

NATIONAL UNIVERSITY OF SINGAPORE

DEPARTMENT OF MATHEMATICS

SEMESTER 2 EXAMINATION 2008–2009

GEK1506 Heavenly Mathematics: Cultural Astronomy

April/May 2009 — Time allowed: 2 hours

Matriculation Number:

INSTRUCTIONS TO CANDIDATES

- (i) This examination paper contains five questions and comprises nine pages including this page and a blank page at the end.
- (ii) Write your matriculation number on the front page.
- (iii) Write your answers on this question paper. You may also write on the back of the pages. There is a blank page at the end if you need more space. Please indicate clearly if you continue a question on the last page.
- (iv) **Explain and justify your answers carefully.**
- (v) Answer all questions.
- (vi) You may use a calculator.

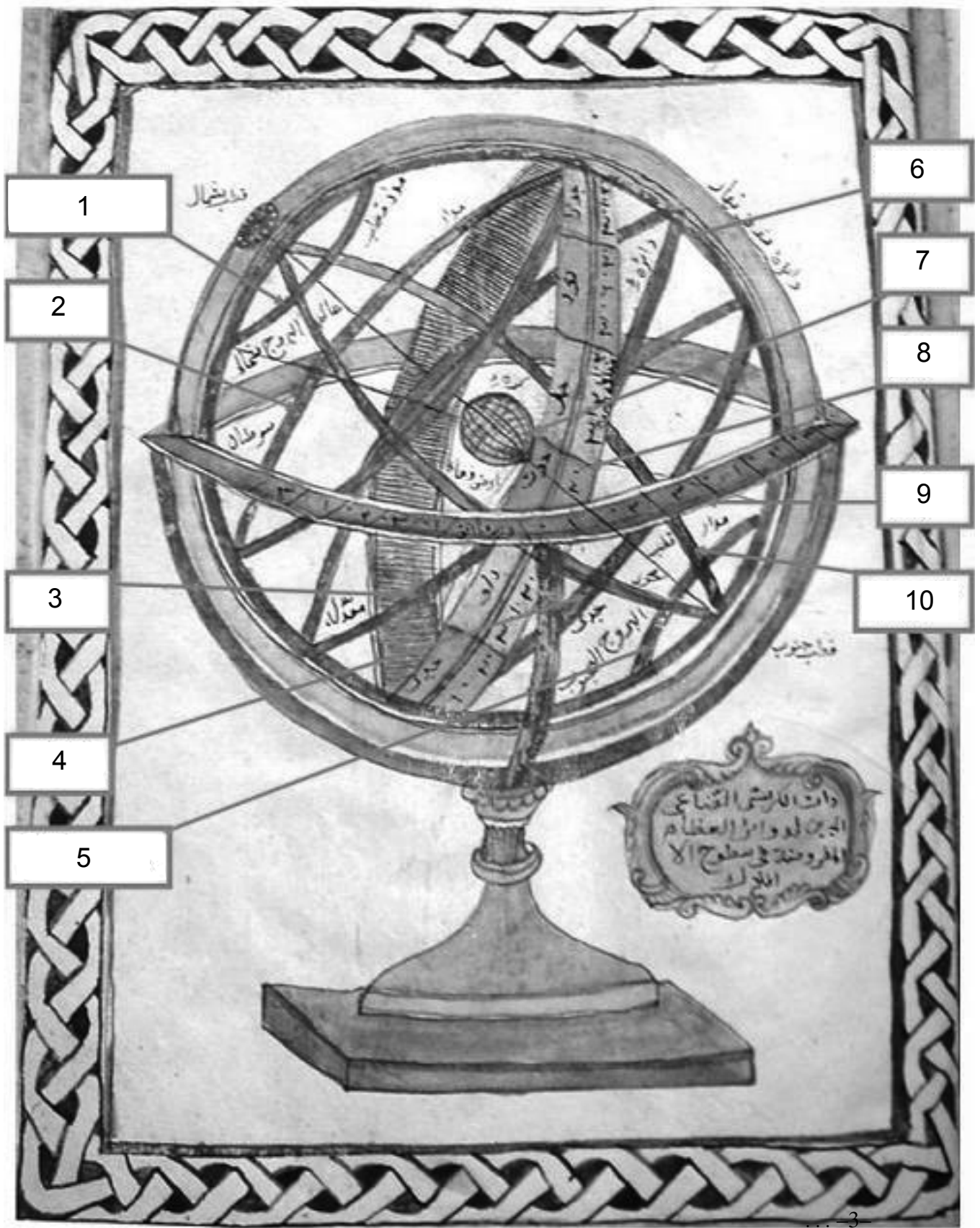


Figure 1: Armillary sphere from the book “Marifetname” (Book of Gnosis) by the Turkish and Sufi philosopher Ibrahim Hakki Erzurumi (1703 - 1780)

1. [10 marks] Figure 1 shows a picture of an armillary sphere from the book “Marifetname” (Book of Gnosis) by the Turkish and Sufi philosopher Ibrahim Hakki Erzurumi (1703 - 1780).

Match the numbers in the figure with the following objects.

- Earth
- Meridian
- Horizon
- Ecliptic
- Equinoctial colure (great circle through the equinoxes and the poles)
- Arctic circle
- Antarctic circle
- Tropic of Capricorn
- Tropic of Cancer
- Equator

2. [20 marks] On the day of the December solstice, the Sun will cross the meridian in Oslo, Norway at 12:15 at an altitude of 6.5° in the South. The equation of time is about 2 minutes on the December solstice and Norway lies in the UTC + 1 time zone and does not use daylight saving time in December. *What is the latitude and longitude of Oslo?*

3. (a) [10 marks] The Hijra is the emigration of Muhammad and his followers to the city of Medina in 622 CE and marks the first year of the Islamic calendar. *Explain how you can use this to give an estimate for what year it is in the Islamic calendar at the moment.* (It is enough to give an estimate. You do not need to use a calculator to get an exact figure.)
- (b) [5 marks] *What time of the day does the Muslim day start?*
- (c) [15 marks] Assume for simplicity that a lunar crescent can be seen 24 hours after the new Moon. Assume that you live on the equator, that we ignore the equation of time, that your longitude equals the longitude of the centre of your time zone and that you do not use daylight saving time. *Which days of the Chinese lunar month can the first day of the Muslim month correspond to? Estimate the probability that it corresponds to the various days.*

4. In the Chinese lunisolar calendar, the solar year is divided into 24 solar terms or jiéqì (节气). They are a generalization of the solstices and equinoxes. Let us consider any one of the jiéqì (节气), for instance Qīngmíng (清明).

- (i) [5 marks] *How will Qīngmíng move in the Gregorian calendar from one year to the next?*
- (ii) [10 marks] *Estimate the probability that Qīngmíng will fall on the same date in the Gregorian calendar for four years.*
- (iii) [5 marks] *How will Qīngmíng move in the Chinese calendar from one year to the next?*

正 月 初 九	雪兰莪赛马	是日肖羊相冲		宜：祭祀祈福求嗣 忌：入宅作灶
13		SELANGOR RACE DAY		30
7 Dzulkaedah				
正 月 初 十	西方情人节	是日肖猴相冲	14	宜：開市安床入殮 忌：嫁娶入宅
Valentine's Day				
8 Dzulkaedah		31		
正 月 十 一		是日肖鷄相冲	15	宜：破土開光納采 忌：開井作灶
9 Dzulkaedah		1		

Figure 2: Detail of a calendar from Singapore

5. (a) [5 marks] In India they use both solar and lunisolar calendars. The Indian calendar most commonly used in Singapore is the Tamil calendar. *How can you use the calendar in Figure 2 to determine if the Tamil calendar is a solar or lunisolar calendar?*
- (b) In the Wikipedia article about the Bengali Calendar, it says “In this calendar ... the year number ... is divided by 39. If after the division the remainder becomes zero or could be divided by 4, the year is then designated as a leap year and contains 366 days There are 10 leap years in every 37 years”
- (i) [5 marks] *What is inconsistent in this statement?*
- (ii) [5 marks] *What is the leap year rule in the Gregorian calendar?*
- (iii) [5 marks] *Why is there a difference between the Gregorian and Bengali leap year rules?*

END OF PAPER