Q1. No Examiner's Report available for this question

Q2.

This question also centres around understanding that the altitude of the Celestial Equator will be the same as the observer's co-latitude – 38° 15'. Aldebaran's declination will put it a further 16° 30' above the Celestial Equator.

The number of candidates who appreciated this was relatively small. They were often the candidates who had drawn a rough sketch of the key angles in the space provided as visualising their interconnections was crucial for success in this question.

The astronomer contacts a colleague in Oxford and tells her the right ascension (RA) and declination (Dec) of Aldebaran.

Oxford has a latitude of 51° 45′ N and a longitude of 1° 15′ W.

Calculate the highest altitude that the star Aldebaran will reach, as seen by the astronomer in Oxford.

(2)

90 – 51 45 + 16

38°15' + 16°30'

Altitude = 54 ~~62~~ ° ~~15~~ 45

Results Plus: Examiner Comments

This type of question, which requires candidates to visualise positions on the Celestial Sphere, is always best approached with the aid of a diagram. This candidate has worked in this way and has successfully achieved the correct answer.

Results Plus: Examiner Tip

Diagrams can be extremely useful, even when the question does not supply one.

Q3.

The first mark in this question was simply for describing that the Sun would rise and set as usual, whilst the second required candidates to appreciate that the date and Alice's latitude would mean that the Sun would pass directly overhead at noon.

Although a diagram was optional, it was by far the most effective way of answering the question, although showing the Sun passing overhead is not straightforward in a diagram on a flat piece of paper and this tested the artistic skills of many candidates.

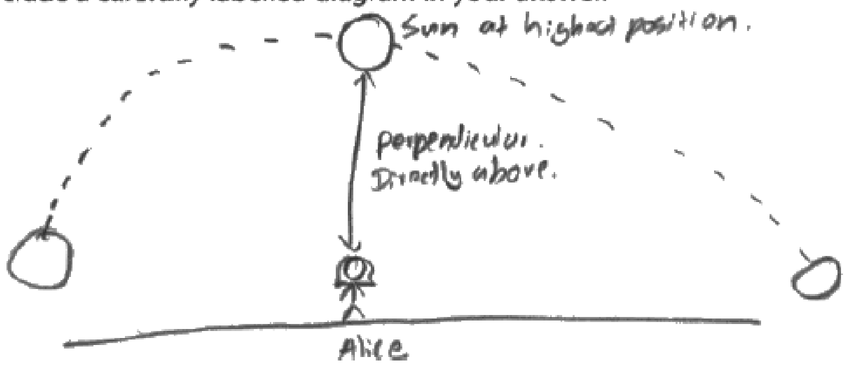
Alice decides to observe the Sun throughout the day on June 21st.

Her location has a latitude of 23½° N.

Describe how the Sun appears to move across the sky from Alice's location on June 21st.

You may include a carefully labelled diagram in your answer.

(2)



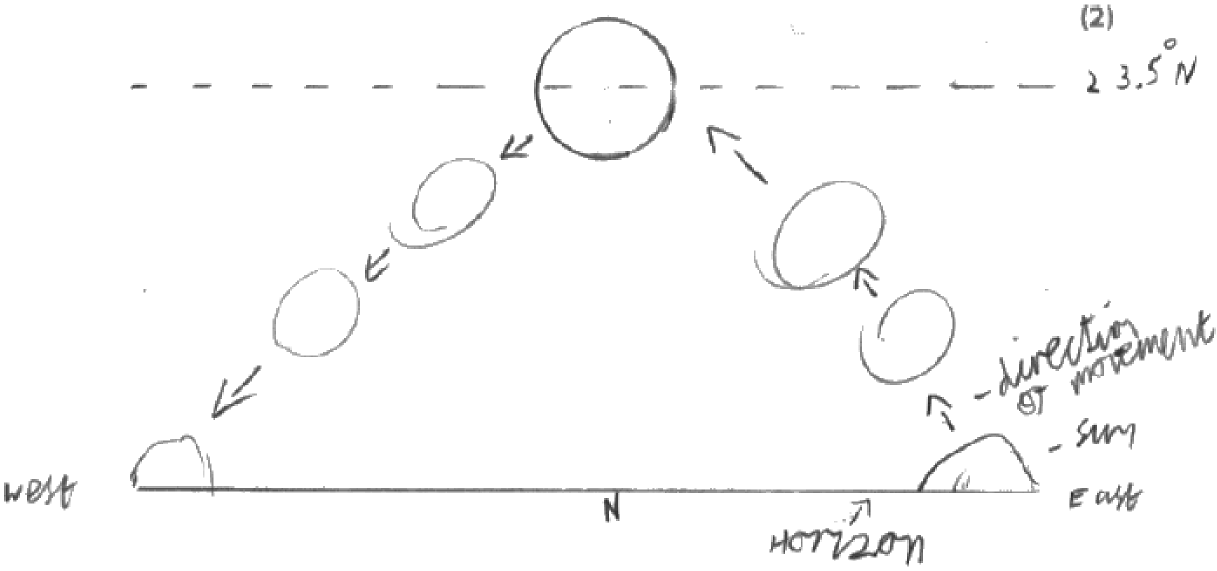
The sun would rise from the horizon, moving to it's highest position, where it is ~~bis~~ directly above alice, perpendicular to the ground. It will then continue to travel till it sets.

Results Plus: Examiner Comments

The two points of the Sun rising and setting and reaching Alice's zenith are both conveyed by this response, with the diagram playing a major role. Candidates who attempted to gain all the marks simply by a written description were usually only partially successful.

Results Plus: Examiner Tip

Whenever a 'carefully labelled diagram' is 'recommended' it is usually the case that full marks will be much harder to achieve without one.



Results Plus: Examiner Comments

Although this candidate has clearly illustrated the idea of the Sun rising in the East and setting in the West, this is not supported by their diagram which has the Sun reaching its highest point when it is due North. In addition, they have not included the fact that the Sun will be directly overhead at noon for Alice.

Q4. No Examiner's Report available for this question

Q5. No Examiner's Report available for this question

Q6.

This question allowed candidates to demonstrate their level of astronomical ability by the depth of the explanation which they provided.

Most candidates were able to explain that these two stars would be circumpolar from Egypt and a good proportion were able to go on to say that it was related to their high declination. Candidates scoring full marks were also able to show that this was because their declinations both exceeded the co-latitude of Egypt (60°).

Two of the brightest stars in Figure 5 are Phecda (γ in Ursa Major) and Kochab (β in Ursa Minor). Their coordinates are shown in Table 1.

	Right ascension (h : min)	Declination (°)
Phecda	15h 20min	72°
Kochab	14h 50min	74°

Table 1

The Ancient Egyptians referred to these two stars as the 'Eternal' or 'Immortal' ones.

Egypt has a latitude of around 30°N.

Explain, using **astronomical** information from Table 1, why they gave them this name.

(3)

Because the declination is above Egypts latitude the two stars will not set beyond beyond the horizon and will always be in the sky for egyptians and thats why they called them eternal or immortal

Results Plus: Examiner Comments

This response comfortably gains a mark for pointing out that neither star will set for observers in Egypt as they are circumpolar and a second mark for suggesting that this is due to their declinations. However, the full explanation required candidates to show that each star's declination was greater than Egypt's co-latitude (90 – latitude).

Because if a stars declination is bigger than 90 - their latitude, they are circumpolar - they don't dip beyond the horizon. Declination $>$ 90 - latitude:

Phecda = $72 > 90 - 30$

circumpolar ← $72 > 60$

Kochab = $74 > 90 - 30$

circumpolar ← $74 > 60$

(Total for Question = 5 marks)

Results Plus: Examiner Comments

This explanation gains all three marks by showing clearly how each star's declination exceeds the observer's colatitude (90 - latitude), making them both circumpolar.

Q7. No Examiner's Report available for this question

Q8.

A large number of candidates spotted that Aldebaran's right ascension can be obtained by subtracting its hour angle from the local sidereal time and thus gained the first mark in this question. However, only a small proportion of these candidates were able to give an astronomical reason for this and even fewer could provide a clearly labelled diagram to illustrate it.

Drawing diagrams to illustrate quantities such as hour angle and right ascension is not straightforward and is clearly a skill which future candidates would be well advised to practise beforehand. As the examples below show, even the highest scoring candidates had some difficulty achieving this third mark.

Candidates are advised to ensure that they have labelled all relevant parts of their diagrams such as the observer's horizon and meridian, Aldebaran's hour circles and position of the First point of Aries. All angular distances between these items should then be clearly and unambiguously marked so that the relationships between them are firmly established.

Judging by the efforts of candidates this year, trying to draw diagrams such as these in '3-D' is probably best avoided. Imagining the area of sky above the horizon either side of the observer's meridian as a large sheet of graph paper is probably the best technique in questions of this kind.

An astronomer observing from Rome sees the star Aldebaran setting. The local sidereal time (LST) is 10:42 and the star's hour angle (HA) is 06h 06min.

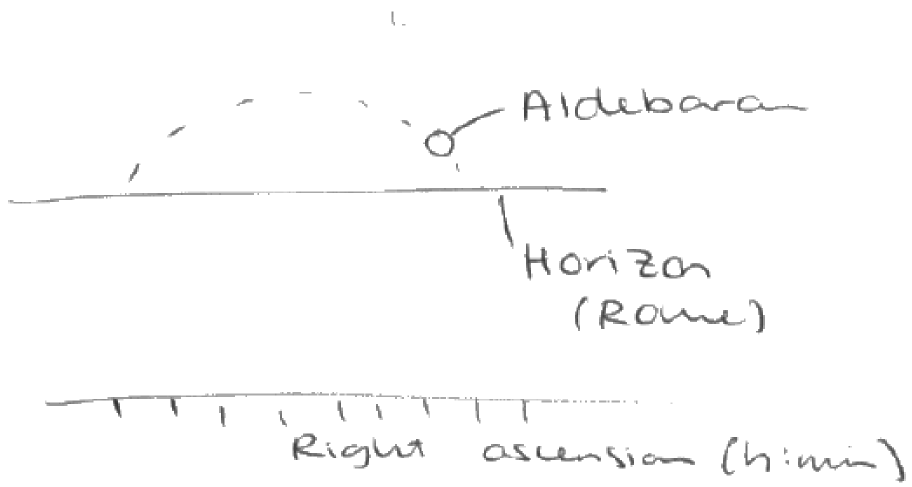
Rome has a latitude of 42°N and a longitude of 12°30′E.

Show that Aldebaran has a right ascension (RA) of 04h 36min.

Use the observational data given above.

Include a carefully labelled diagram in your answer.

(3)



Hour Angle = LST − RA

= 10:42 − RA

RA = 10:42 − 06:06

= 04:36 → 04h 36 min

Results Plus: Examiner Comments

In common with the work of many candidates on this question, this response shows the correct relationship between LST, HA and RA and has used it to produce the correct Right Ascension for Aldebaran. However, the diagram (required by the question) does not show how these three angles relate to each other.

Q9.

The calculation which would yield Aldebaran's declination was less obvious from the data in the question, making this question rather more difficult.

Rome's co-latitude (48°N) gives the altitude of the Celestial Equator on the meridian. For Aldebaran to have an altitude of 64° 30' it must therefore lie 64° 30' – 48° = 16° 30' above the Celestial Equator.

The angles in this question are probably best represented in a diagram as distances up the observer's meridian. Many candidates had great difficulty drawing a convincing diagram of the situation.

The astronomer waits until Aldebaran is due south and measures its angle above the horizon as 64° 30′.

Show that Aldebaran has a declination (Dec) of 16° 30′.

Use the observational data given above.

Include a carefully labelled diagram in your answer.

(2)

Altitude – latitude which Aldebaran would calculate = declination ~~16° 30'~~

64° 30' – 48 = 16° 30'

Results Plus: Examiner Comments

Although this candidate has not given the correct relationship between altitude, latitude and declination in this case, they have correctly used Rome's co-declination to produce the correct declination. This response therefore scored one mark out of two.