Teachers' notes

Coordinate Systems

KS4

Topics covered: Coordinate systems on Earth, and coordinate systems for the night sky (horizonal coordinate system and equatorial coordinate system).

Introduction

This resource aims to support the teaching or revision of three coordinate systems:

- Latitude and longitude on the Earth
- The horizontal coordinate system for the night sky
- The equatorial coordinate system for the night sky

This relates to Topic 1 and Topic 6 within the Pearson Edexcel specification for GCSE Astronomy. However, anyone wanting to learn more about how we refer to objects' positions in the sky may find this useful.

This resource has been designed to check understanding following this animated video: https://www.rmg.co.uk/schools-communities/teacher-resources/coordinate-systems.

However, these questions can also work as a stand-alone exercise if preferred.

Further explanation

In this video we show coordinates referred to with arcminutes and arcseconds, as shown here:

These aren't explored in the video, and we advise that you check students' understanding of this notation and its meaning. Converting from arcminutes and arcseconds to degrees could be one way of checking understanding here.

The symbol for arcminutes is ′ and each arcminute is 1/60th of a degree. The symbol for arcseconds is ″ and each arcsecond is 1/60th of an arcminute.

We also show coordinates of right ascension and refer to minutes and seconds, as shown here:

Again, these aren't explored in the video, and we advise that you check students' understanding of this notation and its meaning. Converting from minutes and seconds to fractions of hours could be one way of checking understanding here. You could also

ask students to convert from hours to degrees, using the fact that 24 hours is equivalent to 360 degrees in this system.

The symbol for minutes is **m** and each minute is 1/60th of an hour. The symbol for seconds is **s** and each second is 1/60th of a minute.

When discussing locations on the Earth, we show the locations of three observatories:

These are the:

- Royal Observatory Greenwich, in the UK
- Kodaikanal Observatory, in India.
- The Astronomical Observatory of Córdoba, in Argentina

Both the Kodaikanal Observatory and The Astronomical Observatory of Córdoba have historical links to the Royal Observatory. The Kodaikanal Observatory took photographs of the Sun, supporting the Royal Observatory Greenwich's studies when the skies were cloudy here. The Astronomical Observatory of Córdoba contributed to the 'Carte du Ciel' project alongside the Royal Observatory Greenwich and many other observatories around the world. This project, initiated in the late 1800s, was an international effort to map the positions of millions of stars. Astronomy takes places all over the world, as well as from space! If you want to explore this further in class, students could look up the locations of other observatories or famous telescopes. Examples include:

- The Very Large Telescope
- The Liverpool Telescope
- The Keck Observatory

Students could look at the locations of various observatories and see if they notice any patterns. You could ask students to think about the advantages and disadvantages of various locations for astronomical observations. Light pollution from cities and weather are big factor.

Student activity

Activity One: Labelling Diagrams

Latitude and Longitude

Q1. Draw and label the approximate locations of the following on the globe above:

- The Equator
- The Prime Meridian
- The Tropic of Cancer
- The Tropic of Capricorn
- North and South Pole

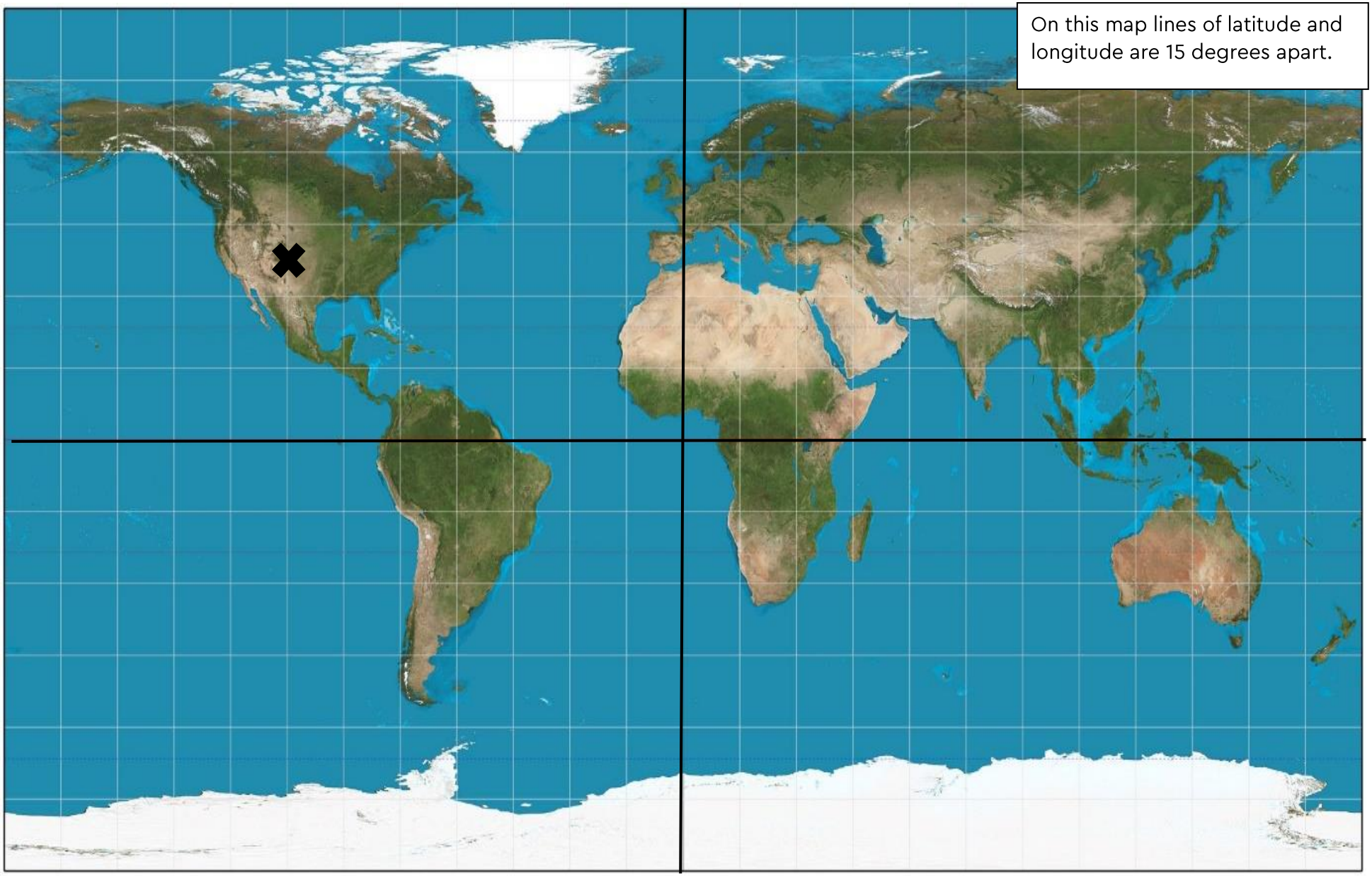
In our video we reference two other observatories:

- Kodaikanal Observatory (10˚N, 77˚E)
- The Astronomical Observatory of Córdoba (31˚S, 64˚W)

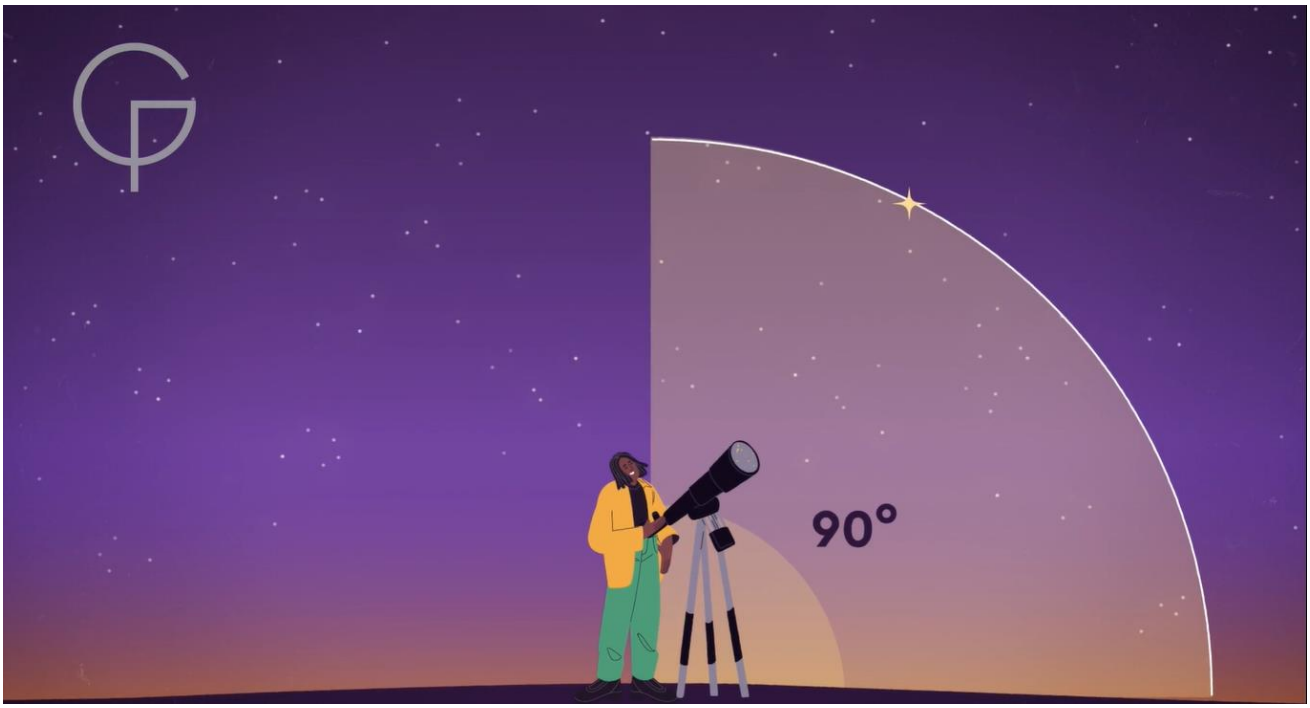
Q2. Can you plot their **approximate** locations on the map on the following page? On this map lines of latitude and longitude are 15 degrees apart.

Q3. We've also highlighted the location of another observatory, the Lowell Observatory in the USA. Can you tell us its approximate coordinates?

Coordinates of Lowell Observatory: _____


On this map lines of latitude and longitude are 15 degrees apart.

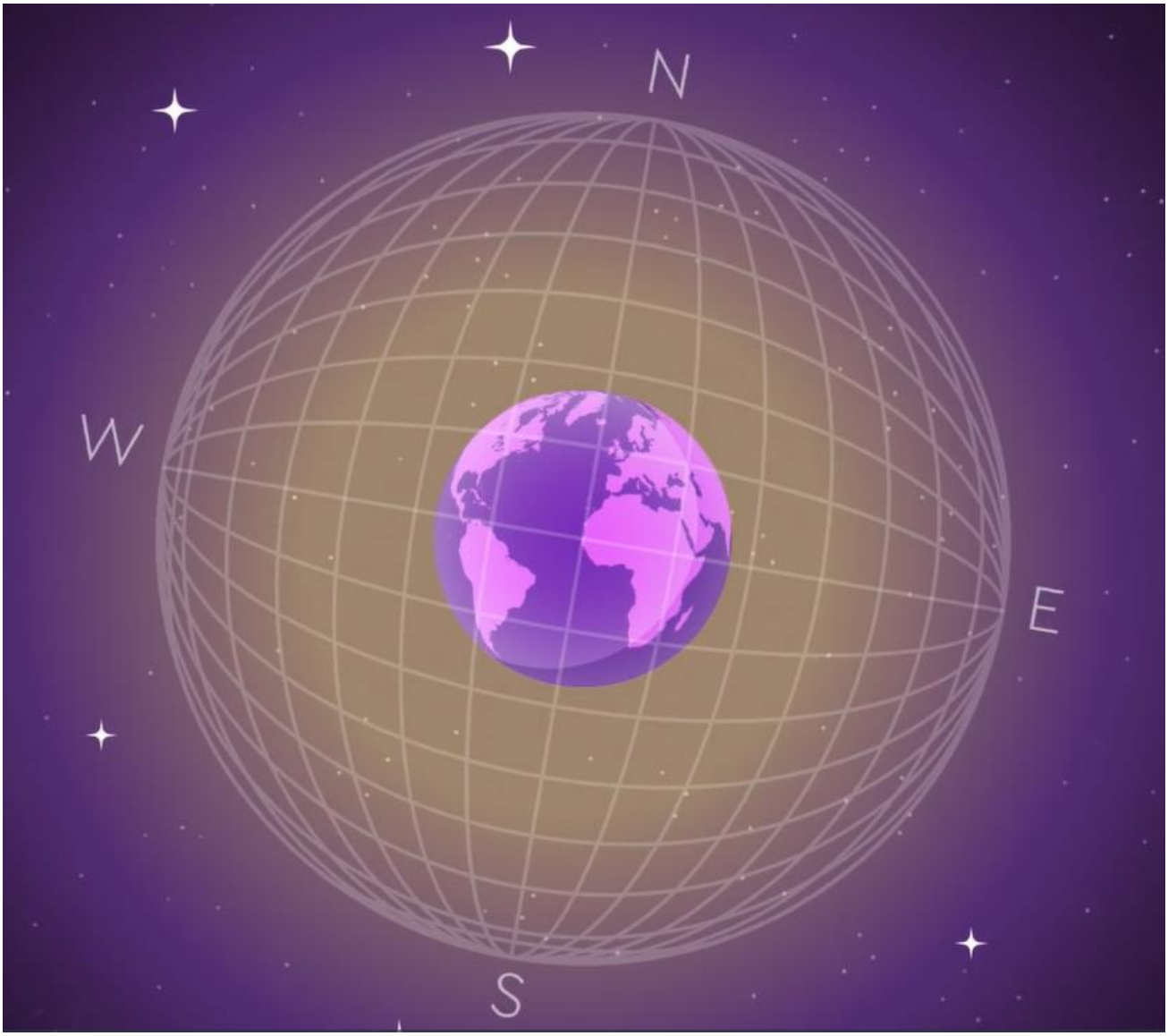
Horizontal Coordinate System



Q4. In this diagram, could you draw and label:

- Lines showing change in altitude
- Lines showing change in azimuth
- The zenith

Equatorial coordinate system



Q5. In this diagram, could you draw and label:

- The celestial north pole and the celestial south pole
- The celestial equator
- The celestial sphere
- Lines indicating declination
- Lines indicating right ascension

Activity Two: Multiple Choice Questions

Q1. When measuring the angle of azimuth in the horizontal coordinate system, what is your reference point?

[A] First point of Aries

[B] North

[C] South

Q2. When measuring the angle of altitude in the horizontal coordinate system, what is your reference point?

[A] East

[B] The celestial equator

[C] The horizon

Q3. Which coordinate system is the same, no matter what your location is on the Earth?

[A] Horizontal

[B] Equatorial

[C] Neither

Q4. What's the celestial equivalent of latitude in the equatorial coordinate system?

[A] Declination

[B] Altitude

[C] Right Ascension

Q5. What is the equivalent of longitude in the equatorial coordinate system?

[A] Declination

[B] Azimuth

[C] Right ascension

Q6. Why can't you use prime meridian as reference in space?

[A] It's not long enough

[B] It doesn't align with lines of declination on the celestial sphere

[C] It moves as the Earth rotates, meaning it would constantly change

Q7. What do we use in the equatorial coordinate system as the celestial equivalent of the prime meridian?

[A] First point of Libra

[B] The orbital plane of the Earth

[C] First point of Aries

Q8. In the drawing below, the 3rd astronomer can't see the location shared with them despite using the equatorial coordinate system. Why is this?

[A] The equatorial coordinate system doesn't work in the southern hemisphere

[B] The Earth is in the way

[C] The object they're looking at through telescopes is too faint

Q9. A galaxy has a declination of -33°. This galaxy lies:

[A] In the northern celestial hemisphere

[B] On the celestial equator

[C] In the southern celestial hemisphere

Q10. Stars lying on the celestial equator have a declination equal to:

[A] 90°

[B] 0°

[C] -90°

Q11. The constellation of Orion has a right ascension of 5h and the constellation of Scorpius has a right ascension just under 17h. This tells us that:

A] You can only ever observe Orion at 5:00 am and Scorpius at 5:00 pm.

[B] Orion and Scorpius lie directly opposite each other on the sky

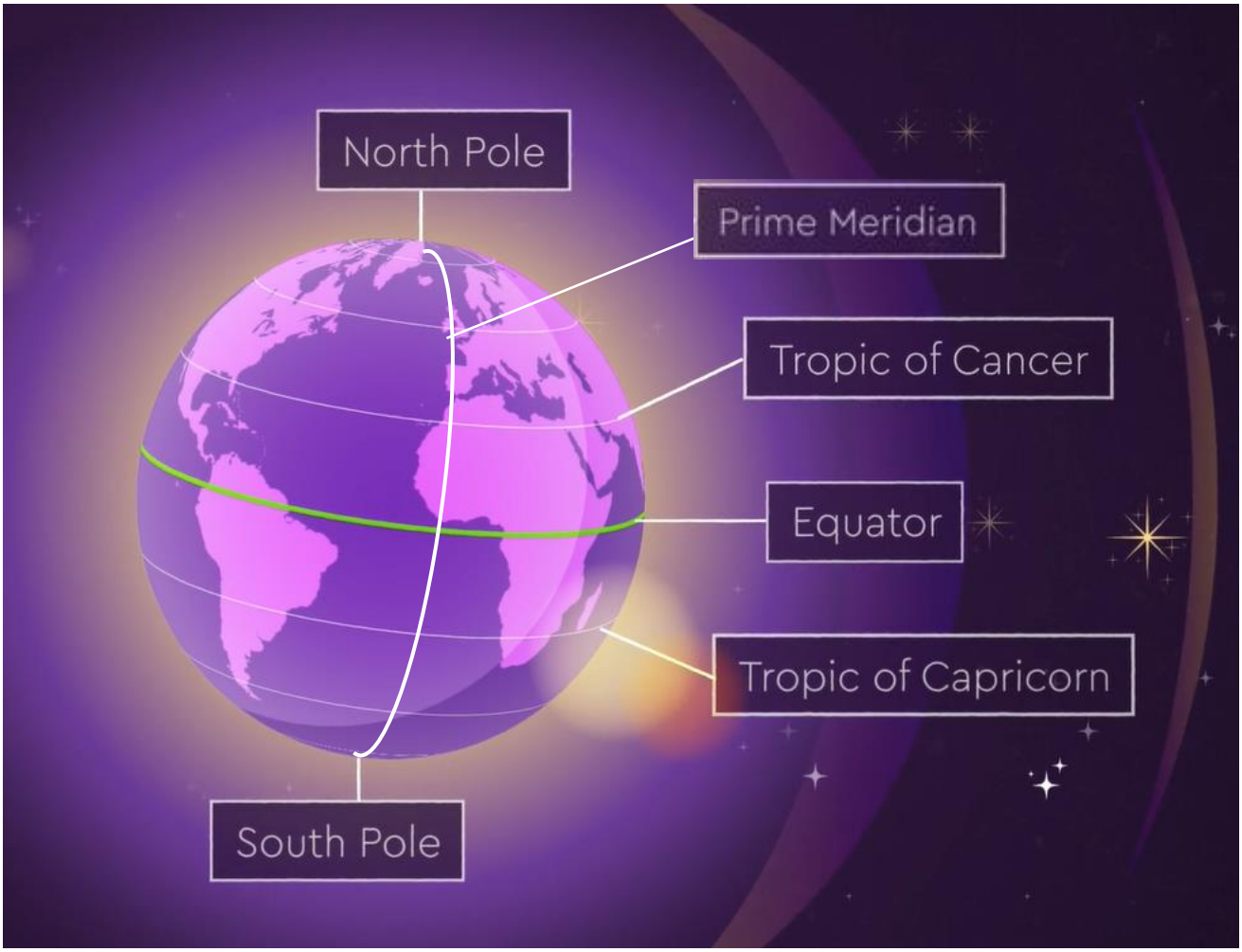
[C] No matter where Orion is in the sky, Scorpius lies exactly 90° away from it

Student activity - Answers

Activity One: Labelling Diagrams

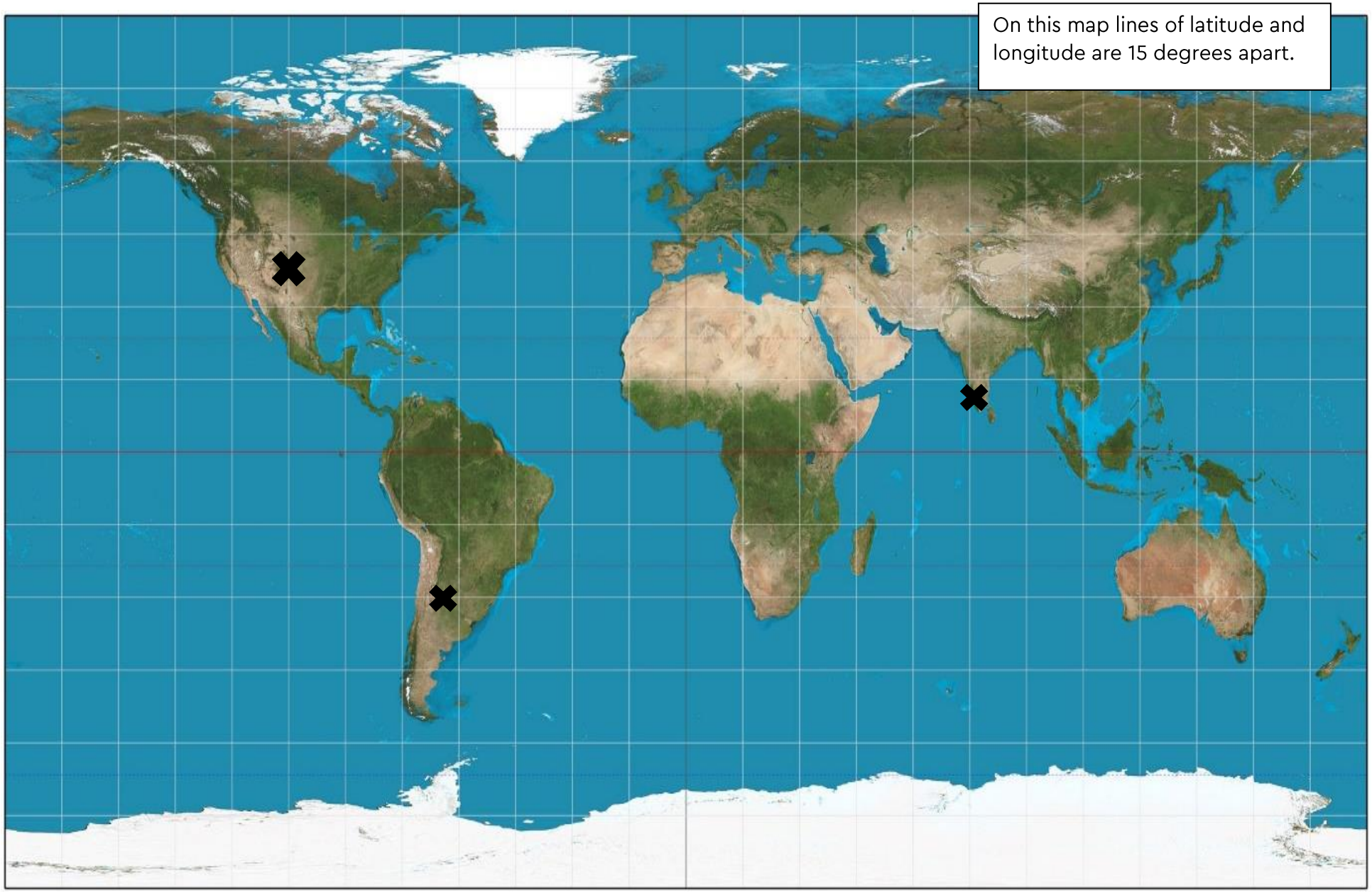
Latitude and Longitude

Q1.



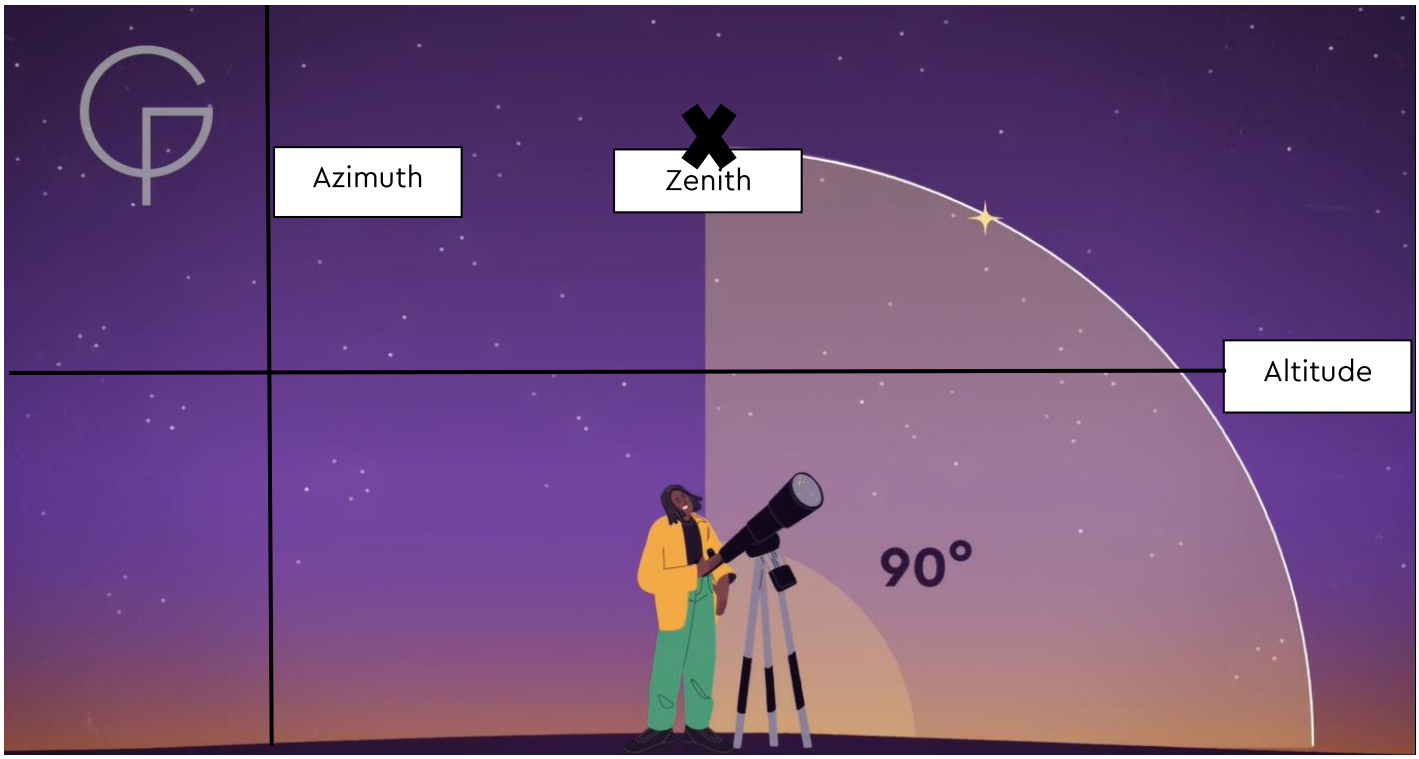
Q2. See map on following page.

Q3. Coordinates of Lowell Observatory: 37˚N, 104˚W (this is the exact coordinates, we'd expect only approximate coordinates using the map)


On this map lines of latitude and longitude are 15 degrees apart.

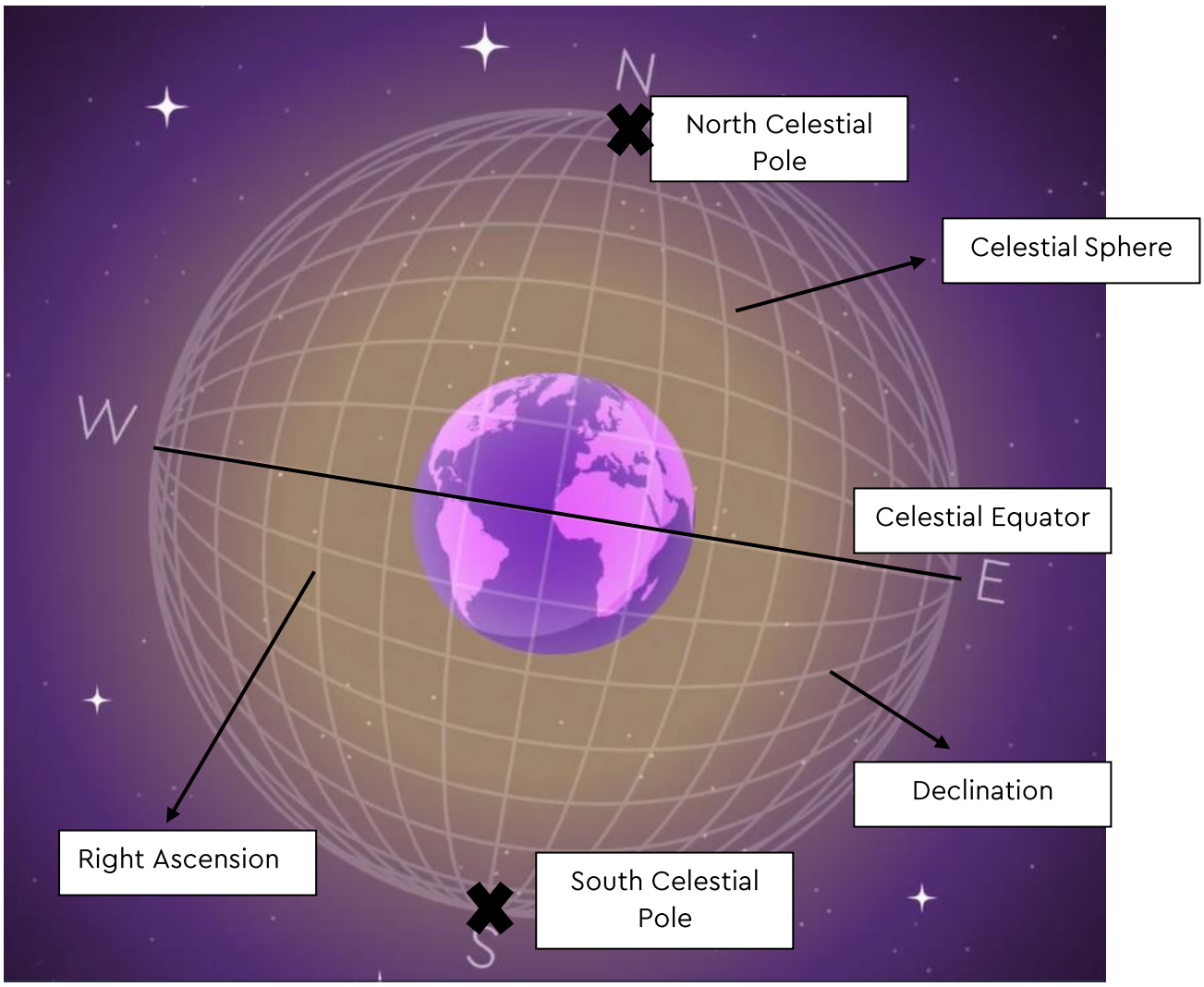
Horizontal Coordinate System

Q4.



Equatorial coordinate system

Q5.



Activity Two: Multiple Choice Questions

Q1. When measuring the angle of azimuth in the horizontal coordinate system, what is your reference point?

[B] North

Q2. When measuring the angle of altitude in the horizontal coordinate system, what is your reference point?

[C] The horizon

Q3. Which coordinate system is the same, no matter what your location is on the Earth?

[B] Equatorial

Q4. What's the celestial equivalent of latitude in the equatorial coordinate system?

[A] Declination

Q5. What is the equivalent of longitude in the equatorial coordinate system?

[C] Right ascension

Q6. Why can't you use prime meridian as reference in space?

[C] It moves as the Earth rotates, meaning it would constantly change

Q7. What do we use in the equatorial coordinate system as the celestial equivalent of the prime meridian?

[C] First point of Aries

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Q9. A galaxy has a declination of -33°. This galaxy lies:

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Q11. The constellation of Orion has a right ascension of 5h and the constellation of Scorpius has a right ascension just under 17h. This tells us that:

[B] Orion and Scorpius lie directly opposite each other on the sky