

THEORETICAL QUESTIONS

1. A probe is sent to study a newly discovered comet. If the comet has a mass estimated to be 10^{14} kg and a radius of 5 km, what escape velocity would it need to achieve to leave the comet's gravitational influence?
 - (A) 168 m/s
 - (B) 435 m/s
 - (C) 620 m/s
 - (D) 847 m/s

2. Planet A spins on its axis once every 24 hours, while planet B takes 36 hours for a complete rotation. If planet A completes 3 orbits around its star at the same time it takes planet B to complete 1 orbit, how many times faster does planet A rotate compared to planet B?
 - (A) 24 times
 - (B) 28 times
 - (C) 30 times
 - (D) 33 times

3. Your new telescope is designed to study Proxima Centauri, a different star system. If it needs the same orbital period as The James Webb Space Telescope around the Sun, how far away from Proxima Centauri would it need to be?
 - (A) 605 million km
 - (B) 600 million km
 - (C) 720 million km
 - (D) 808 million km

4. Two asteroids, X and Y, collide at an angle. Asteroid X has a mass of 5 kg and is moving at 10 m/s westbound, while asteroid D has a mass of 7 kg and is moving at 8 m/s northbound. If they stick together after the collision, what is the magnitude and direction of their resulting velocity?
- (A) 2.25 m/s, clockwise from west
 - (B) 3.40 m/s, clockwise from east
 - (C) 6.67 m/s, counter-clockwise from west
 - (D) 8.00 m/s, counter-clockwise from east
5. After collecting some samples from a stationary asteroid, an arbitrary space probe launched itself to go back to Earth. At launch, the space probe accelerates 48ms^{-2} and the asteroid accelerates 5ms^{-2} in the opposite direction. How much heavier is the asteroid compared to the space probe?
- (A) 0.104
 - (B) 0.050
 - (C) 0.020
 - (D) 3.360
6. You are on a planet with two moons, Luna and Terra. Luna orbits your planet twice as fast as Terra. If Luna eclipses Terra today, how long will it take for another lunar eclipse to occur?
- (A) $T - T/2$ days
 - (B) T day
 - (C) $T + T/2$ days
 - (D) $T + 3T/2$ days
7. You are observing an inferior planet in your solar system. When it appears at its greatest western elongation, how far is it from you if your planet is 1.5 AU from the star and the inferior planet is 0.7 AU from the star?
(Assume circular and coplanar orbits)
- (A) 1.5 AU
 - (B) 1.8 AU
 - (C) 0.7 AU
 - (D) 2.1 AU
-

8. If the orbital period of Venus is 224.7 Earth days and its average distance from the Sun is 0.723 AU, what is the orbital period of Mars, which has an average distance of 1.524 AU?
- (A) 520 Earth days
(B) 687 Earth days
(C) 710 Earth days
(D) 800 Earth days
9. If $p = 4$, $q = 6$ and $q = 4p + y^2 - pq$, then, $y = ?$
- (A) 2.98
(B) 3.00
(C) 3.74
(D) 4.25
10. Consider two vectors; $u = 3i + 2j$ and $v = 5i - yj$. What is the value of y if $u + v = 8i - 9j$?
- (A) 24
(B) 8
(C) 6
(D) 11
11. Simplify: $(x^2 + 4x + 3)/(x + 1)$
- (A) $(x + 3)$
(B) $(2x + 3)$
(C) $(x - 3)$
(D) $(x + 3)^2$

12. Two stars, Alpha and Beta, are both born from the same collapsing gas cloud. During their early stages, both stars begin accelerating away from their birthplace due to the outward pressure from the stellar winds of nearby newborn stars. However, Alpha reaches a velocity of 100 kilometers per second after 1 million years, while Beta takes 2 million years to achieve the same speed. What can you say about the net force acting on Alpha compared to Beta during their acceleration phases?
- (A) The net force acting on Alpha is zero
 - (B) The net force acting on Alpha is lesser than Beta
 - (C) The net force acting on Alpha is greater than Beta
 - (D) The net force acting on Alpha is similar to Beta
13. Give an example of how the Stefan-Boltzmann Law is used in everyday life.
- I. Cooking
 - II. Incandescent light bulbs
 - III. Observing colour changes
 - IV. Night vision devices
- (A) II & III
 - (B) II & IV
 - (C) All of the above
 - (D) I, II & IV
14. Imagine you are designing a telescope specifically for studying binary star systems. Which of the features would you consider important?
- I. Fast time resolution
 - II. Focus on far-infrared or radio capabilities wavelength
 - III. High angular resolution
 - IV. Extreme cost
- (A) I & III
 - (B) I & II
 - (C) II & IV
 - (D) All of the above
-

15. The Apollo missions sent by NASA to the Moon between 1969 and 1972 have brought back many Moon rocks to Earth. By studying these rocks, scientists have determined how the Moon was formed. Which of the following statements about the formation of the Moon is **TRUE**?
- (A) The Moon was formed together with the Earth
 - (B) The Moon was once part of the Earth and somehow got separated in time
 - (C) The collision between Earth and Mars produced debris which orbits around the Earth to form the Moon
 - (D) The collision between Earth and another small planet produced debris which orbits around the Earth to form the Moon
16. In the Solar System, the four giant gas planets (Jupiter, Saturn, Uranus and Neptune) have rings, while the inner terrestrial planets (Mercury, Venus, Earth and Mars) do not have rings. What is the reason for this to occur?
- (A) The existence of the Roche limit for planets
 - (B) The existence of the Chandrasekhar limit for planets
 - (C) The gravity of the giant gas planets is so strong that the particles in the rings cannot escape
 - (D) The terrestrial planets are so near to the Sun that the Sun's radiation and solar wind blew away the rings that try to form around these planets
17. Which of the following is the most volcanically active celestial body in the Solar System?
- (A) Io
 - (B) Mars
 - (C) Ganymede
 - (D) Saturn
18. In 2006, the International Astronomical Union (IAU) downgraded the status of Pluto from a planet to that of a "dwarf planet". The reason for this downgrade is because
- (A) Pluto is usually the farthest from the Sun, however its orbit "crosses" inside of Neptune's orbit for 20 years out of every 248 years
 - (B) Pluto has not cleared its neighbouring region of other objects
 - (C) Pluto has been discovered not to be round but instead oval in shape
 - (D) Pluto is so far from the Sun that it will soon escape from the gravitational pull of the Sun and will leave the Solar System
-

19. Why does the Moon look brighter than Mars when seen during the night sky from Earth?
- (A) The Moon is much closer to the Earth than Mars
 - (B) The Moon is much larger than Mars
 - (C) The Moon reflects lighter than Mars
 - (D) The Moon produces light by itself, but Mars doesn't
20. Shenzhou 16 was launched on 30 May 2023. Before docking with the China Space Station, it orbits around the Earth. How long did it take for Shenzhou 16 to complete one orbit around the Earth?
- (A) 60 minutes
 - (B) 90 minutes
 - (C) 120 minutes
 - (D) 24 hours
21. Which of the following objects is best viewed using a low power eyepiece?
- (A) The Moon
 - (B) Polaris
 - (C) Mars
 - (D) Andromeda Galaxy
22. The first reflecting telescope was a _____ design, it consists of a parabolic shaped primary mirror and a flat secondary mirror.
- (A) Newtonian
 - (B) Cassegrain
 - (C) Nasmyth
 - (D) Gregorian

23. Which of the following statements about field of view is **FALSE**?
- (A) The apparent field of view can be approximated by measuring the time required for a star to drift from one side of the field to the other
 - (B) The true field of view can be approximated by dividing the apparent field of view by the magnification
 - (C) The apparent field of view is the angular size of the sky as seen through the eyepiece
 - (D) The true field of view is the angular size of the sky as seen through the telescope
24. Which of the following is true about an alt-az telescope mount?
- (A) It is aligned with the north celestial pole
 - (B) It experiences symmetric gravitational forces anywhere on Earth
 - (C) It is massive and more difficult to operate as compared to an equatorial mount
 - (D) We can attach constant speed motors on each of its axes to track stars
25. A star is
- (A) A glowing ball of gas held together by its own gravity and powered by nuclear fusion at its centre
 - (B) A glowing ball of gas held together by its own gravity and powered by nuclear fission at its centre
 - (C) A glowing ball of gas held together by its own gravity, but not necessarily powered by nuclear reaction
 - (D) A glowing ball of gas powered by nuclear reaction at its centre, but not necessarily held together by gravity
26. The Sun is classified as a G2V star. The luminosity class of the Sun is indicated by the
- (A) 'G' in 'G2V'
 - (B) '2' in 'G2V'
 - (C) 'V' in 'G2V'
 - (D) 'G2' in 'G2V'
-

27. A person falling feet first into a black hole would be stretched enormously in height and squeezed horizontally, a process known as
- (A) Noodlification
 - (B) Pastafication
 - (C) Spaghetification
 - (D) Vermicellification
28. A _____ is a hypothetical structure linking disparate points in spacetime.
- (A) Dark-energy star
 - (B) White hole
 - (C) Black hole
 - (D) Wormhole
29. Spiral galaxies with the Hubble type 'Sa' have _____ bulge-to-disc luminosity ratio and _____ wound spiral arms as compared to 'Sc' galaxies.
- (A) Smaller, looser
 - (B) Smaller, tighter
 - (C) Larger, tighter
 - (D) Larger, looser
30. The Hubble classification of elliptical galaxies goes from E0 to E7, where the larger the number,
- (A) The more circular the galaxy
 - (B) The more elongated the galaxy
 - (C) The larger the bar in the galaxy
 - (D) The larger the size of the galaxy

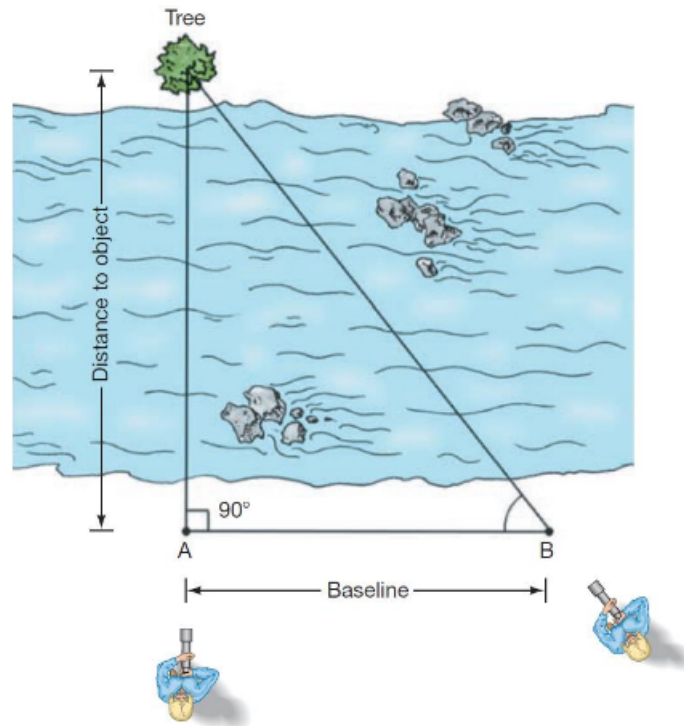
31. The figure below shows an image of NGC1300, which is classified as a _____ galaxy.



- (A) Elliptical
 - (B) Spiral
 - (C) Barred spiral
 - (D) Irregular
32. The Magellanic Clouds orbiting around the Milky Way are classified as
- (A) Irregular galaxies
 - (B) Interstellar medium
 - (C) Star clusters
 - (D) H I regions
33. The following celestial entities are known as large-scale structures, except the
- (A) Clowes-Campusano Large Quasar Group
 - (B) Sloan Great Wall
 - (C) Hercules-Corona Borealis Great Wall
 - (D) Virgo Supercluster

34. The assumption that the universe is both homogeneous (same everywhere) and isotropic (same every direction) is known as the
- (A) Universal principle
 - (B) Copernican principle
 - (C) Cosmological principle
 - (D) Anthropic principle
35. Currently, the absolute size of our universe is
- (A) Constant
 - (B) Expanding at a constant rate
 - (C) Decelerating
 - (D) Accelerating
36. Astronomical observations suggest that our universe started with a Big Bang, expanding to what it is today. Based on current observations, it will possibly end with a
- (A) Big Crunch
 - (B) Big Bounce
 - (C) Big Freeze
 - (D) Big Rip
37. Kepler's third law states that the square of a planet's orbital period (P) is proportional to the cube of its semimajor axis (r) from the Sun. Therefore, if a planet has an orbiting period that is twice as long as the Earth's orbital period, its semimajor axis from the Sun will be _____ times as far.
- (A) $\sqrt[3]{4}$
 - (B) $\sqrt[3]{2}$
 - (C) 4
 - (D) 2

38. The image below visualises the method of triangulation, which is used to measure the parallax angles of stars. Supposed that the length of the baseline is 3.0 m and the parallax angle is 36.87° , use the sine rule to find the distance from point A to the tree.



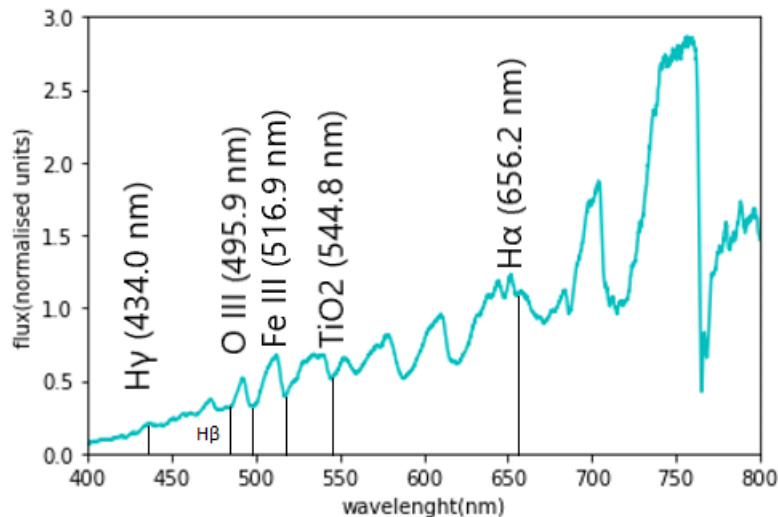
- (A) 3.0 m
(B) 4.0 m
(C) 5.0 m
(D) 6.0 m
39. The building blocks of life we find on Earth are made of complex organic molecules. The term 'organic' is used to refer to _____ molecules.
- (A) Hydrogen-based
(B) Carbon-based
(C) Nitrogen-based
(D) Oxygen-based
-

40. Which of the following is the correct sequence of evolutionary phases (from earlier to later) that contributed to the development of life on Earth?

- I. Stellar evolution
 - II. Planetary evolution
 - III. Chemical evolution
 - IV. Biological evolution
- (A) I, II, III, IV
(B) I, II, IV, II
(C) I, III, II, IV
(D) I, III, IV, II

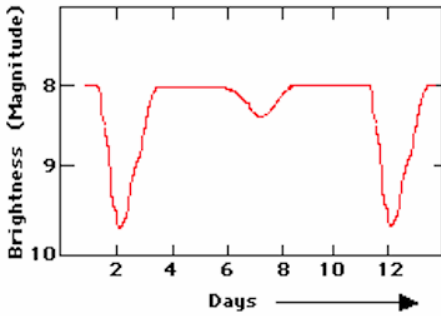
PRACTICAL QUESTIONS

41. Yahaya is inside the Main Terminal Building of Kuala Lumpur International Airport. He observed the image of the Sun on the floor of the terminal. He realised that the Sun's rays forming the image on the floor are entering through a tiny triangular shaped window in the high ceiling. He measured the diameter of the image on the floor to be 0.175 m. Find the height of the ceiling.
- (A) 12.55 m
(B) 18.75 m
(C) 21.55 m
(D) 38.55 m
42. The figure below is the spectrum of the light of a certain star. The spectrum of a star can tell a lot of information about the star. Give the name of the star that corresponds to this spectrum.

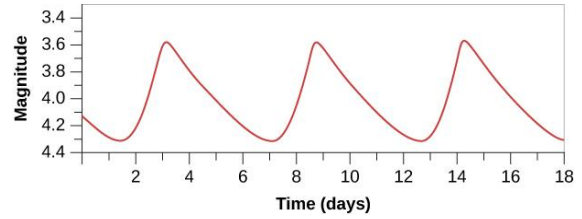


- (A) Sirius A, an A-type star
(B) Regulus A, a blue-white subgiant B-type star
(C) Betelgeuse, a red supergiant M-type star
(D) Alpha Centauri A, a G-type star

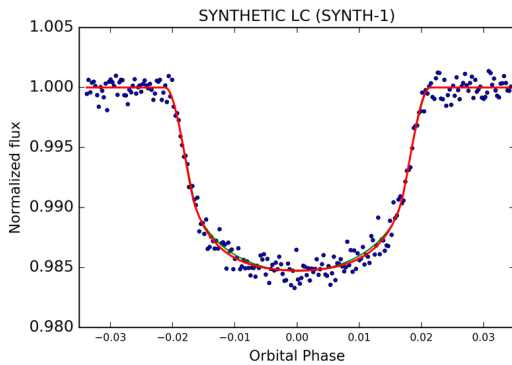
43. In the four graphs below are shown four types of light-curves of stars. Which of the answers below is the **COMPLETELY CORRECT MATCH** of the light-curves and their corresponding stars.



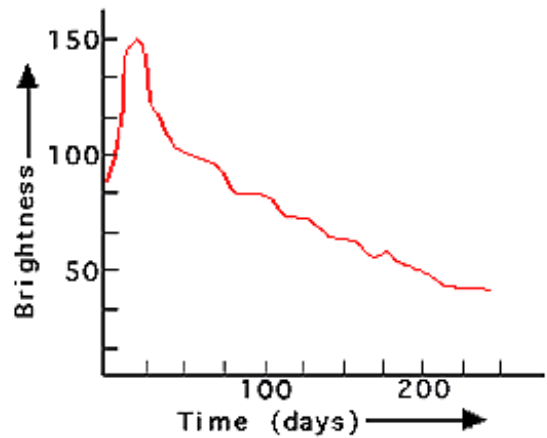
Light curve 1



Light curve 2



Light curve 3



Light curve 4

- | | |
|---|--|
| <p>(A) Light-Curve 1 is a pulsating variable star
Light-Curve 3 is a supernova</p> | <p>Light-Curve 2 is a pulsar
Light-Curve 4 is a Venus transit of the Sun</p> |
| <p>(B) Light-Curve 1 is a rotating variable star
Light-Curve 3 is a Venus transit of the Sun</p> | <p>Light-Curve 2 is an eclipsing binary star system
Light-Curve 4 is for a supernova</p> |
| <p>(C) Light-Curve 1 is an eclipsing binary star system
Light-Curve 3 is a transiting exoplanet</p> | <p>Light-Curve 2 is a Cepheid variable star
Light-Curve 4 is for a supernova</p> |
| <p>(D) Light-Curve 1 is a Cepheid variable star
Light-Curve 3 is a transiting exoplanet</p> | <p>Light-Curve 2 is an eclipsing binary star system
Light-Curve 4 is a pulsar</p> |

44. On 8 April 2024, a Total Solar Eclipse will be visible in parts of Mexico, United States and Canada as shown in the map below. As the path of totality crosses the United States, the city of Dallas in the state of Texas is the city in the United States that will experience the longest time of 3 minutes and 51 seconds under the full shadow (umbra) of the Moon. Which statement below is **COMPLETELY CORRECT** concerning the phenomena that can be observed from the city of Dallas as this city comes under the full shadow (umbra) of the Moon?



- (A) The sky becomes completely dark, the Sun's chromosphere and corona, the bright Moon, planets and stars become visible
- (B) The sky becomes completely dark, the Sun's photosphere and corona, the bright Moon, planets and stars become visible
- (C) The sky becomes completely dark, solar prominences and corona, planets, stars and the Milky Way become visible
- (D) The sky becomes completely dark, the Sun's chromosphere and corona, planets and stars become visible
45. Which statement below completely and correctly describes the characteristics of a charge-coupled-device (CCD) sensor to make it suitable for optical astronomy.
- (A) Highly sensitive to light, low in noise, linear response, large dynamic range, good quantum efficiency
- (B) Medium sensitive to light, low in noise, linear response, large dynamic range, good quantum efficiency
- (C) The sky becomes completely dark, solar prominences and corona, planets, stars and the Milky Way become visible
- (D) The sky becomes completely dark, the Sun's chromosphere and corona, planets and stars become visible
-

Questions 46 to 55 will refer the data below

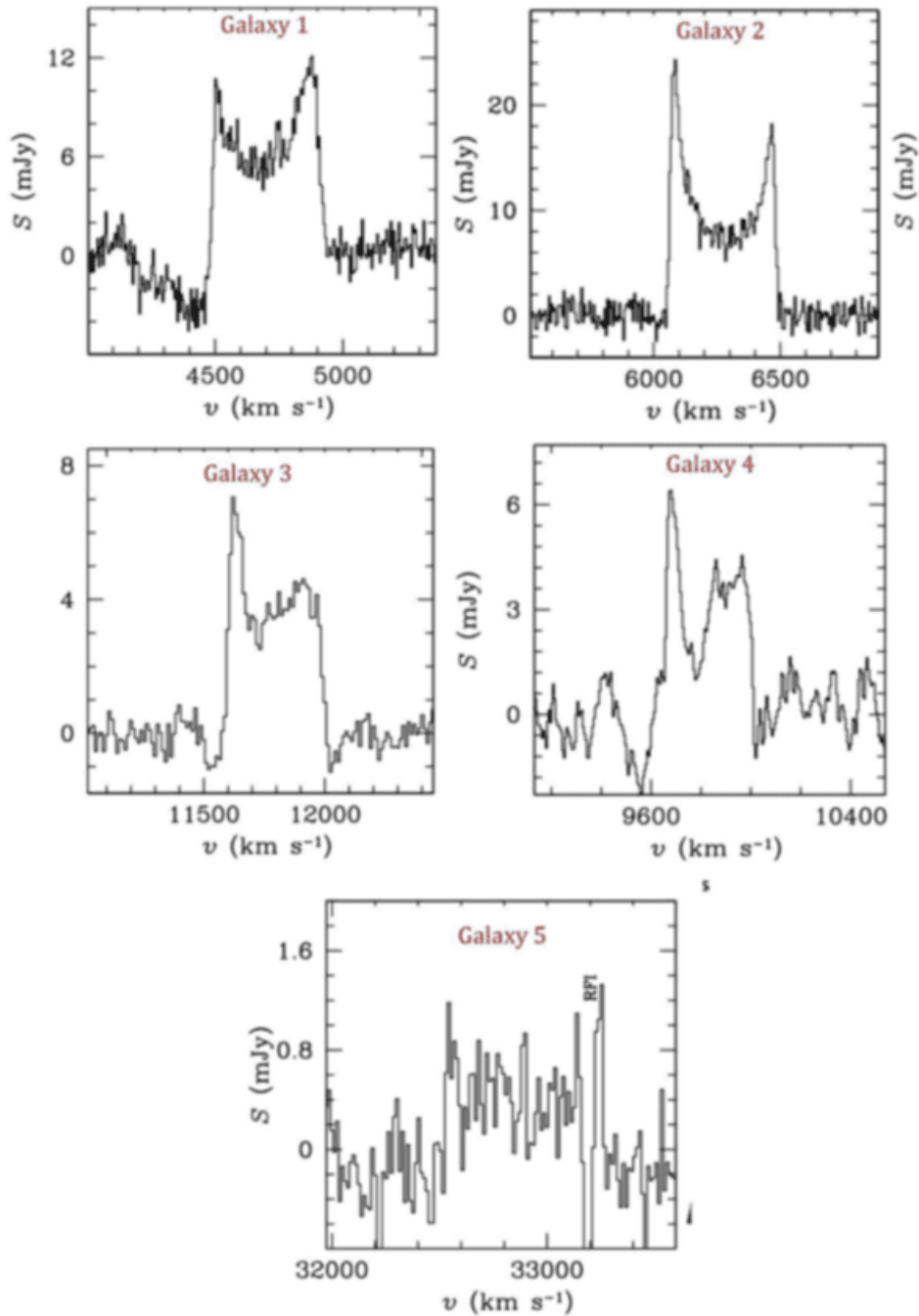


Figure above shows the spectral data from 5 galaxies which exhibit the HI emission. On each plot, x-axis represents the radial velocity of the galaxy, while Y-axis represents the flux. Using Tully-fisher relation and distance modulus, astronomers can estimate the distance from us to the galaxies.

Malaysian Astronomy Olympiad (MyAO) 2024

Table below would help you answer questions 46 to 50. To obtain the v_{FWHM} , astronomers measure the width of the speed, V at half point of the peak flux.

Galaxy	Peak flux (mJy)	Peak flux \times 0.5 (mJy)	v_1 , (kms $^{-1}$)	v_2 , (kms $^{-1}$)	v_{FWHM} , (kms $^{-1}$)
1	P				
2		Q			
3			R		
4				S	
5					

46. What is the value of P & Q?

	P	Q
(A)	12	16
(B)	16	12
(C)	12	12
(D)	16	16

47. What is the value of R?

- (A) 4500
- (B) 6100
- (C) 11600
- (D) 32500

48. What is the value of S?

- (A) 4900
- (B) 6450
- (C) 11950
- (D) 10000

49. Which of the below matching is correct?

	v_{FWHM} of Galaxy 1 (kms^{-1})	v_{FWHM} of Galaxy 2 (kms^{-1})	v_{FWHM} of Galaxy 3 (kms^{-1})	v_{FWHM} of Galaxy 4 (kms^{-1})	v_{FWHM} of Galaxy 5 (kms^{-1})
(A)	450	350	270	300	500
(B)	400	350	350	300	300
(C)	450	270	350	300	500
(D)	400	350	250	300	300

Astronomers also have to consider the inclination of the observed galaxy since the galaxy might not necessarily be observed exactly edge on. Using the formula;

$$v_{FWHM_{(cor)}} = v_{FWHM} / \sin\theta$$

we can correct the V_{FWHM} and proceed with using the Tully-fisher relation to calculate the luminosity of the galaxy. The Tully-fisher relation states that:

$$L = (v_{FWHM_{(cor)}})^4$$

Using the calculated luminosity, the absolute magnitude can be obtained using the luminosity-absolute magnitude relationship;

$$M = -2.5 \log_{10}(L) + 4.28$$

Finally, using the distance modulus, the distance of the galaxies can be obtained. Table below would help you answer questions 50 to 55.

Galaxy	v_{FWHM} (kms ⁻¹)	Inclination angle, $\theta(^{\circ})$	$v_{FWHM_{(cor)}}$ (kms ⁻¹)	Luminosity, $L (L_{\odot})$	Absolute magnitude, M (mag)	Apparent magnitude, m (mag)	Distance, D (Mpc)
1		70.3				12.61	
2		74.1		T		12.82	
3		54.8				14.00	
4		64.5		U		15.28	
5		82.2				14.95	

50. Which of the following statements is **CORRECT**?

- (A) Galaxy 1 rotates faster than galaxy 3
- (B) Galaxy 1 rotates faster than Galaxy 2, but slower than Galaxy 3
- (C) Galaxy 2 rotates faster than Galaxy 4, but slower than Galaxy 5
- (D) Galaxy 4 rotates the fastest

51. What is the value T and U?

	T	U
(A)	8.40×10^9	13.65×10^9
(B)	20.34×10^9	17.53×10^9
(C)	32.83×10^9	33.65×10^9
(D)	17.53×10^9	12.2×10^9

52. If observed from 10 Mpc away, which galaxy is the most bright and least bright?

	Brightest	Least bright
(A)	Galaxy 4	Galaxy 2
(B)	Galaxy 2	Galaxy 3
(C)	Galaxy 5	Galaxy 1
(D)	Galaxy 1	Galaxy 5

53. How far away is Galaxy 3 from the Earth?

- (A) 125314117 Mpc
- (B) 125314×10^3 Mpc
- (C) 125 Mpc
- (D) 125×10^6 Mpc

54. Rank the Galaxies from closest to farthest away from Earth

- (A) Galaxy 2, Galaxy 1, Galaxy 5, Galaxy 3, Galaxy 4
- (B) Galaxy 4, Galaxy 3, Galaxy 5, Galaxy 1, Galaxy 2
- (C) Galaxy 2, Galaxy 5, Galaxy 1, Galaxy 4, Galaxy 3
- (D) Not enough information

55. Rank the galaxy from the biggest to smallest

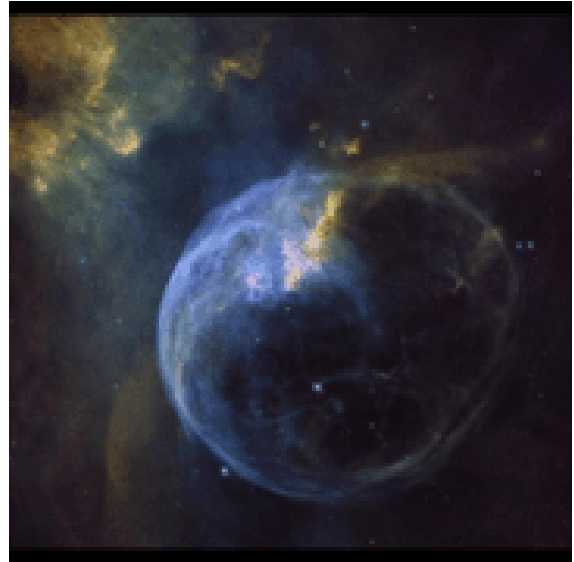
- (A) Galaxy 2, Galaxy 1, Galaxy 5, Galaxy 3, Galaxy 4
- (B) Galaxy 4, Galaxy 3, Galaxy 5, Galaxy 1, Galaxy 2
- (C) Galaxy 2, Galaxy 5, Galaxy 1, Galaxy 4, Galaxy 3
- (D) Not enough information

MAPS AND IMAGES QUESTIONS

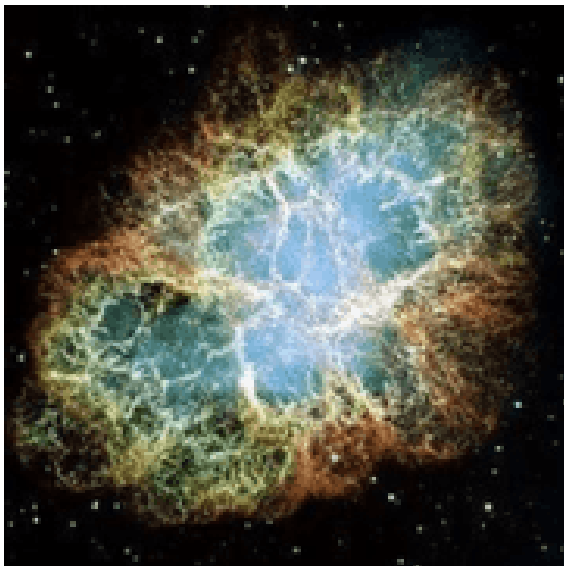
56. The four pictures below show four astronomical objects in the Milky Way Galaxy. Which of the answers below is the **COMPLETELY CORRECT MATCH** of the astronomical objects and the constellations that they are located in?



Object 1



Object 2



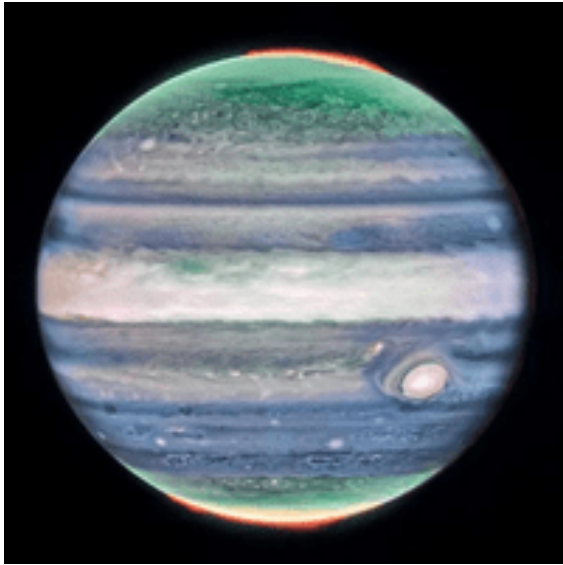
Object 3



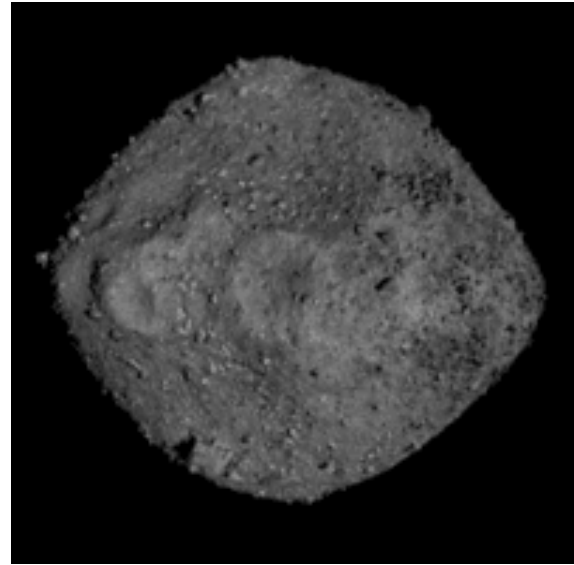
Object 4

	Object 1	Object 2	Object 3	Object 4
(A)	Scorpius	Cassiopeia	Taurus	Coma Berenices
(B)	Canis Major	Cassiopeia	Taurus	Orion
(C)	Ursa Major	Orion	Gemini	Coma Berenices
(D)	Libra	Lyra	Bootes	Gemini

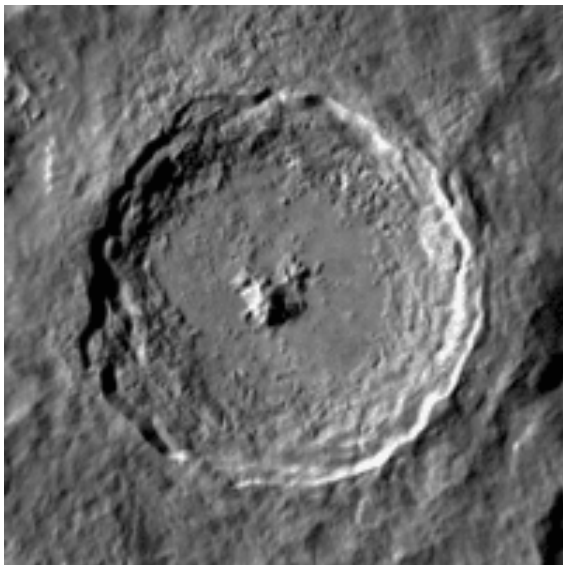
57. The four pictures below show four astronomical objects in the Solar System. Which of the answers below is the **COMPLETELY CORRECT MATCH** of the four astronomical objects?



Object 1



Object 2



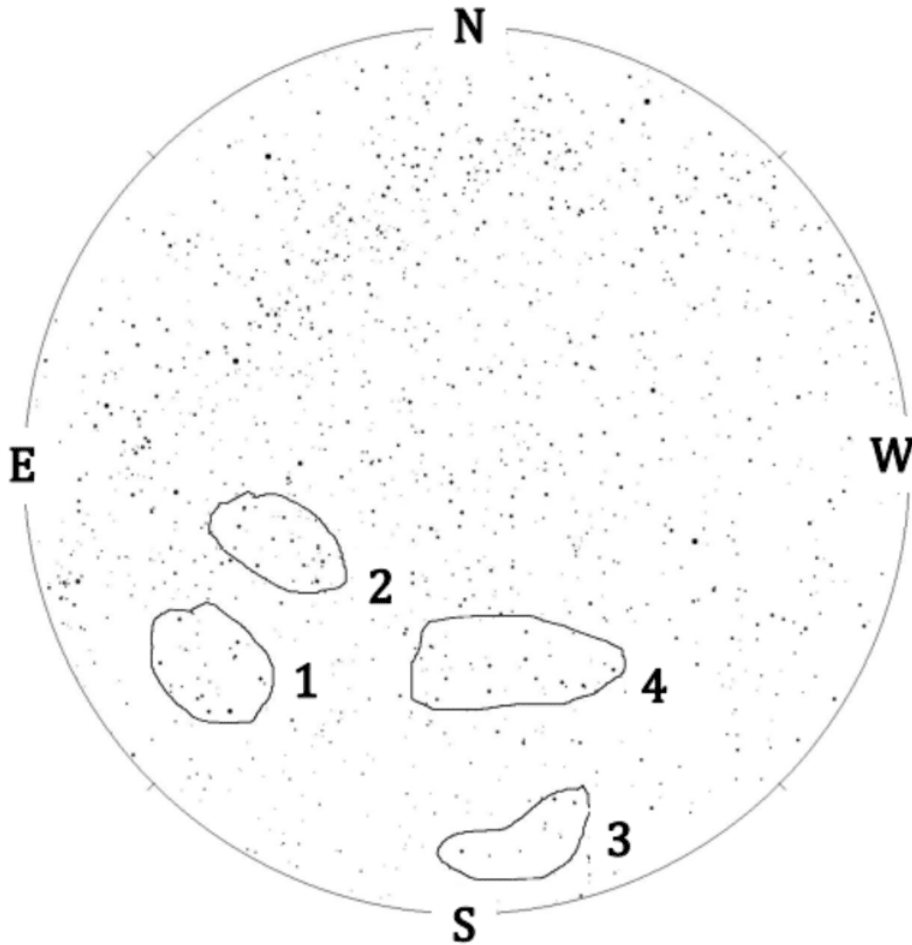
Object 3



Object 4

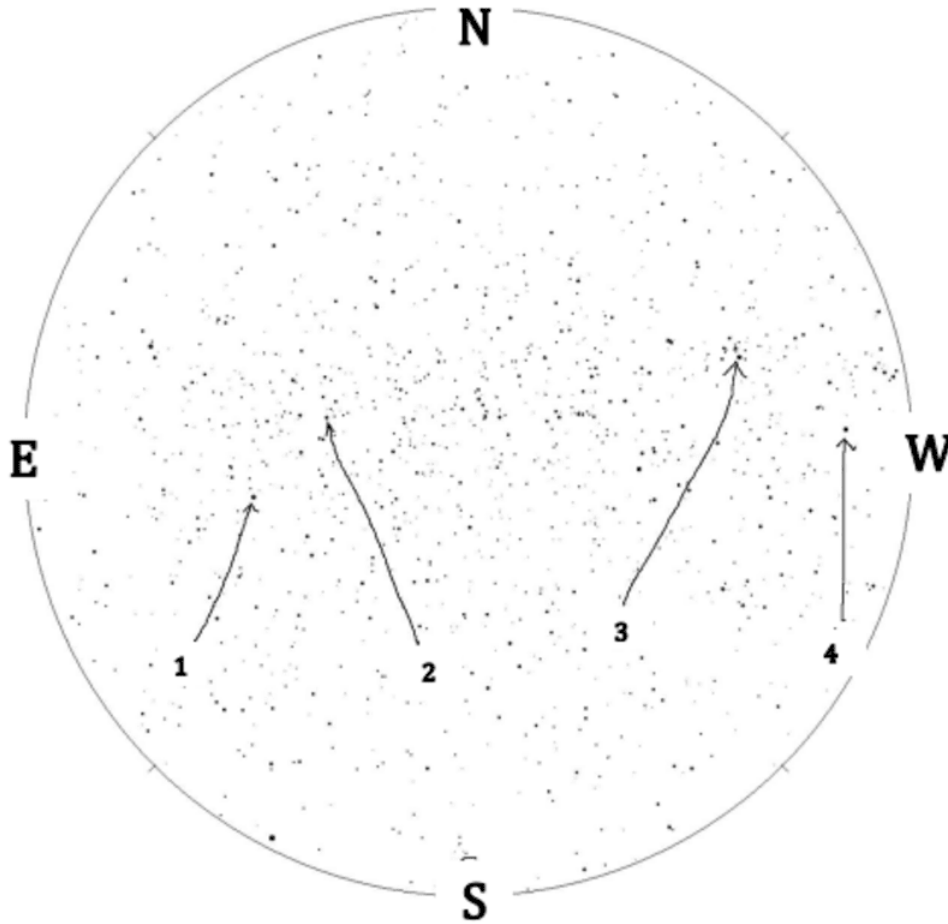
	Object 1	Object 2	Object 3	Object 4
(A)	Jupiter	Asteroid Itokawa	Moon crater Copernicus	Contact binary asteroid Ida
(B)	Saturn	Asteroid Vista	Moon crater Nasireddin	Comet Tuttle
(C)	Titan (moon of Saturn)	Pallas	Moon crater Clavius	Arrokoth (Kuiper Belt object)
(D)	Jupiter	Asteroid Benu	Moon crater Tycho	Arrokoth (Kuiper Belt object)

58. In the star chart below are drawn the boundaries of four constellations. Which of the answers below shows the **COMPLETELY CORRECT MATCH** of the constellations with their names?



	1	2	3	4
(A)	Auriga	Perseus	Lyra	Cygnus
(B)	Auriga	Gemini	Ursa Minor	Ursa Major
(C)	Orion	Lepus	Canis Minor	Canis Major
(D)	Hercules	Bootes	Aquarius	Capricorn

59. In the star chart below are shown the four pointers pointing at four stars. Which of the answers below shows the **COMPLETELY CORRECT MATCH** of the pointers pointing to the stars?



	1	2	3	4
(A)	Sirius	Procyon	Antares	Spica
(B)	Vega	Deneb	Betelgeuse	Aldebaran
(C)	Vega	Deneb	Aldebaran	Betelgeuse
(D)	Sirius	Procyon	Aldebaran	Rigel

60. Emma is a keen astrophotographer and wants to capture pictures of Jupiter. Which of the astrophotography setups below will Emma choose to capture very high-quality pictures of Jupiter?
- (A) A 6-inch aperture Newtonian Telescope on an EQ-6 German Equatorial Mount and a SONY AR7 IVA mirrorless camera
 - (B) A 6-inch aperture Maksutov Telescope on an EQ-6 German Equatorial Mount and a SONY AR7 IVA mirrorless camera
 - (C) A 6-inch aperture Apochromatic Telescope on an EQ-6 German Equatorial Mount and a SONY AR7 IVA mirrorless camera
 - (D) A 6-inch aperture Schmidt-Cassegrain Telescope on an EQ-6 German Equatorial Mount and a SONY AR7 IVA mirrorless camera

END OF QUESTION PAPER
