer: C Apply Kepler’s Third Law.
25	Imagine that the Earth’s spin was reversed, so that the planet rotated about its axis from East to West, at the same rate at which it now rotates from West to East. If Earth’s orbital motion about the Sun were unchanged, which of these statements is true? A. The duration of the sidereal day would not change B. The sidereal day would be 8 minutes longer than it is now. C. The duration of the Solar Day would not change. D. The Solar Day would be 4 minutes longer than it is now. E. The Solar Day would be 8 minutes longer than it is now.	Answer: A By definition, solar day is of 24 hours. But, the duration of a sidereal day is 23 hours 56 minutes. This is because of the Earth’s revolution around the Sun. Since the Earth rotates and revolves in the same direction, it has to rotate by more than 360 degrees to have Sun at its zenith. Therefore, a solar day is longer than a sidereal day. If the Earth’s spin is reversed, a solar day would be shorter than the sidereal day by 4 minutes, i.e., 8 minutes shorter than now.
26	Which of the following cannot be a standard candle? A. Type Ia supernovae B. Quasars C. Cepheid variables	Answer: C. Quasars are intrinsic variable – their luminosity while

	D. RR Lyrae variables E. None of the above	enormous, can vary quite dramatically. Thus they cannot be standard candles. In comparison, Type Ia supernovae can be standard candle as they explode with the same mass. Cepheid variables' and RR Lyrae variables' luminosity is correlated to their periods.
27	Procyon is one of the brightest stars in the night sky and the brightest star in the constellation Canis Minor. It has an absolute magnitude 2.6. What is the distance of a similar star with apparent magnitude 13 from Earth? A. 600 parsec B. 1000 parsec C. 5000 parsec D. 10000 parsec E. 20000 parsec	Answer: A. 1000 parsec (1200 parsec, = 10exp(13 - 2.6 + 5 / 5))
28	More than half of the Messier objects charted are: A. star clusters B. galaxies C. supernova remnants D. nebulae E. double stars	Answer: A While the Messier catalogue does contain all of these objects, by and large it focuses on star clusters.
29	Suppose the crew of Apollo 11 were to observe Earth from Mare Tranquillitatis for an extended period of time. What is the frequency of Earthrise in Earth time units? The approximate location is shown in the figure below.  A. Every 12 hours B. Every 24 hours C. Every sidereal month D. Every synodic month	Answer: E

	E. Undefined: Earth does not set.	
30	It is local midnight and here are some objects I can see when looking due North. - Vega - Scutum Further, the constellation Corona Australis lies near the Zenith. What is the current season at my location? A. Summer B. Spring C. Winter D. Fall E. Not enough Information	Answer: C From the given constellations, I can surmise that 1) I am in the southern hemisphere and 2) It is summer in the northern hemisphere. Hence, I am in winter.
31	Which of the following processes in stars do not release a net amount of energy to their surroundings? A. CNO cycle B. Proton-proton chain C. Triple alpha process D. R-process E. B and C only	Answer: D The r-process produces elements heavier than iron and as such requires large amounts of energy to operate.
32	The sun has an apparent magnitude of -26.7, and the associated solar flux is approximately 1,368 W/m2 (watts per square meter). Given that the apparent magnitude of Vega is 0, how much flux does Vega gives to earth (in W/m2)? A. 5.38 x 10-10 B. 5.38 x 10-9 C. 2.69 x 10-9 D. 5.38 x 10-9 E. 2.69 x 10-8	Answer: E Since flux is proportional to apparent brightness, simply compute the ratio of brightnesses m-m_sun=-2.5log log F/F_sun F=2.69 x 10^(-8)
33	Argo Navis was a large southern sky constellation that in modern times have been split up into multiple smaller constellations. From the following list of constellations; I) Pyxis II) Carina III) Vela IV) Triangulum V) Puppis Which of the following are true? A. Only II and III are part of Argo Navis B. Only I and IV are not part of Argo Navis C. Only I and V are part of Argo Navis D. None of the five are part of Argo Navis	Answer: C Argo Navis composes of Carina (The Hull), Vela (The Sails) and Puppis (The Stern). While Pyxis (The Compass) is close to the original Argo Navis, its stars were not included in the original composition

E. All the five are part of Argo Navis

34 M40 is a double star in Ursa Major. The following observational data was collected of the 2 stars.

	A	B
RA	12h 22m 12.5s	12h 22m 19s
Dec.	+58° 4′ 58.5″	+58° 5′ 10.4″
Spectral type	K0 III	G0 V
Abs Magnitude	0.88	4.0
Distance	350pc	140pc
Mass (M⊙)	1.1	1.2

What type of binary is this star system?

A. Astrometric
B. Eclipsing
C. X-Ray
D. Optical
E. Spectroscopic

Answer: D

The distance is enough clue that this is an optical binary, where the stars are not related to each other.

35 The following summarises the data of two different stars:

	Star A	Star B
Effective Temperature	T_A	T_B
Radius	R_A	R_B
Absolute Bolometric Magnitude	M_A	M_B

Which of the following represents the correct relationship between the physical quantities above?

A. $\frac{R_A}{R_B} = \left(\frac{T_B}{T_A}\right)^2 * 10^{\frac{M_B-M_A}{5}}$

B. $\frac{R_A}{R_B} = \left(\frac{T_B}{T_A}\right)^2 * 10^{\frac{M_B-M_A}{2.5}}$

C. $\frac{R_A}{R_B} = \left(\frac{T_A}{T_B}\right)^2 * 10^{\frac{M_A-M_B}{2.5}}$

D. $\frac{R_A}{R_B} = \left(\frac{T_A}{T_B}\right)^2 * 10^{\frac{M_B-M_A}{5}}$

E. $\frac{R_A}{R_B} = \left(\frac{T_B}{T_A}\right)^2 * 10^{\frac{M_A-M_B}{2.5}}$

Answer: A

From the formula book, we can utilise the formula relating absolute magnitude to luminosity:

$$\frac{L_1}{L_2} = 10^{\left(\frac{M_2-M_1}{2.5}\right)}$$

And the relationship between luminosity to radius and effective temperature of the star:

$$L = 4\pi R_A^2 \sigma T_A^4$$

Hence,

$$\frac{R_A^2 T_A^4}{R_B^2 T_B^4} = 10^{\left(\frac{M_B-M_A}{2.5}\right)}$$

		Bringing the temperature terms over and taking a power half on both sides (note that the power ½ is distributed over the temperature term and the $10^{something}$ term. Hence, $\left(\frac{R_A}{R_B}\right)^2 = \left(\frac{T_B}{T_A}\right)^4 * 10^{\left(\frac{M_B - M_A}{2.5}\right)}$ Therefore, $\frac{R_A}{R_B} = \left(\frac{T_B}{T_A}\right)^2 * 10^{\left(\frac{M_B - M_A}{5}\right)}$
36	During the 4th century BC, Aristotle developed his **geocentric model** of the universe involving transparent and unchanging solid spheres which planets are attached to, that rotate at different speeds in order to explain the motion of the planets across the night sky. Which of the following explanations would not have proven his model **wrong**? A. Tycho, a prominent Danish Astronomer, observed the formation of a bright new star around Cassiopeia in 1572. B. Tycho also observed a comet passing through the ecliptic between planets in 1577. C. Kepler highlighted the lack of parallax of a new star formed in the “starry sphere” in 1604 D. Galileo observed 4 “stars” revolving around Jupiter. E. Ptolemy observed the retrograde motion of Mar, which is the apparent backward motion of Mars’ orbit.	Answer: E A and C suggests that the spheres are not unchanging, D proves that not all celestial bodies revolve around Earth while B suggests that the spheres are not solid. E does not prove Aristotle wrong as the multiple spheres account for the retrograde motion of Mars.
37	Suppose I have data on a star cluster. If I plot the following pairs of variables on the x & y axis respectively, which pair will NOT yield a typical HR diagram plot? A. Spectral class and Luminosity B. Temperature and Absolute magnitude C. Spectral class and Absolute magnitude D. Temperature and Luminosity E. All of the above are valid axes	Answer: E Simply recall that spectral class is indicative of surface temperature and absolute magnitude is a measure of luminosity.
38	With respect to a hypothetical observer on the Sun, the phases of the Moon as seen by the observer repeat once	Answer: E.

	and only once approximately every ....? (Exclude eclipses/occultations from consideration) A. 24 hours B. 27.3 days C. 29.5 days D. 365.25 days E. None of the above	As seen from the Sun, the phase of the Moon is always full.
39	Julius Caesar was traitorously stabbed by his trusted advisor, Brutus, on 15 March 44 BCE. Which constellation was likely to be seen (closest to the zenith) at local midnight on that fateful day? You are given that Athens has a latitude of 37.98 degrees North, and at a longitude of 23.73 East. A. Orion B. Coma Berenices C. Canis Major D. Cassiopeia E. Perseus	Answer: B The other constellations are autumn/winter constellations
40	Sharadh's Q11 (as of Box Version Jan 27)	
41	Oslo, the capital of Norway, is one of the northern-most capital cities in the world, with coordinates: 59.9139° N, 10.7522° E. Which of the following constellations will never appear in Oslo's night sky across 2019? A. Cygnus B. Cassiopeia C. Carina D. Canis Major E. Canis Minor	Answer: C. In fact, anything within 59.9139° degrees from celestial South pole can never be observed.
42	Which of the following famous stars is incorrectly matched to its approximate average surface temperature? A. Aldebaran – 3900 K B. Regulus – 5100 K C. Vega – 9 600 K D. Rigel – 12100 K E. Spica – 20900 K	Ans: B Obs question in disguise. Actual temperature is ~ 12500K.
43	Sharadh's Q8 & Q9 (as of Box Version Jan 27)	
44	Sharadh's Q8 & Q9 (as of Box Version Jan 27)	

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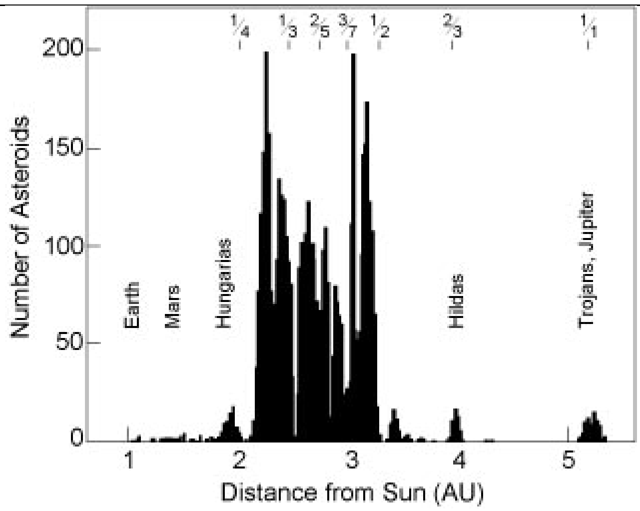

The figure shows the relationship between distance from the sun and asteroid population. It is noted that conspicuous gaps exist, most notably at 2.5 and 3.3 AU. The cause for these gaps can be used to explain what other phenomenon(s)?
(I) - Gaps in Saturn rings
(II) - Instability strip in the HR diagram
(III) - Eccentricities of Ganymede and Io orbit varying with a common period
(IV) - Sudden end of the Kuiper Belt at around 50 AU (the Kuiper Cliff)

A. I and III only
B. I and IV only
C. II and III only
D. II and IV only
E. I, II and III only
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Answer: A

Orbital resonance is the mechanism causing these gaps, and similarly causes the gaps in Saturn’s rings and causes the orbital eccentricity of Ganymede and Io to vary together. Note that no orbital resonance exists at 50AU, and thus it cannot be the cause of the Kuiper Cliff
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Consider the following statements about comets.

I. A comet usually has two main tails, known as coma tail and dust tail.
II. The two tails of a comet never point towards the sun.
III. Short period comets all originate from the Asteroid belt between Mars and Jupiter.
IV. Long period comets are believed to originate from the Oort Cloud.
V. The coma is the cloud of gas surrounding the comet’s nucleus.

Which of the statements above are correct?
a. I, II, III
b. I, III, IV
c. II, III, IV
d. II, IV, V
e. III, IV, V
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Answer: D

I is false: a comet usually has a gas tail and a dust tail.

III is false: asteroids generally do not have enough ices to form a tail in the first place. Rather, short-period comets are believed to be formerly long-period comets which have had their orbits subsequently modified by gravitational interactions with the planets.
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47	For Question 47-49, refer to the table below. Kiayee attempted to observe the following objects recorded in his cheatsheet at local midnight December 22. <insert table, placing it here would break formatting> Given that he observed the object Betelgeuse at the zenith, what is the latitude of his current location? A. +7°24’ B. -7°24’ C. +82°35’ D. -82°35’ E. 0°00’	Answer: A Refer to the declination of Betelguese
48	Which of the following objects could he not have seen at that point in time? A. Double Cluster B. M 41 C. North America Nebula D. Spirograph Nebula E. None of the above	Answer: C Given that Betelgeuse is on the local meridian, Local Sidereal Time is given to be 5:55:10, North American Nebula is at 20:58:47 which is below the horizon.
49	Suppose now that M78 is setting. Which of the following objects would be the first one to next cross the local meridian? A. Betelgeuse B. Spirograph Nebula C. λ Cen (RA: 11h36m, Dec: -63°01’) D. Jewel Box Cluster (RA: 12h54m, Dec: -60°21’) E. North America Nebula	Answer: D Compute the local sidereal time (we can do this since M78 is on the celestial equator). This gives us LST= 11h46m. While λ Cen is closest to the meridian, it crossed the meridian 10 minutes ago. Thus the next object to cross the local meridian is the Jewel Box Cluster
50	Which flag contains stars/objects/constellations that lie strictly within the southern sky? A. 	Answer: D D being New Zealand’s Flag is commonly known to display the Southern Cross. A the flag of Alaska shows the Big Dipper. B the flag of Brazil shows the Southern Cross as well but also shows Spica, which lies north of the

	B.  C.  D.  E. All 4 flags contain stars/objects/constellations that lie strictly within the southern sky	celestial equator. D is the Imperial flag of Japan which shows the Sun, which traverses both the northern and southern sky at different points in the year.

Table for Q47

Object	RA (J2000)	Declination (J2000)	Apparent Mag	Surface Brightness: Mag/arcmin
Betelgeuse	5h55m	+7°24’	0.50	N.A.
M 41	6h46m	-20°45’	4.5	12.19
Double Cluster	2h19m	+57°07’	3.7 & 3.8	10.92
M 78	5h46m	+0°00’	8.3	12.24
North America Nebula	20h58m	+44°19’	4.0	13.94
Spirograph Nebula	5h27m	-12°41’	9.6	N.A.
Eskimo Nebula	7h29m	+20°54’	9.7	8.86