Edexcel **GCSE Astronomy**

Model Answers

2003/04

GCSE Astronomy (24 June 2003)

Question 1

(a) (i) Jupiter

(ii) Venus

(iii) Uranus

(b) (i) Choose one from

* Diameter (and therefore total volume also)
* Average Density
* Total Mass (Venus is 82% of Earth's mass)

(ii) Choose one from

* Surface temperature on Venus is about 750K
* Venus' atmosphere is mainly Carbon Dioxide, which is a very small constituent of Earth's atmosphere
* Venus has no surface water
* The atmospheric pressure on Venus is about 90 times that of the Earth.
* Venus is permanently covered by thick cloud
* Rotation of Venus = 243 Earth days
* Sense of Rotation - Venus rotates in a retrograde motion in comparison with most other bodies of the Solar System, and definitely opposite that of the Earth

(There are other associated ways that the planets differ)

Question 2

(a) (i) waxing crescent

(ii) terminator

(iii) 3500 km

(b) (i) diagram - M is in lower left quarter of the circle

(ii) diagram - L is on opposite side of the Earth to the Sun

Question 3

(a) (i) Saturn

(ii) Titan

(iii) It appears to be the only moon in the Solar System that has an appreciable atmosphere. Like the Earth's atmosphere, it appears to be mostly Nitrogen. This atmosphere blocks the view of the surface from Earth.

(b) – cosmic rays would be extremely dangerous

– length of time without gravity

– technology required for return

– provisions for journey and while there

– extreme conditions on planet itself

Question 4

(a) (i) diagram of Orion Nebula

(ii) N below Orion's belt

(iii) arrow along Orion's belt to the left

(b) Constellations are not actually connected, only appear to be so from Earth. On the other hand, a physical grouping of stars is actually held together gravitationally.

Question 5

(a) 1 day

(b) (i) west

(ii) 6 minutes difference in time correspond to

$$\frac{6}{60} \times 15^\circ, \text{which equals } 1.5^\circ$$

(iii) 0.5 degrees corresponds to

$$\frac{0.5}{15} hours = \frac{1}{30} hours = 2 minutes$$

and since Clare lies East of Greenwich, she will see Aldebaran at 19:28 GMT.

Question 6

(a) (i) Place O to the left of the Earth such that Mars-Earth-Sun are lined up

(ii) Place C to the right of the Sun, such that Earth-Sun-Moon are lined up

(b) 2.5 AU

(c) 10.5 AU

Question 7

(a) Choose two from

- They have an 11 year circle, being more numerous at maximum, and could be non-existent at minimum
- Sunspots move closer and closer to the Equator as the cycle reaches maximum
- they appear dark because they have a lower temperature than the rest of the surface
- large spots are made up of a dark center called the umbra, surrounded by a less dark penumbra
- the temperature is actually lower in the umbra, about 4200K, the penumbra is about 5700K
- they take about two weeks to move across the disk of the Sun, if they live that long
- most spots are hollows with respect to the Sun's surface
- they are centers of strong magnetic fields
- the typical sunspot has about the same diameter as the Earth.

(b) 11 years

(c) (i) they move closer and closer to the Equator as maximum approaches

(ii) they increase in number towards maximum, and decrease (sometimes to zero) at minimum

Question 8

(a) diagram - the ecliptic passes through 0 degrees Declination at Right Ascension of 0 and 12 hours. It will peak at 23.5 degrees at 6 hours (+23.5) and 18 hours (-23.5).

(b) (i) Sun will be at 6 hours (where it peaks)

(ii) Sun will be at 12 hours (on the Equator, i.e. 0 degrees declination)

Question 9

(a) A comet's orbit usually has a high eccentricity, i.e. it is very elongated. Planetary orbits are much more similar to circular orbits

Planetary orbits are restricted to the plane of the Solar System within a few degrees. Cometary orbits usually have a plane varying considerably from the plane of the Solar System

Comets typically come close to the Sun at perihelion and reach the depths of the Solar System at aphelion.

Comets can be perturbed in a major way, by interaction with Jupiter for example

(b) The Oort Cloud is assumed to be a vast cloud of comets located at a vast distance from the Sun (at least 50,000 AU - so far that the Hubble Telescope is unable to detect them). Gravitational disturbance from a nearby star can send these comets on an elliptical orbit of the type descibed in (a).

Question 10

(a) (i) Star γ is 2 magnitudes brighter than star δ, which corresponds to $2.5^2 = 6.25$ times brighter.

(ii) Since star β is 2.5 magnitudes fainter than α, it will be one magnitude fainter than α, i.e. β will have a magnitude of 0.8

(b)

$$M = m + 5 - 5\log d$$
$$= 3.0 + 5 - 5\log 1000$$
$$= 8 - (5 \times 3)$$
$$= -7$$

Question 11

(a) Clyde Tombaugh

(b) It has quite a high eccentricity, such that although nominally further away than Neptune, for part of its orbit it does move closer to the Sun than Neptune.

Its orbit is noticeably inclined to the plane of the Solar System, much more than the other planets.

(c) Pluto, Charon and Triton appear to be similar. If this so, then they are likely to be members of a much larger class of objects, rather than a small class with Pluto and Charon meeting by chance and Triton encountering Neptune by chance. Since 1992, over 100 Trans-Neptunian objects have been discovered. It is proposed that this is indicative of the existence of a large number of Kuiper Belt objects of which Pluto, Charon and Triton could form a part.

Question 12

(a) Any magnification will make the image fainter, so a bright image is required in the first place. The larger the diameter of the objective, the more light will be collected by the telescope.

(b)

$$\frac{20^2}{5^2} = 16$$

(c)

$$\text{Magnification } = \frac{36}{f_e} = 24$$

therefore

$$f_e = \frac{36}{24} = 1.5cm$$

(d) ray diagram

curved mirror at back, reflecting to a flat mirror which deflects to an eyepiece on the side

Question 13

(a) (i) The clouds re-emit energy they have absorbed from stars embedded within the nebula itself

(ii) Young stars (clouds undergoing starbirth)

(b) (i) Spherical cluster of many stars. Towards the center, the stars seem to merge into a single glowing mass.

(ii) 1. stars are predominantly older Population II stars
2. little gas and dust between the stars

Question 14

(a) diagram

(b) (i) hotter

(ii) 1. At maximum, the corona becomes more extended
2. At maximum the corona is more 'circular', whereas at minimum it is viewed to be only extended primarily around the equatorial regions.

(iii) The corona is normally drowned out by light from the photosphere, but during a total eclipse the Moon covers the photosphere, enabling the corona to be seen.

(iv) With little light reaching Earth from the Sun, little can be scattered to create the blue sky we normally experience during the day.

Question 15

(a) Circumpolar stars are visible in the sky all year round.

(b) B will be to the right, horizontal with Polaris, and the same distance away as at A (it has traveled on the arc of a circle from A to B - a circle with center Polaris)

(c) At a latitude of 57 degrees N, a star would be circumpolar if it was at a declination of 90-57 = 33 degrees N or greater. Therefore a star at + 30 degrees would **not** be circumpolar.

(d) This star will have a declination of + 33 degrees.

Question 16

(a) Drowns out light from fainter objects making it dificult to observe from urban areas and causing professional observatories to seek more isolated areas for their instruments.

(b) refraction diagram, showing how light will bend towards Earth, making a star appear to be in a different place than it actually is.

(c) The longer the wavelength of the radiation, the larger the telescope needs to be to resolve the radiation. Radio waves have longer wavelengths than light waves.

Question 17

(a) Kepler's Second Law - A line between a planet and the Sun sweeps out equal areas in equal times.

(b)

$$T^2 = r^3$$

$$T^2 = 8^3 = 512$$

$$T = \sqrt{512} = 22.6 \text{ years, to 1 decimal place}$$

(c)

$$\left(\frac{r_1}{r_2}\right)^3 = \left(\frac{T_1}{T_2}\right)^2$$

$$\left(\frac{r_1}{r_2}\right)^3 = \left(\frac{18}{4.5}\right)^2$$

$$\left(\frac{r_1}{r_2}\right)^3 = 4^2 = 16$$

$$\left(\frac{r_1}{r_2}\right) = \sqrt[3]{16} = 2.52 \text{ to 2 sig figs} \approx 2.5$$

Question 18

(a) afternoon

because shadows are lengthening

(b) Equation of time gives

$$-6 = 12:10 - MST(\textit{Mean Solar Time})$$

therefore

$$MST = 12:16$$

now, 16 minutes corresponds to

$$\frac{16}{60} \times 15 = 4^\circ$$

and this will be

$$4^\circ \text{ East}$$

because the shortest time is observed **after** the same phenomenum is observed on the Greenwich Meridian

(c) 2 months later, on Sept 15, in the Northern Hemisphere it will be lower than on July 15.

On September 15, the Sun will be on the Celestial Equator - 2 months earlier it will be high above the horizon during Summer.

Question 19

(a) (i) (1st. picture) elliptical; (2nd. picture) spiral

(ii) bright resolution

(b) The further away a galaxy is, the faster it is receeding, which implies an expansion. The only galaxies likely to be moving towards us will would be galaxies close to us, undergoing local motion, but the overall motion is away from us.

Question 20

(a) light from a star will be collimated into a narrow beam, and this beam will be split into its spectrum by a prism or a grating.

(b) The components will differentiated by the effects of the Doppler shifts on their spectra. A component moving towards us will have its spectrum blue-shifted, a component moving away will have its spectrum red-shifted.

GCSE Astronomy (24 June 2004)

Question 1

(a) (i) closest to Earth is the Moon

(ii) furthest away is Pluto

(iii) the largest is Saturn

(b) Pluto and the Moon

(c) William Herschel discovered Uranus

Question 2

(a) (i) diagram - place M to the left of the Earth

(ii) diagram - place M between Earth and the Sun

(Note : Place M at a sensible distance from Earth corresponding to its orbit around the planet)

(b) (i) full

(ii) new

(c) Light from the moon dims, but it is still visible by virtue of light from the Sun refracted through the Earth's atmosphere. The color is often reddish (or coppery). Darkness and coloring varies from eclipse to eclipse.

Question 3

(a) Belts and zones could be visible on the surface, although general details are less distinct than Jupiter. A ring system is definitely visible (except in those years when the ring system is edge-on to us). The Cassini Division, a gap between the two brightest rings, might be visible. The largest satellite, Titan, is also likely to be visible.

(b) (i) Galileo Galilei

(ii) Johannes Kepler

(iii) Nicolas Copernicus

Question 4

(i) 1 year

(ii) 1 day

(iii) 4 minutes

Question 5

(a) primitive material from the time of the origin of the Solar System. About 90% of meteorites are stones, others are iron. In general, assumed to be great similarity between meteorite and asteroid composition.

(b) Meteors are caused by cometary dust, i.e. material deposited along the orbit of a comet. Whenever the earth enters these orbits, the dust will been seen burning up in the Earth's atmosphere as meteors.

Question 6

(a) Constellations only appear to be connected when viewed from the earth by virtue of being in the same area of the sky. Physical groupings like the Pleiades really are actually connected gravitationally to one another.

(b) (i) Ursa Major

(ii) Orion

(iii) Cassiopeia

Question 7

(i)
- surface very varied (remarkably so) - *(like a jigsaw puzzle, according to one description I have seen. Like nothing ever seen before, according to another)*
- canyons as deep as 20 kilometers
- terraced layers
- regions of broken terrain which indicates intense geological activity in the past
- younger areas which could be evidence of volcanism of some description
- older areas as well
- may be mostly water ice

(ii)
- very few craters, indicating young surface
- very flat features resembling frozen lakes/water
- extensive ridges and valleys
- existence of geysers, ejecting nitrogen

Question 8

(a) It 'lightens' the sky, making it difficult to see the faint Milky Way. In areas of high pollution, the Milky Way cannot be seen with the naked eye.

(b) atmospheric pollutants

(c) (i) definite cloudy band across the sky

(ii) optical instruments will resolve the Milky Way into individual stars - many of them

Question 9

(a) Jupiter and Mars

(b) Whereas smaller bodies tended to agglomerate into larger planetoids and planets, the gravitational effect of Jupiter could have caused collisions which were more destructive than normal and acted against such an agglomeration, rather than in favor of it.

(c) Possibilities :

- Research shows an impact occured at Chicxulub in Mexico,
- (strongly believed to have caused) the extinction of the dinosaurs
- some object caused widespread destruction in Tunguska, Siberia in the early 20th. century
- several other crater sites have been identified

Question 10

(a) M on opposite side of Earth to the Sun, such that the three bodies are in line (i.e. right at top of diagram)

(b) By virtue of the fact that the planetary orbits are elliptical, not circular, the distance at opposition varies from year to year.

(c) It was in opposition to the Sun (in the position described in (a)), being illuminated by the Sun

(d)

$$T^2 = r^3$$

Therefore

$$T = \sqrt{r^3}$$

You are given r = 1.5. Therefore

$$T = \sqrt{1.5^3} = 1.8 \; years \quad to\ one\ decimal\ place$$

Question 11

(a) To visit the Moon and carry out scientific experiments there.

(b) gibbous

(c) crescent

(d) (i) anomalous mass concentrations (i.e. where material is denser than elsewhere), submerged in the maria

(ii) bombardment by 'dense' bodies, the sites of which have become covered with mare material

(e) The black sky on the Moon is the natural color for a body with no atmosphere. On the Earth, the Sun's light is scattered by the atmosphere, scattered preferentially towards the blue end of the Spectrum. This is the blue light that we observe when we see the sky is blue.

(f) various subjective answers !!!

Question 12

(a) +12 degrees

(b) Right Ascension = 11.9 hours

Declination = +14 degrees

(c) From 75 degrees every star with a declination greater than (90-75) = 15 degreees North will be circumpolar. So with a declination of 12 degrees, star β will **not** be circumpolar from Resolute.

(d) Summer

(e) A factor of 6.25 times brighter corresponds to the star being two magnitude brighter, so star α will have an apparent magnitude of 1.4.

Question 13

(a) Choose from Radio, Microwave, Ultra Violet, Gamma Rays

(b) Infra Red is absorbed heavily by water vapor and carbon dioxide. Therefore telescopes are placed high up, where the air is thinnest and driest.

(c)
- Detection of possible planets around other stars
- Observation of far galaxies whose emissions have been red-shifted into the Infra-red
- Observation of the center of the Milky Way whose light is obscured to optical telescopes by dust and gas.

(d) In orbit. The atmosphere shields us from X-rays effectively.

Question 14

(a) black hole or neutron star

(b) Cepheid, Algol (or eclipsing binary) ,Supernova

(c)
- Emission Nebulae (or HII region), detecting by virtue of re-emitted light from the star nursery within it.

- Reflection Nebulae, illuminated by nearby stars without nebula becoming hot enough to start glowing by itself.
- Dark nebula (or molecular cloud) - a relatively dense concentration of matter, seen only by its blocking out of light beyond it.
- Planetary Nebulae. Cloud forming a ring around a central body.

Question 15

(a) A stream of charged particles being emitted from the Sun at all times, primarily protons, alpha particles and electrons.

(b) Particles in the wind cascade towards the Earth's magnetic poles, stimulating the atmospheric atoms and ions to radiate light.

(c) By nuclear reaction - specifically fusion of hydrogen whereby hydrogen nuclei fuse to form helium nuclei. The helium nuclei have less energy than the constituent hydrogen nuclei, the difference in energy being responsible for the heating of the Sun

Question 16

(a) 1. It is almost at the North Celestial Pole, permanently placed to the North in the sky.

2. Its elevation above the horizon is equal to the latitude on the Earth from where it is viewed.

(b) Circumpolar stars are stars that are in the night sky all the year round.

(c) diagram showing circular orbits of stars from which the rotational period can be determined.

Question 17

(a) Observations are 2 days apart. A difference of 3m 56s per day means observations are 7m 52 s earlier after two days, so the time of observation on December 6th. is 2.50.08

(b) 2.5 degrees corresponds to a difference in Right Ascension of

$$\frac{2.5}{15} \times 60 = 10mins$$

Since the second student is west of the first student, the second student will view Sirius at 03:08 GMT.

Question 18

(a) Ability to differentiate (separate) stars that are close together.

(b) (i) Telescope A (*because magnification is determined by dividing the Focal length of the objective by the Focal length of the eyepiece, using formula in (ii)*

(ii) Magnification of A $= \frac{60}{20} = 3$.

(iii) Resolving power is directly related to the diameter of the objective *(for the same wavelength of light),* so Telescope B has the higher resolution.

(c) Its 'seeing' is not disturbed by the fluctuations of the atmosphere

Question 19

(a) The gravitational effect of matter in the Universe will affect the expansion of the Universe. Depending on how much matter there is, the Universe will either expand for ever, or reverse direction. Only a small fraction of matter is visible by virtue of its light, so dark matter becomes a major area of investigation.

(b) Some stars have been found to "wobble" which could indicate the gravitational effect of planets. IRAS has detected disks of matter around some stars, disks of the type that could condense to a planetary system. Hubble seems to have imaged a planet being ejected from a new double-star system.

Question 20

(a) The visual magnitude that a star would have if viewed at a standard distance, which is actually 10 parsecs.

(b) Spectral analysis can allow determination of the absolute magnitude. Once you know this as well as apparent magnitude from observations on Earth, you can calculate the distance.

If you know the spectral type of a Main sequence star, you can use a Hertzsprung-Russell diagram to read off its absolute magnitude.

(c) using the formula

$$M = m + 5 - 5\log d$$

and since the absolute magnitude of both stars is the same

$$-0.5 + 5 - 5\log d_A = m_B + 5 - 5\log d_B$$

$$m_B = -0.5 - 5\log d_A + 5\log d_B$$

$$= -0.5 + 5(\log d_B - \log d_A)$$

$$-0.5 + 5(\log 10d_A - \log d_A)$$

$$-0.5 + 5\log\left(\frac{10d_A}{d_A}\right)$$

$$= -0.5 + 5\log 10$$

$$= 4.5$$