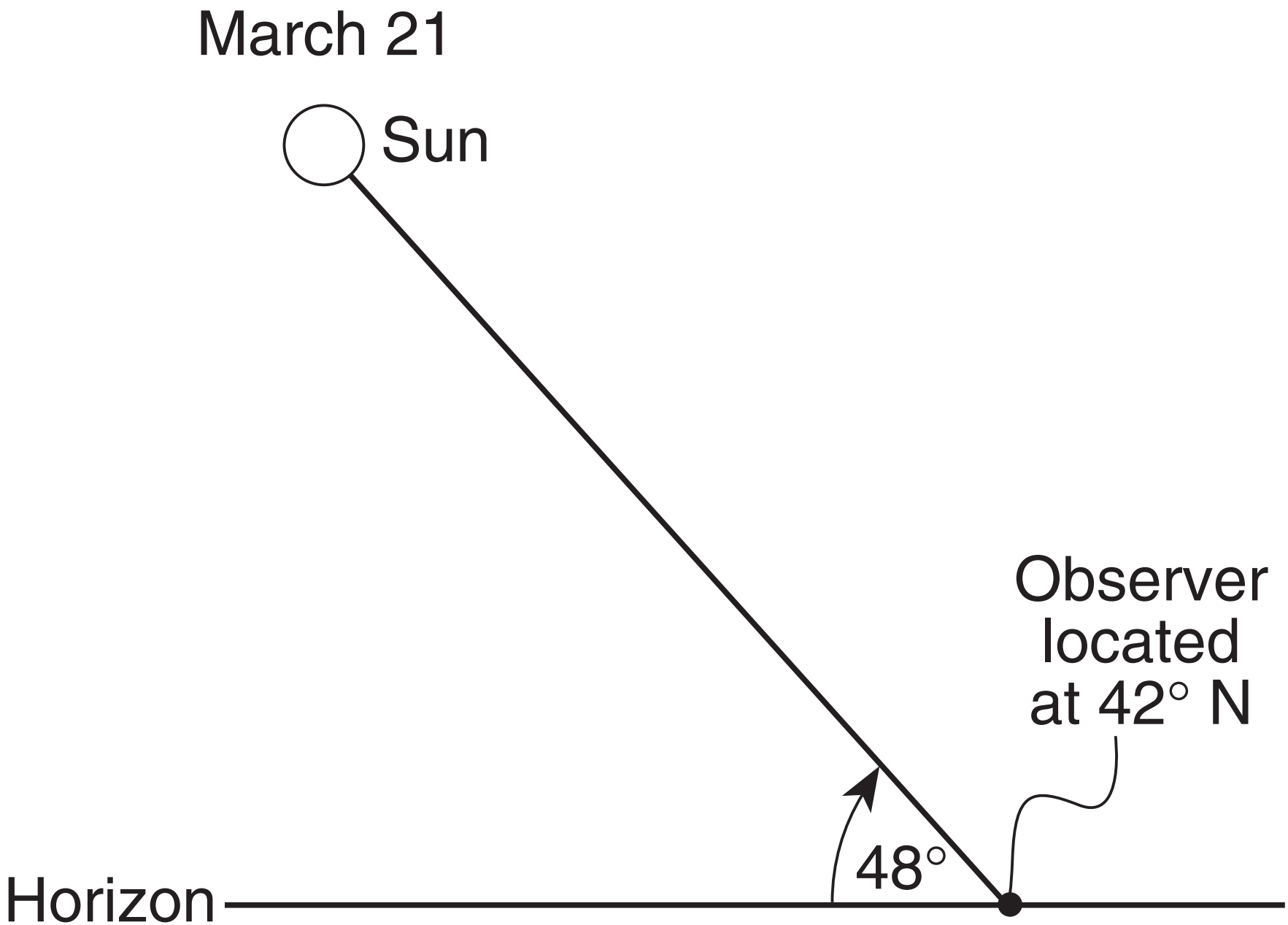
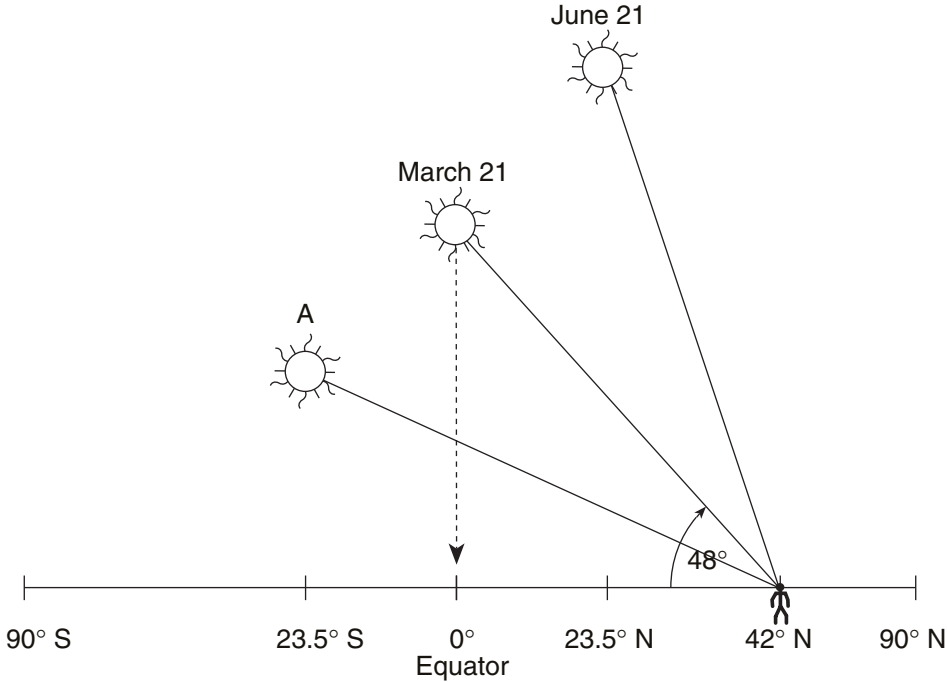
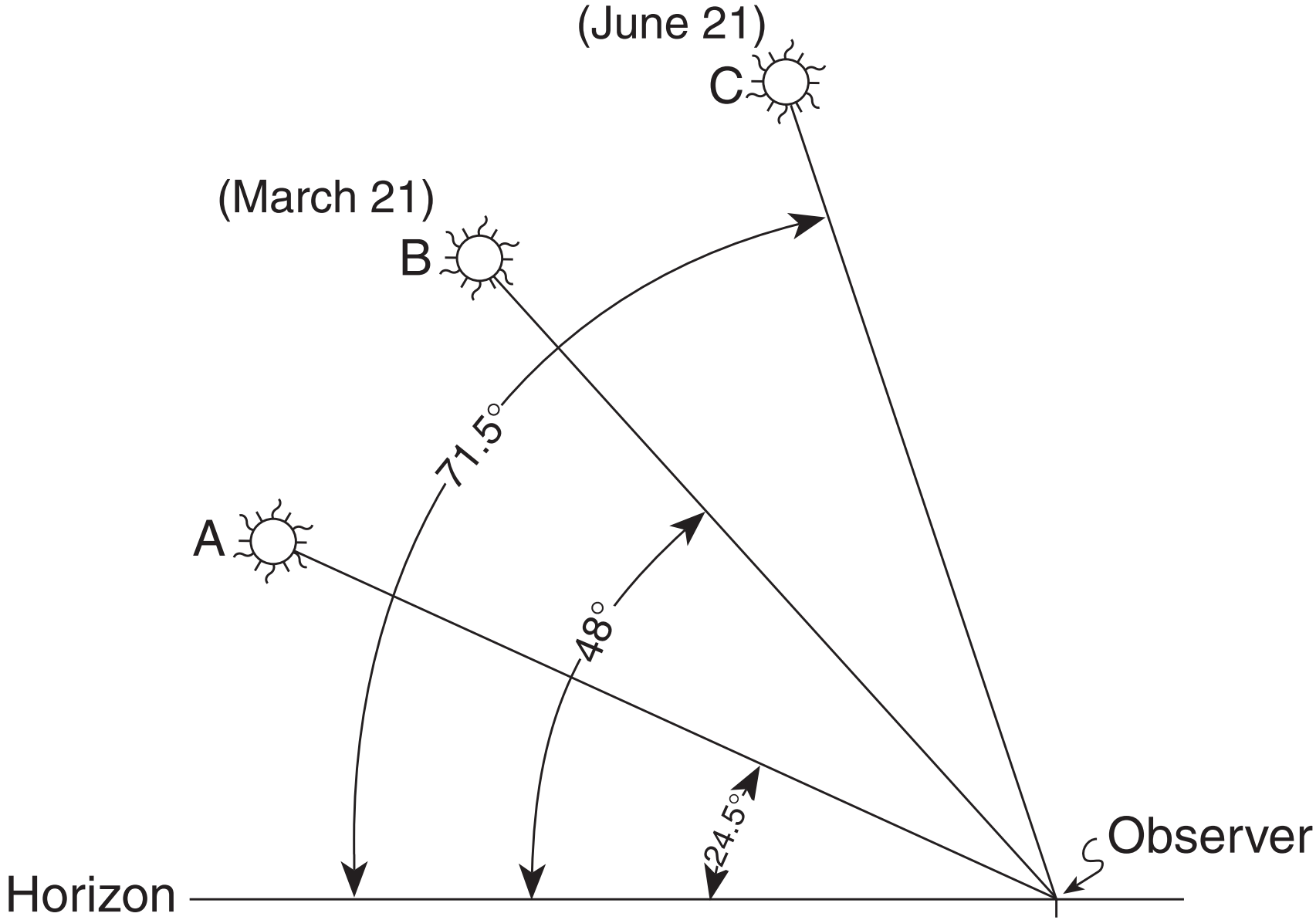
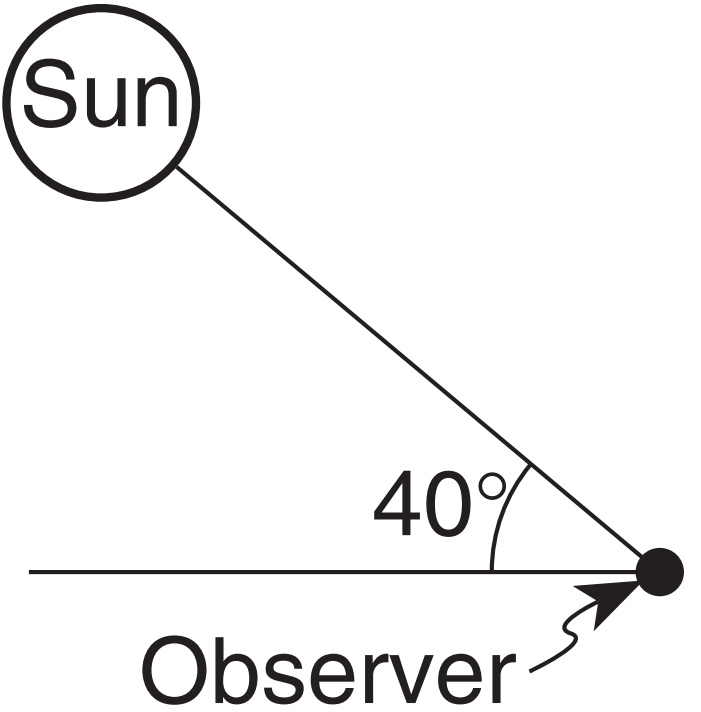
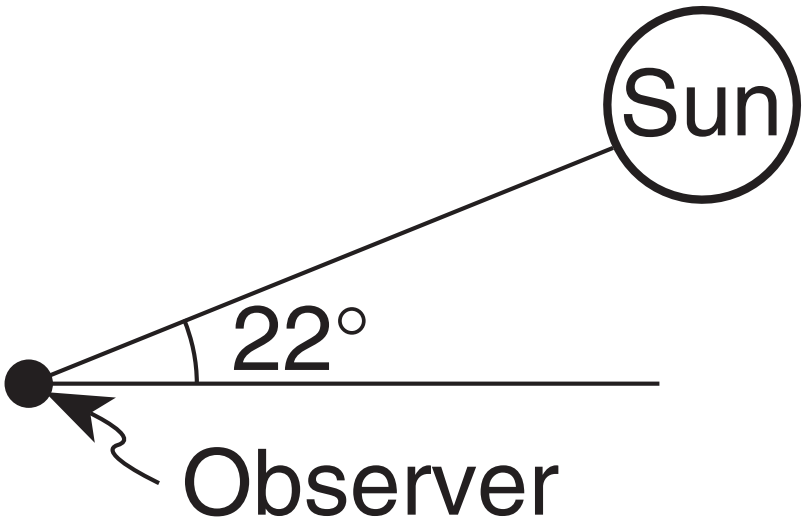
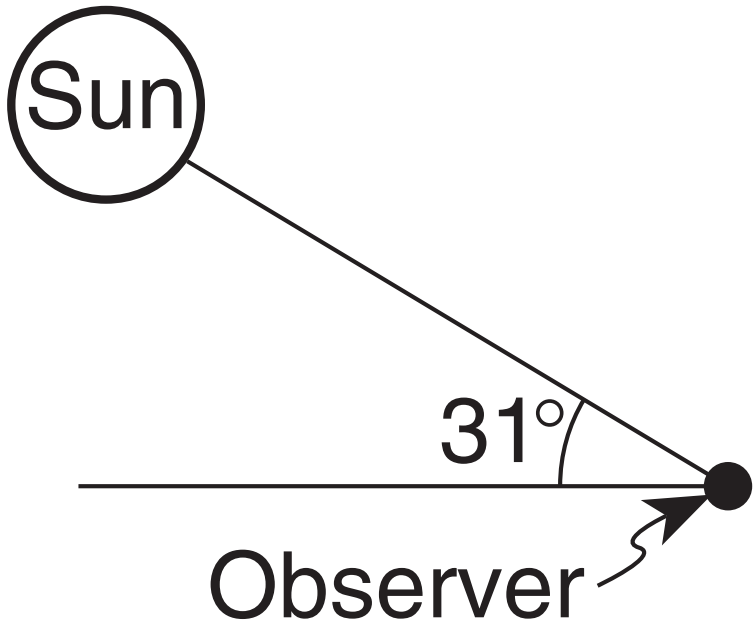

March 21
Sun
Observer
located
at 42° N
48°
Horizon

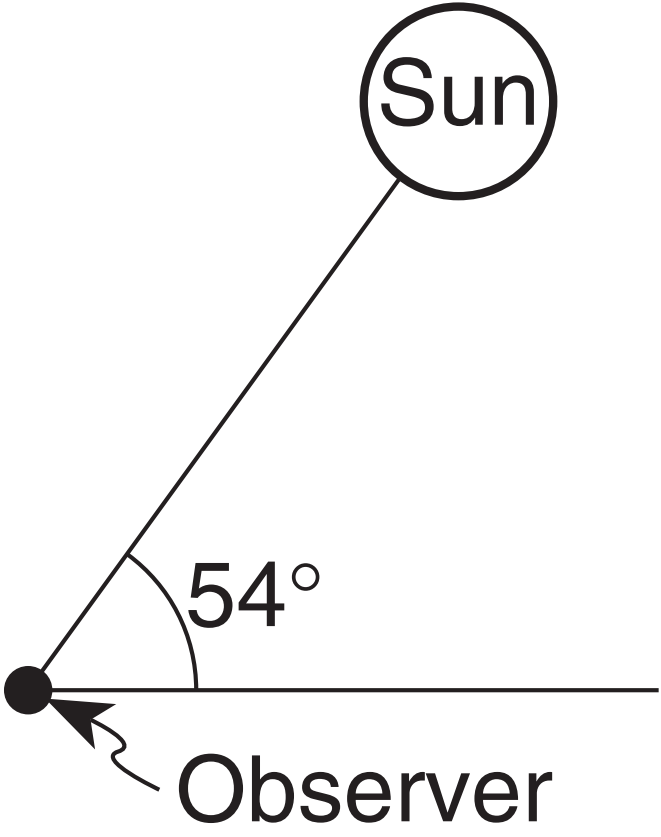

June 21
March 21
A
48°
90° S
23.5° S
0°
Equator
23.5° N
42° N
90° N

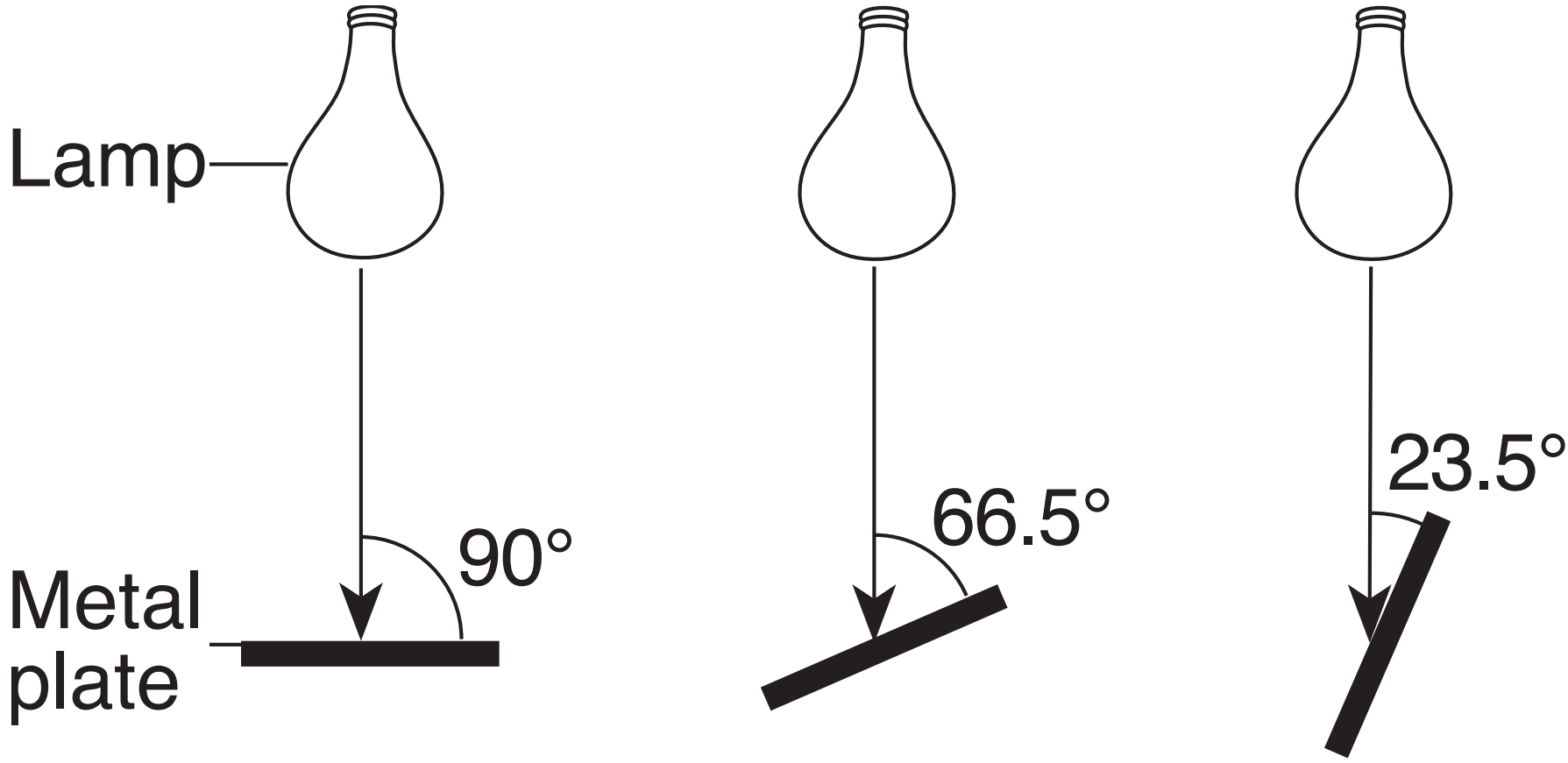

(June 21)
C
(March 21)
B
A
71.5°
48°
24.5°
Observer
Horizon


Sun
40°
Observer

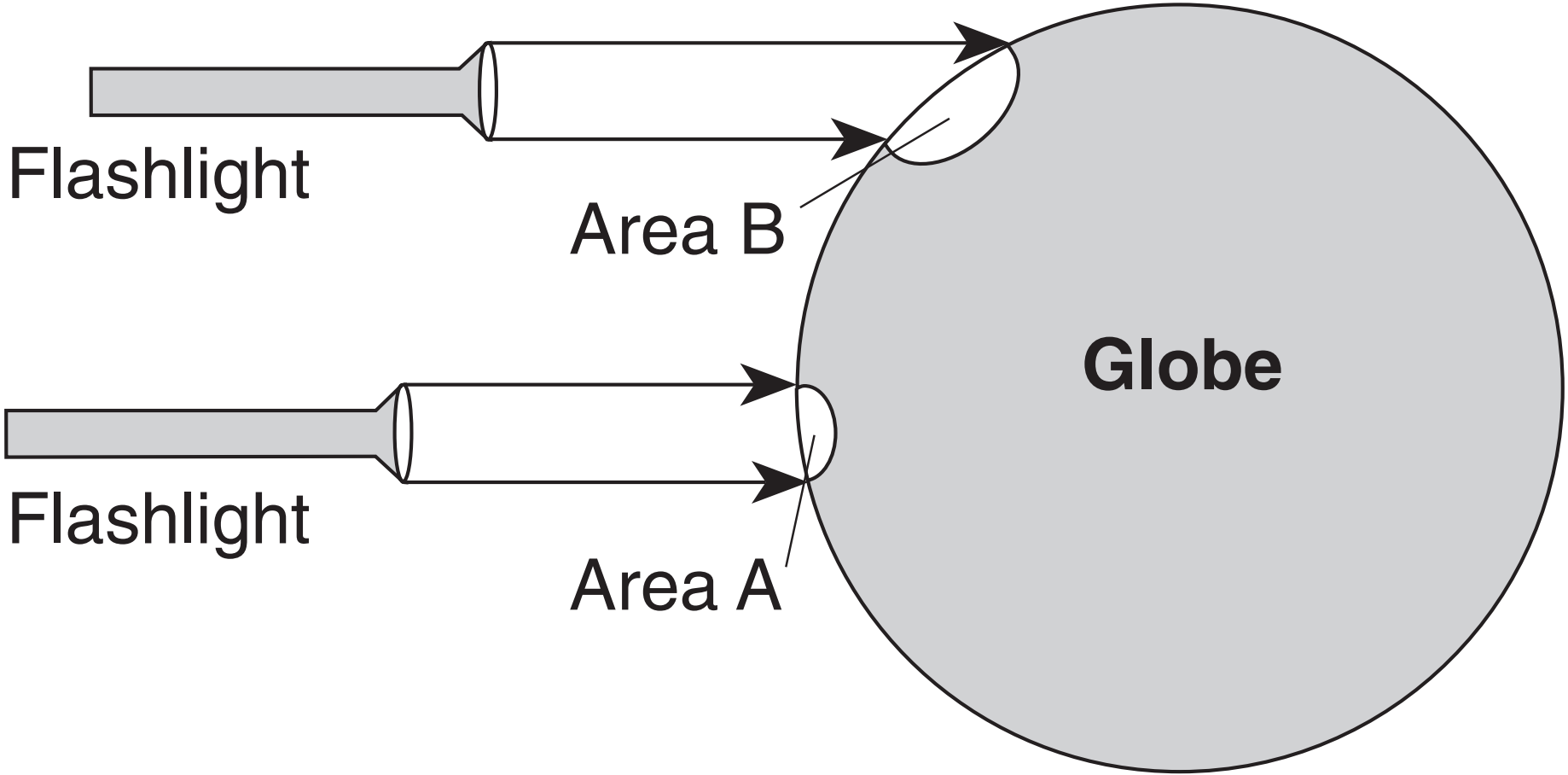

Sun
22°
Observer

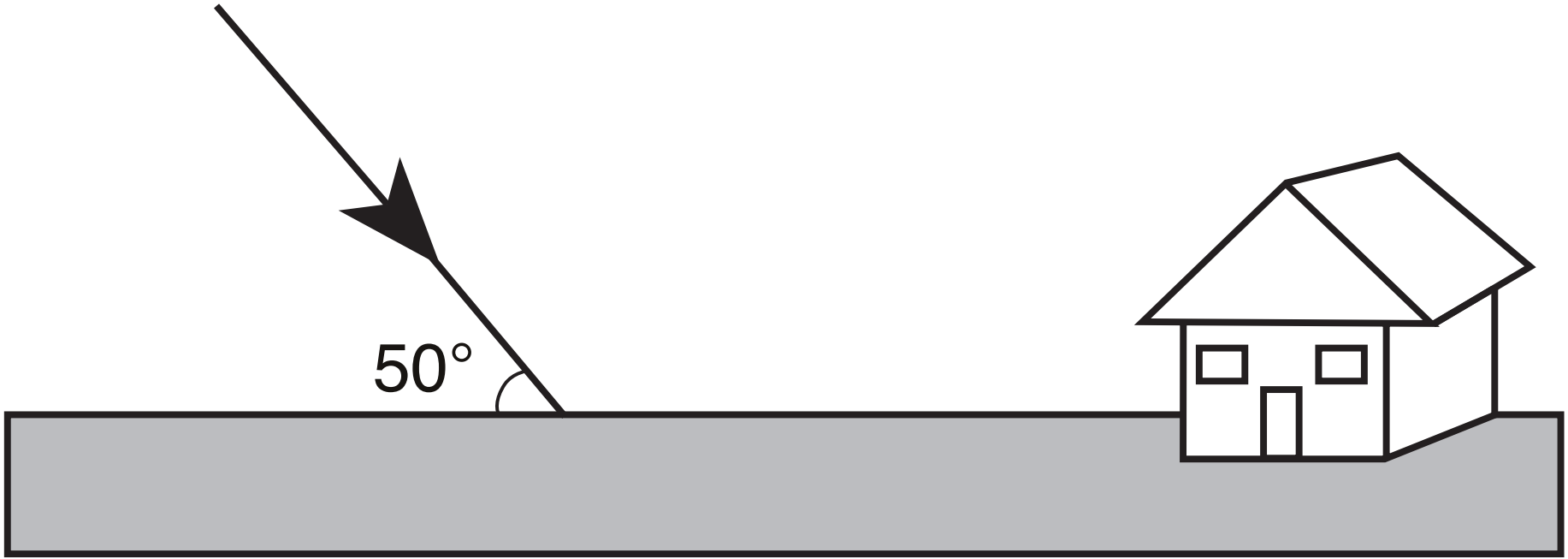

Sun
31°
Observer

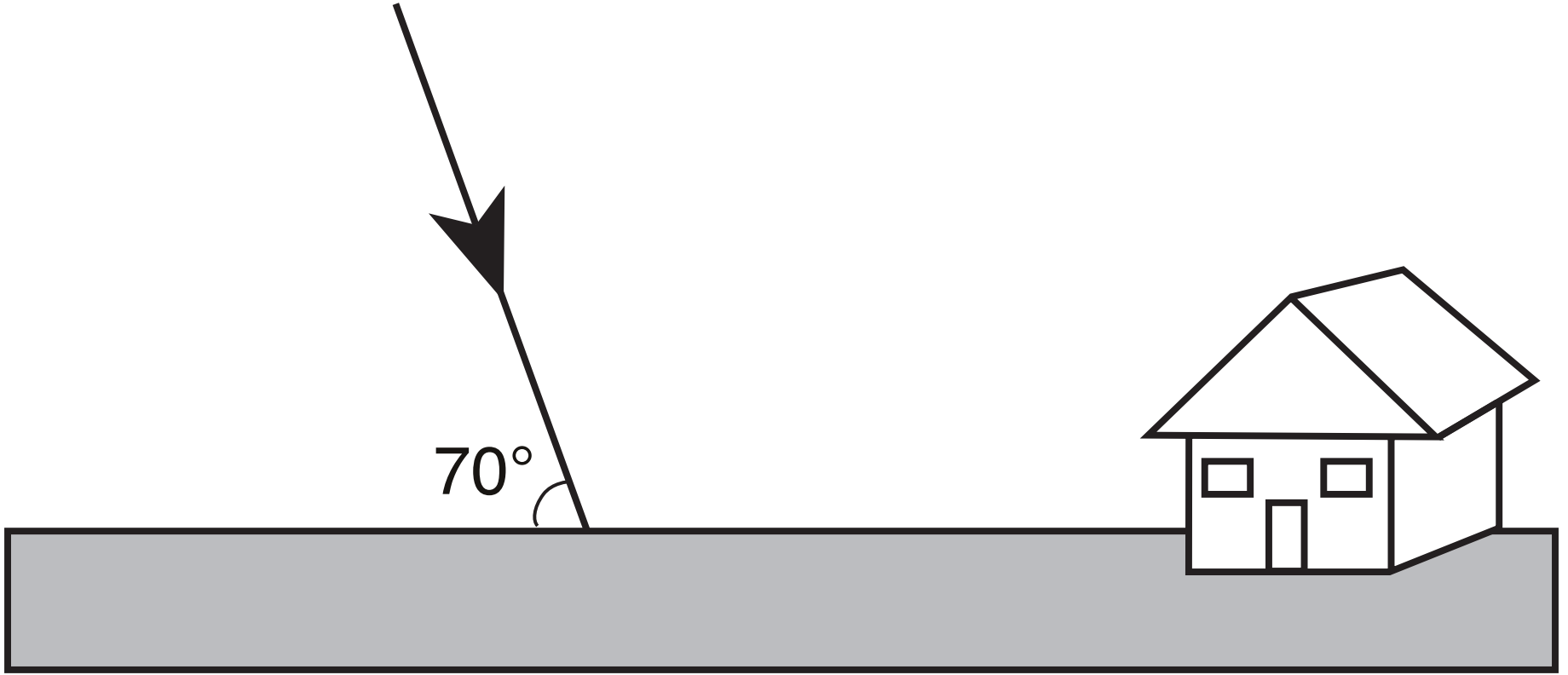

Sun
54°
Observer



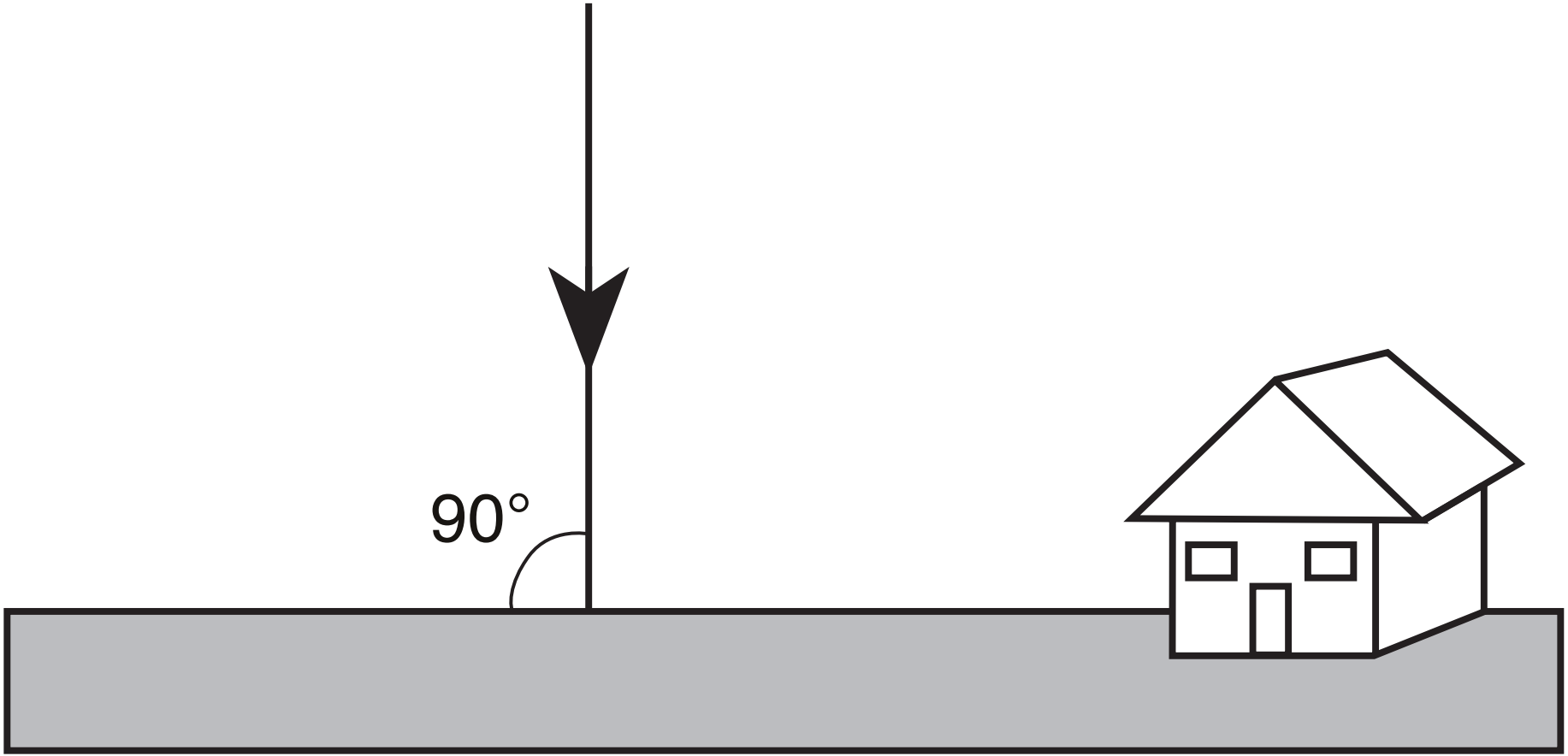

**Angles of Incidence**


Flashlight
Area B
Globe
Flashlight
Area A


50°

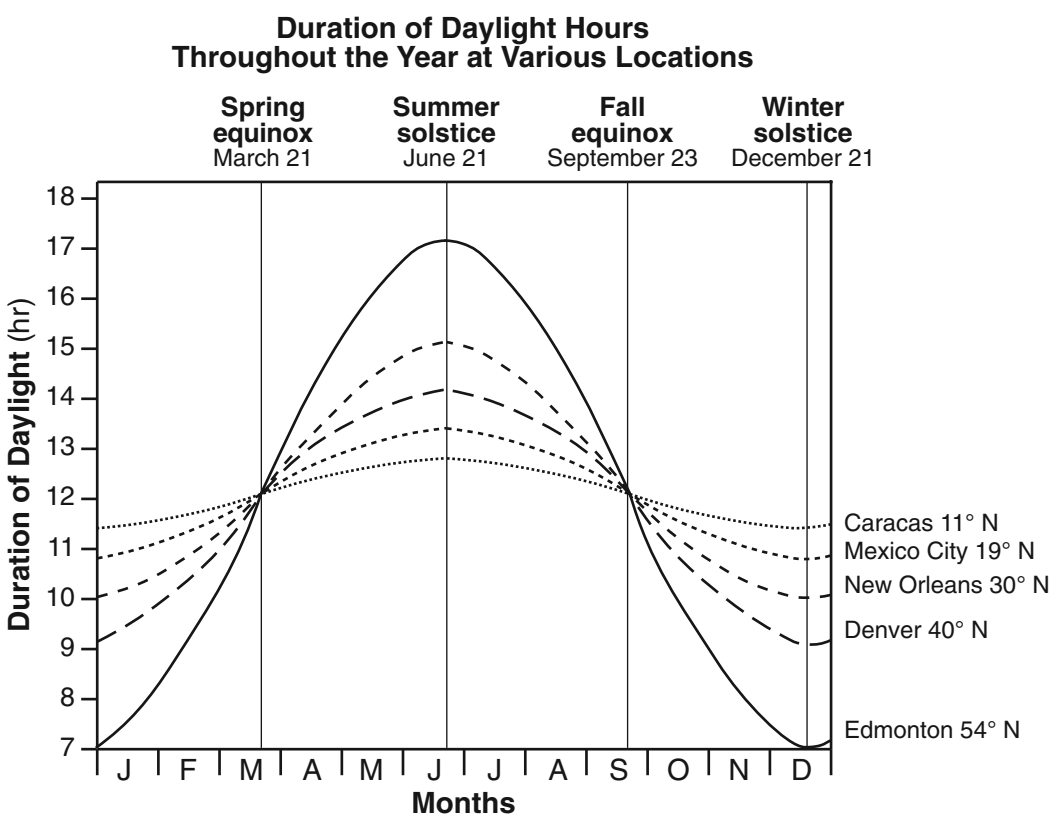

70°

30°

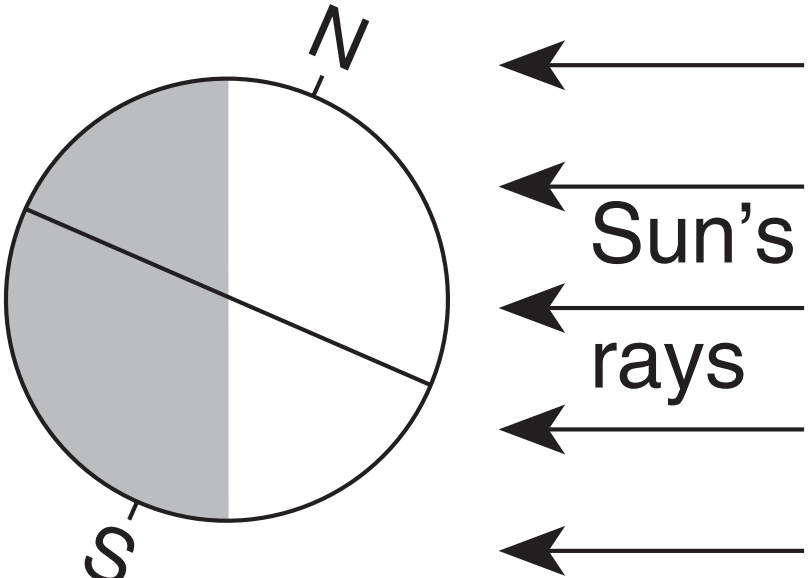

90°

## Apparent Diameter of the Sun During the Year

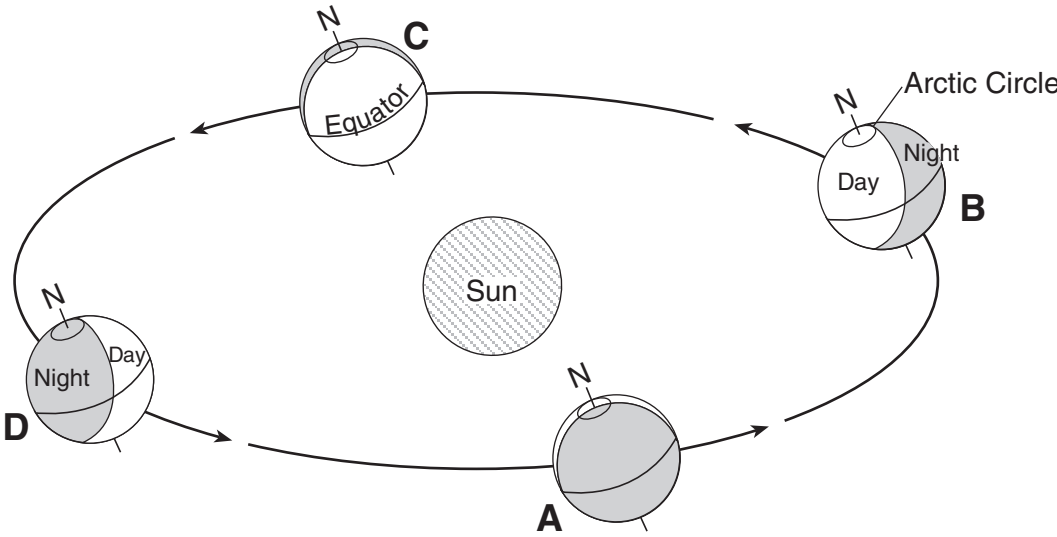
| Date | Apparent Diameter<br>( ' = minutes " = seconds) |
|---|---|
| January 1 | 32'32" |
| February 10 | 32'25" |
| March 20 | 32'07" |
| April 20 | 31'50" |
| May 30 | 31'33" |
| June 30 | 31'28" |
| August 10 | 31'34" |
| September 20 | 31'51" |
| November 10 | 32'18" |
| December 30 | 32'32" |

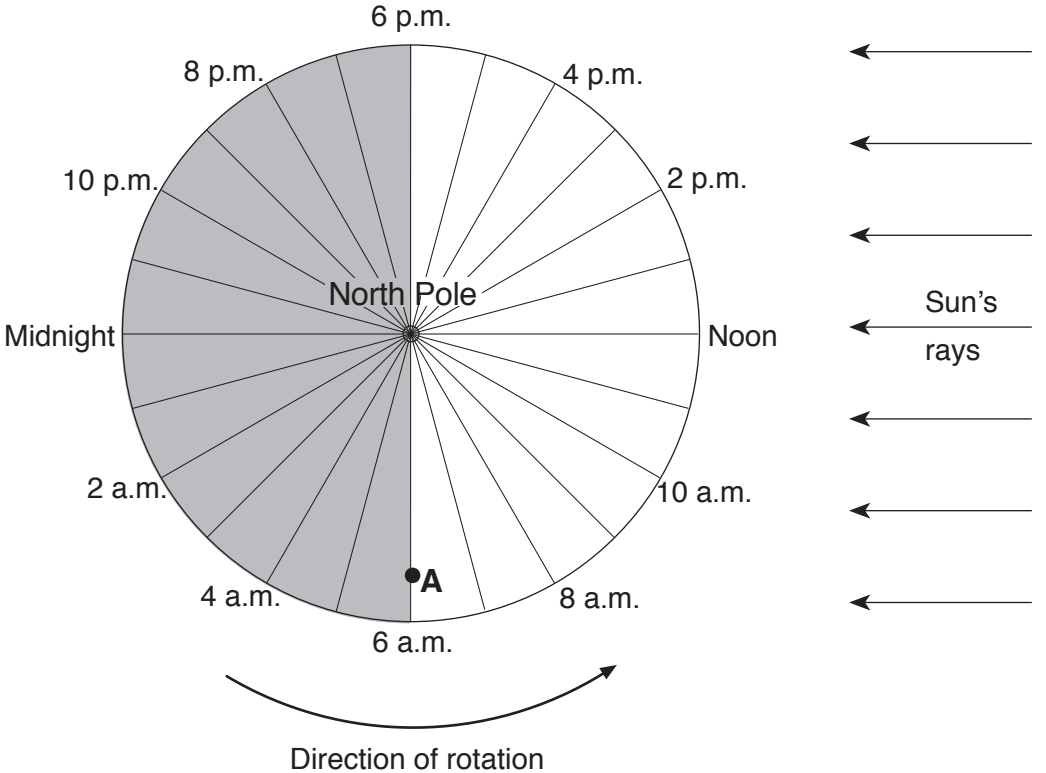

Duration of Daylight Hours
Throughout the Year at Various Locations
Spring equinox
March 21
Summer solstice
June 21
Fall equinox
September 23
Winter solstice
December 21
Duration of Daylight (hr)
18
17
16
15
14
13
12
11
10
9
8
7
J
F
M
A
M
J
J
A
S
O
N
D
Months
Caracas 11° N
Mexico City 19° N
New Orleans 30° N
Denver 40° N
Edmonton 54° N

| Observer | Duration of Insolation March 21 | Duration of Insolation June 21 |
|---|---|---|
| *W* | 12 hr | 0 hr |
| *X* | 12 hr | 12 hr |
| *Y* | 12 hr | 18 hr |
| *Z* | 12 hr | 24 hr |

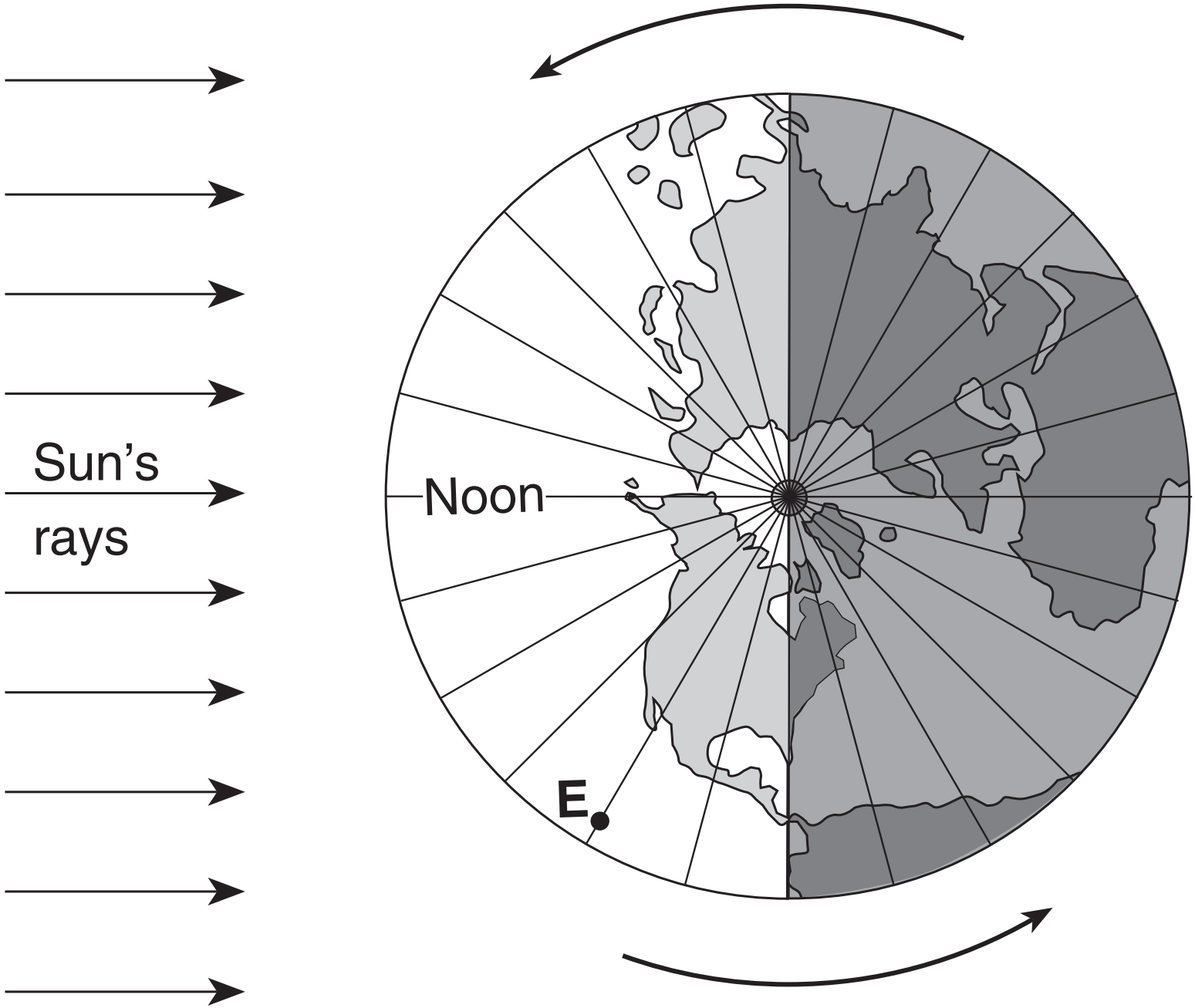

N
S
Sun's
rays

## Diagram 1

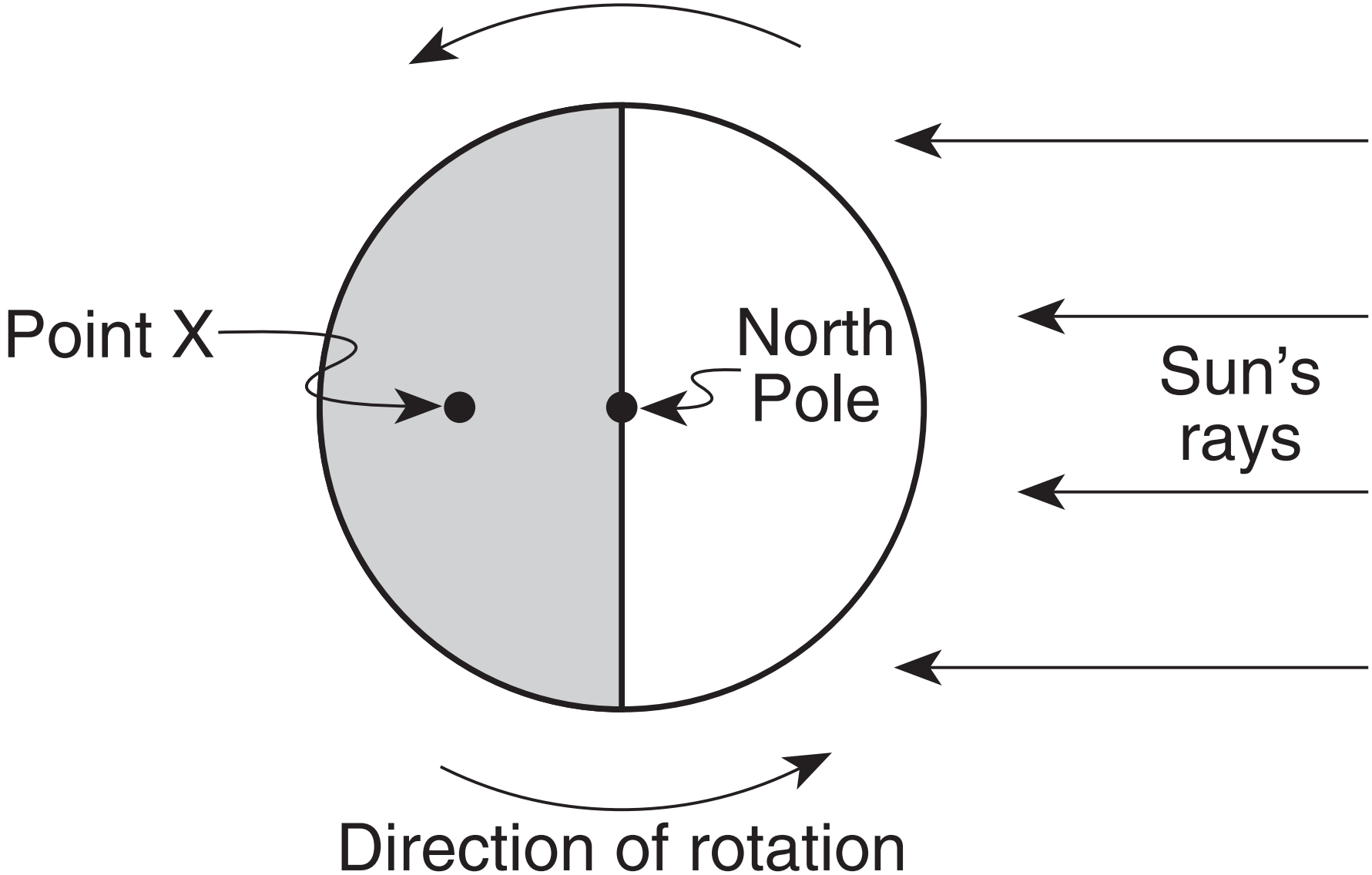


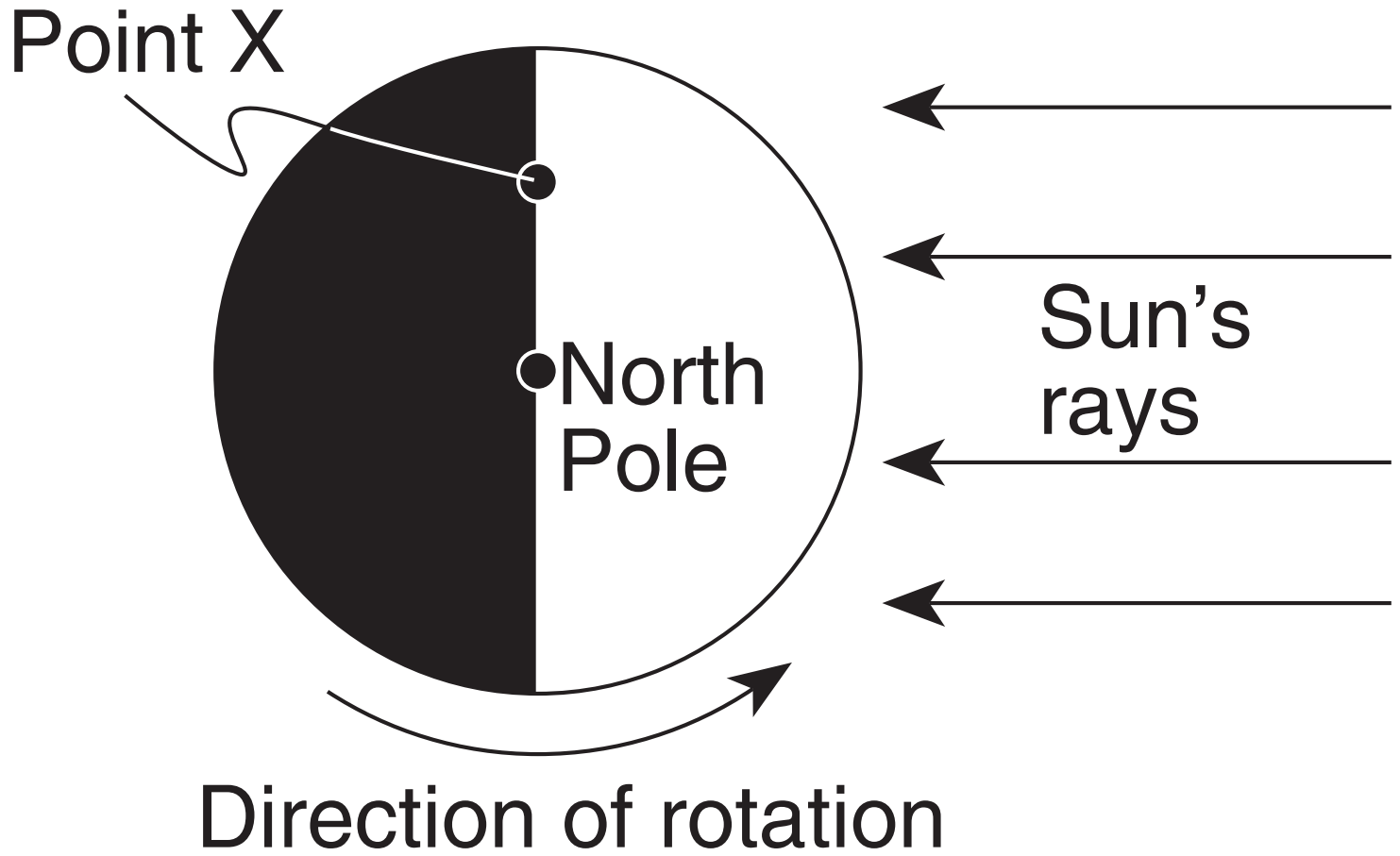

6 p.m.
8 p.m.
4 p.m.
10 p.m.
2 p.m.
North Pole
Midnight
Noon
Sun's
rays
2 a.m.
10 a.m.
A
4 a.m.
8 a.m.
6 a.m.
Direction of rotation

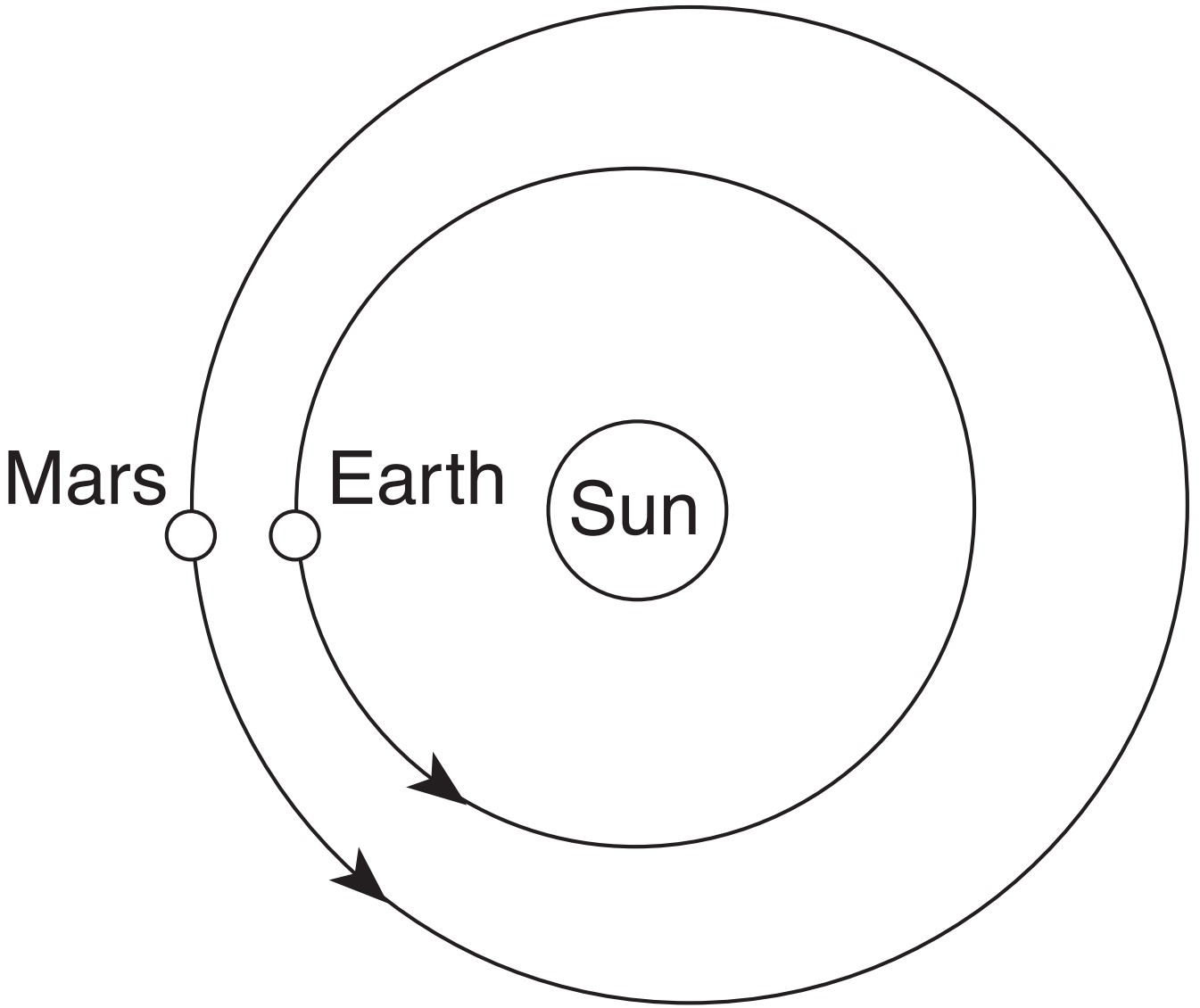
# Diagram 2



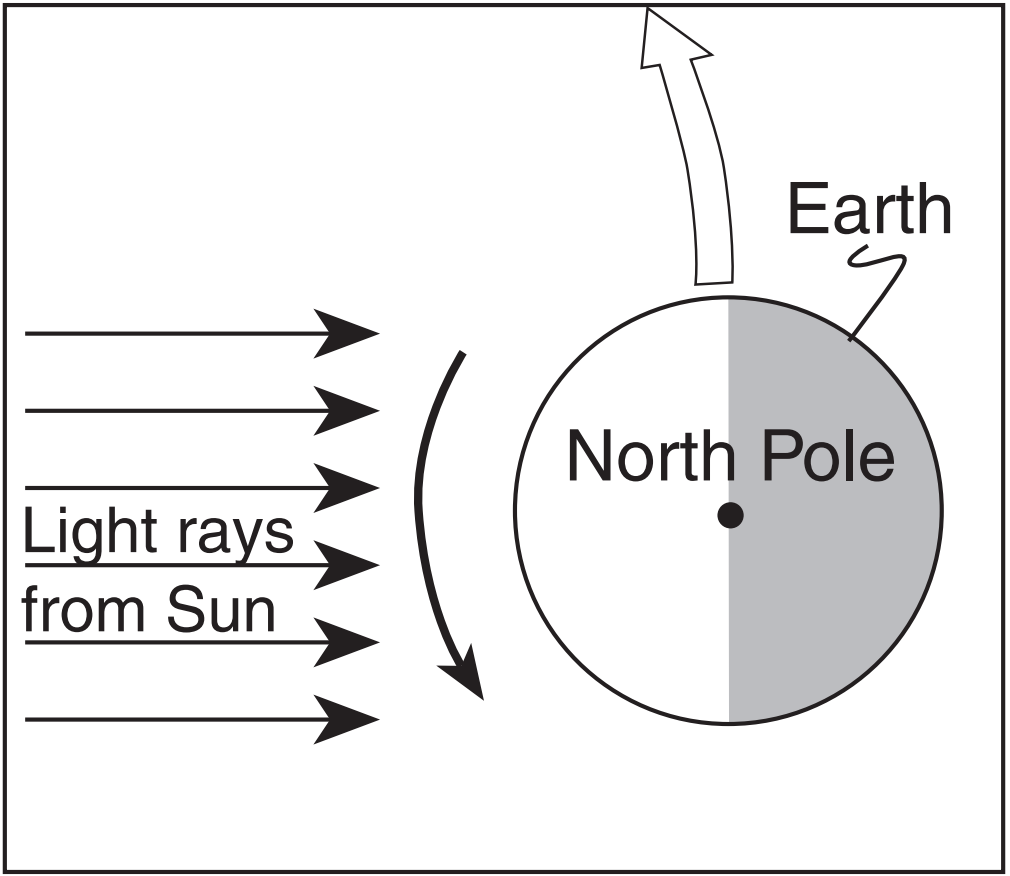

**March 21**

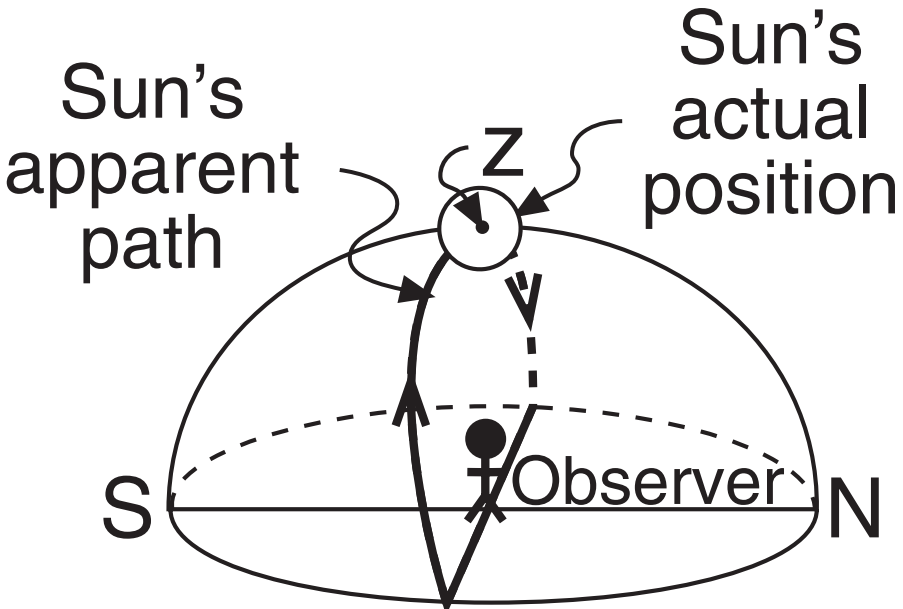

Point X
North Pole
Sun's rays
Direction of rotation

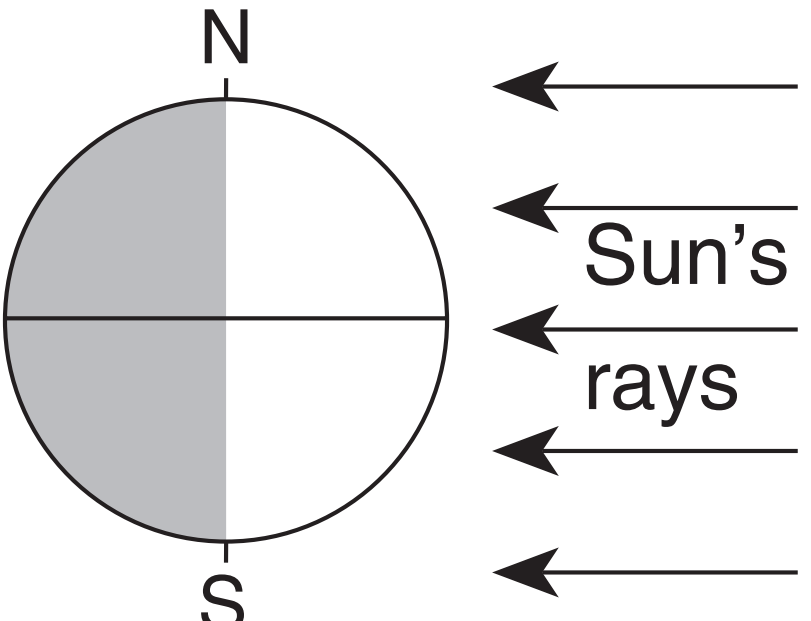

Point X
North Pole
Sun's rays
Direction of rotation

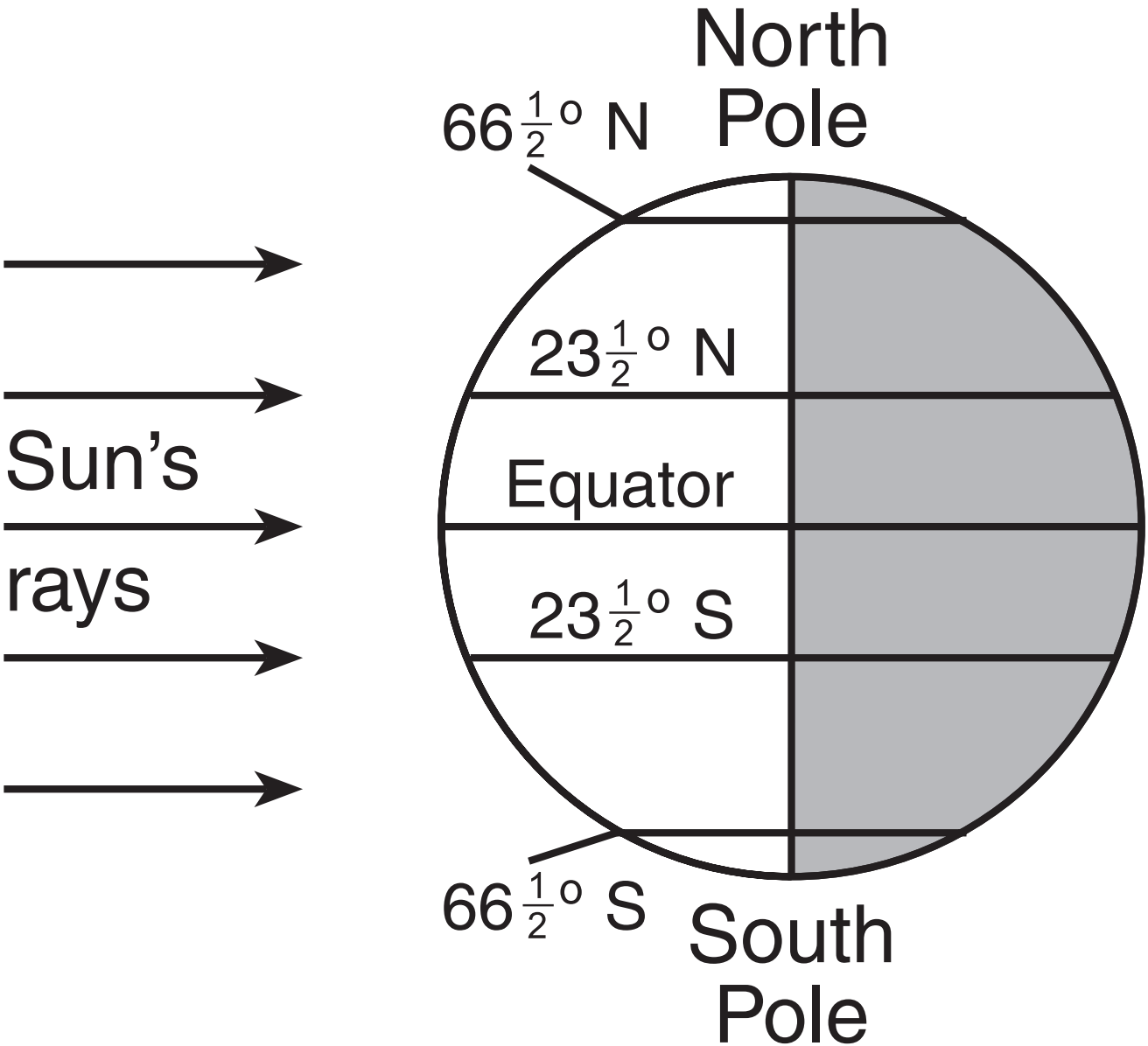


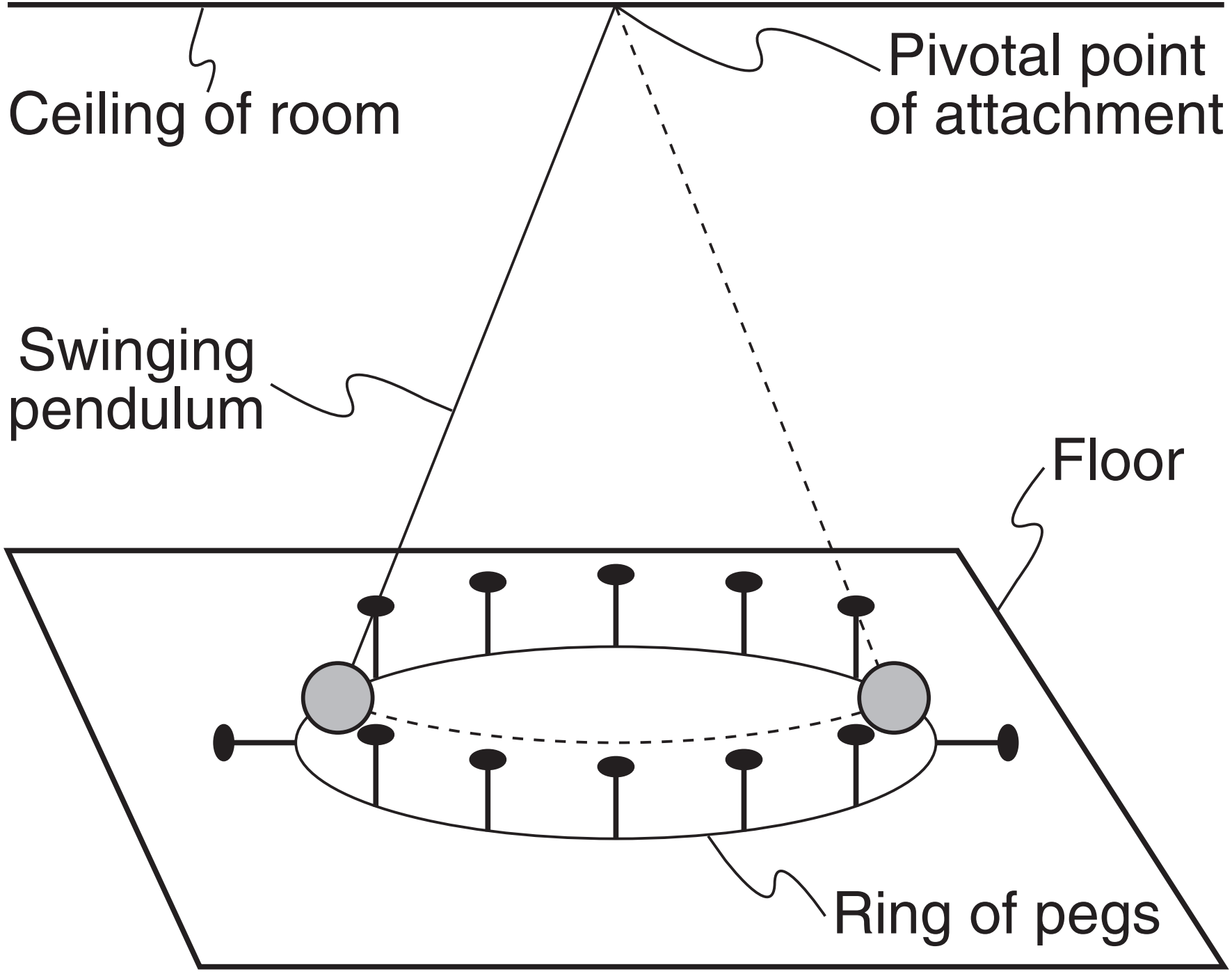

(Not drawn to scale)

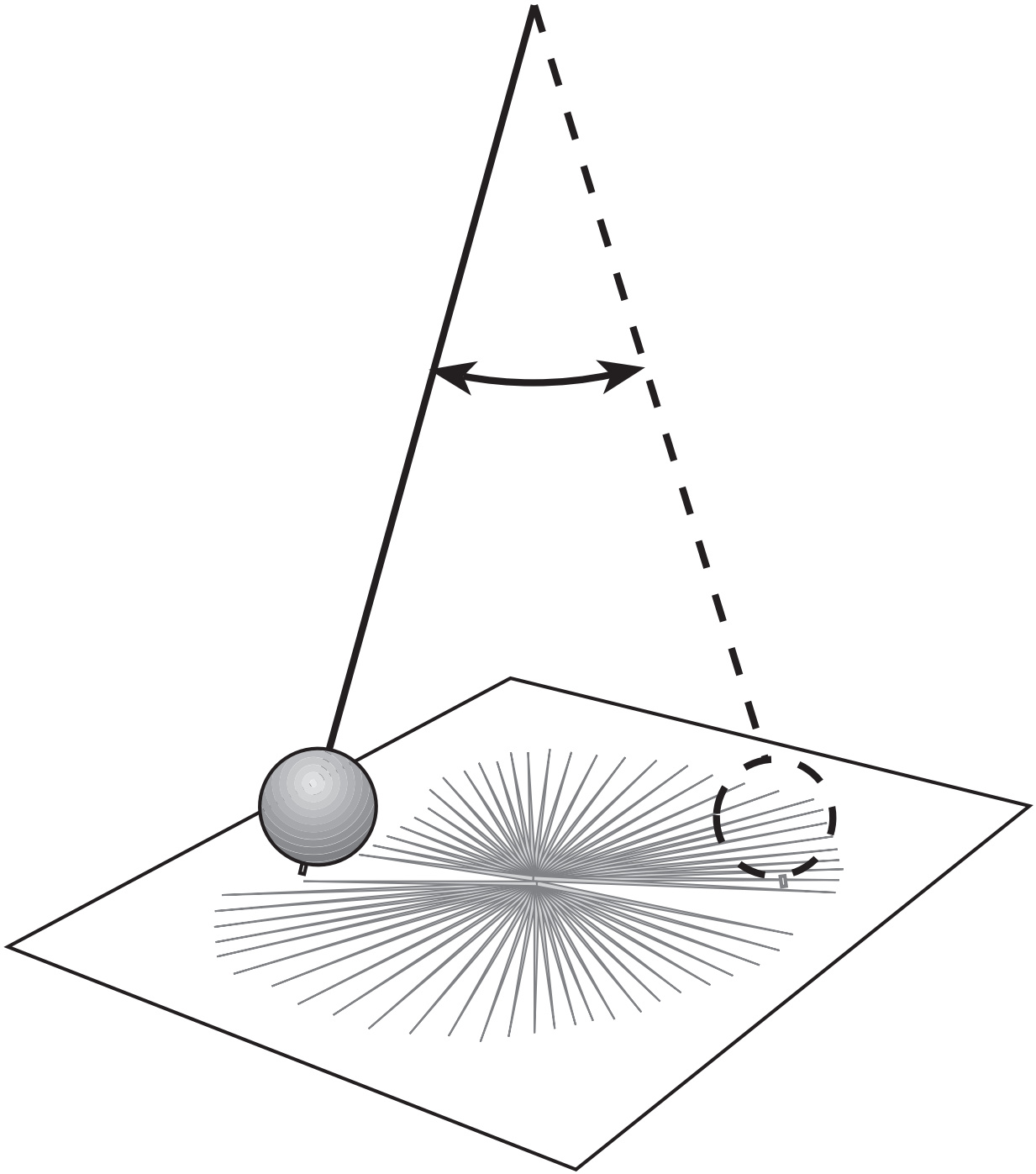

Earth
North Pole
Light rays
from Sun

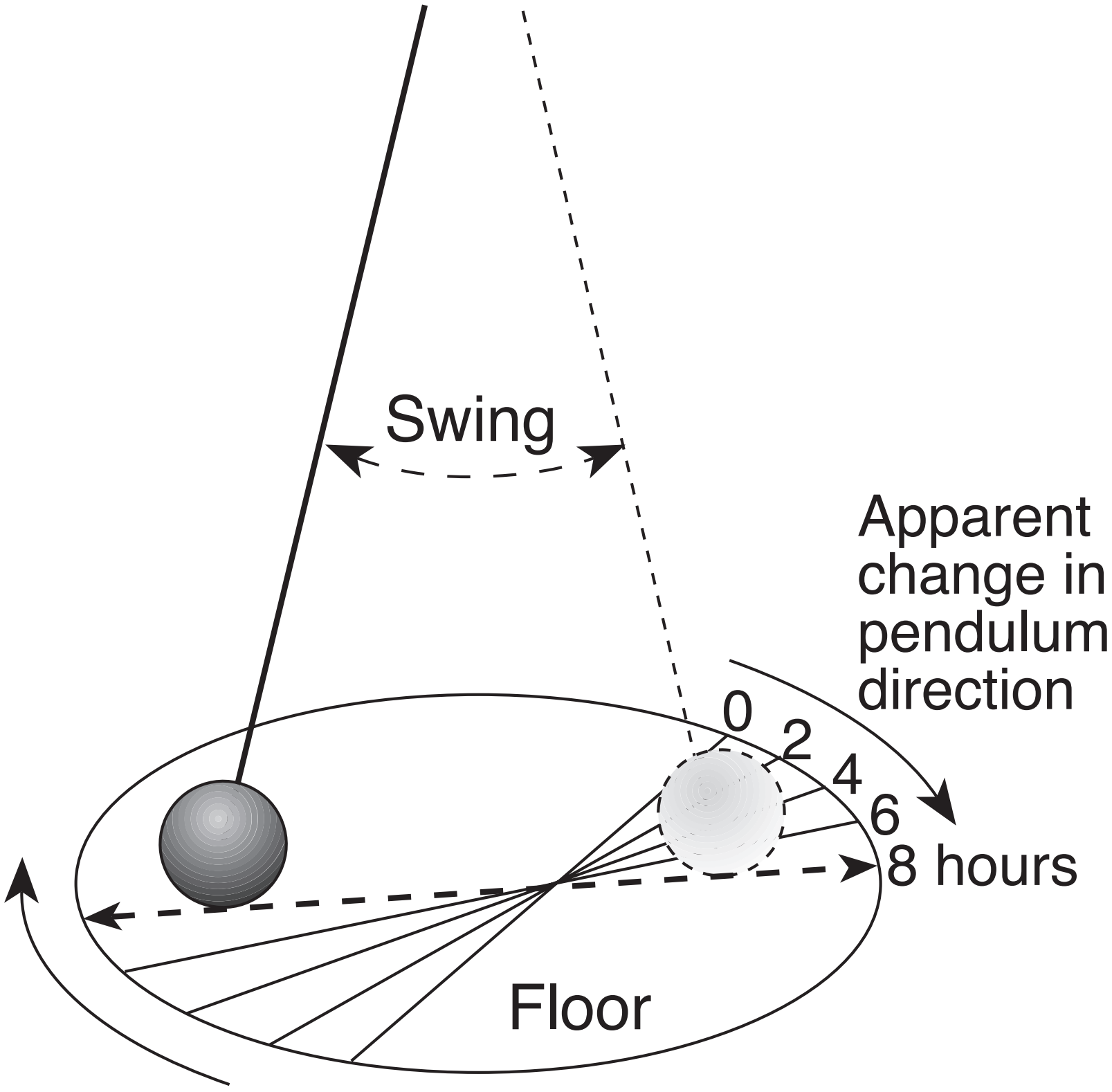

Sun's apparent path
Sun's actual position
Z
Observer
S
N

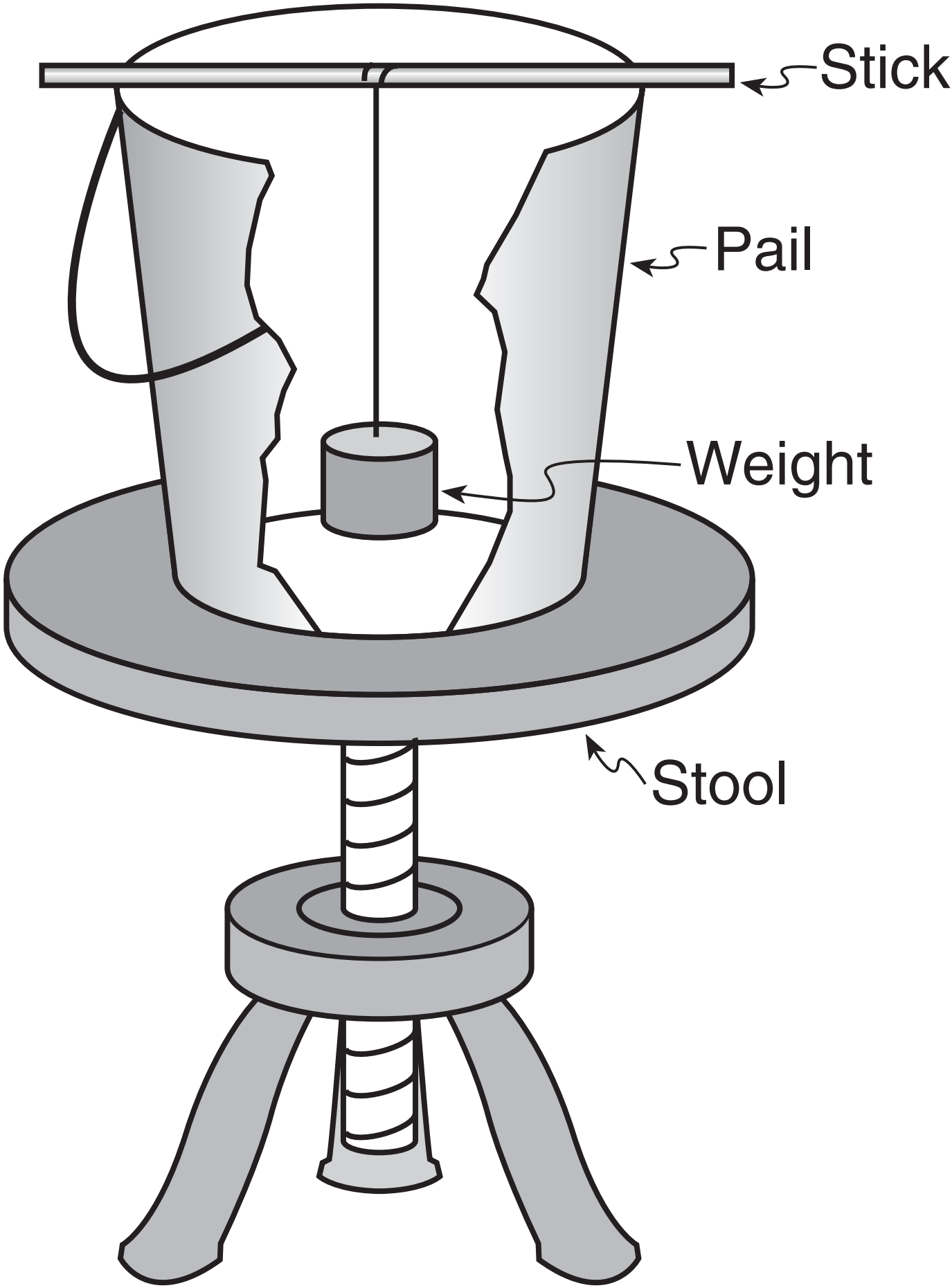

N
S
Sun's
rays

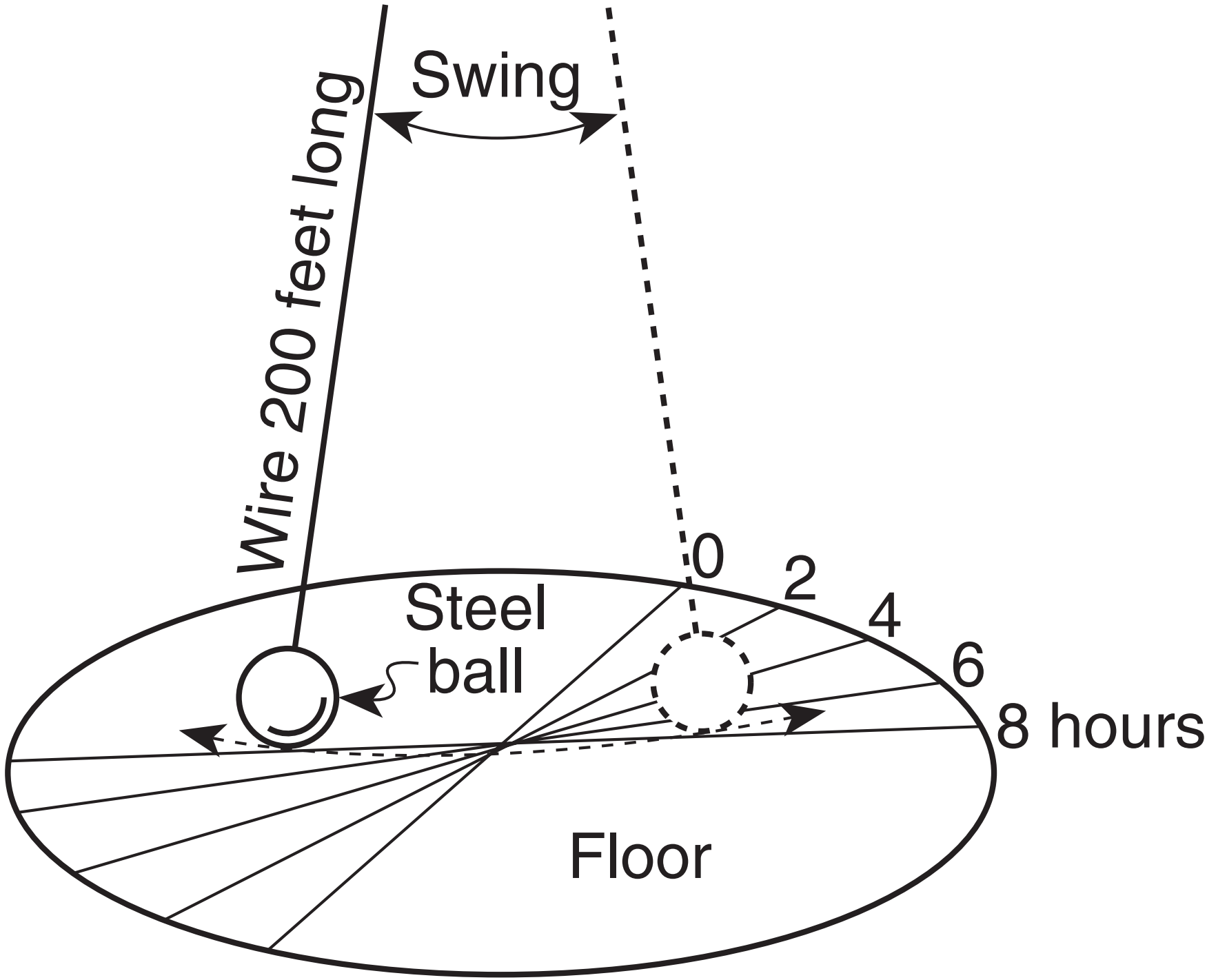

North Pole
66 1/2° N
23 1/2° N
Equator
23 1/2° S
66 1/2° S
South Pole
Sun's rays

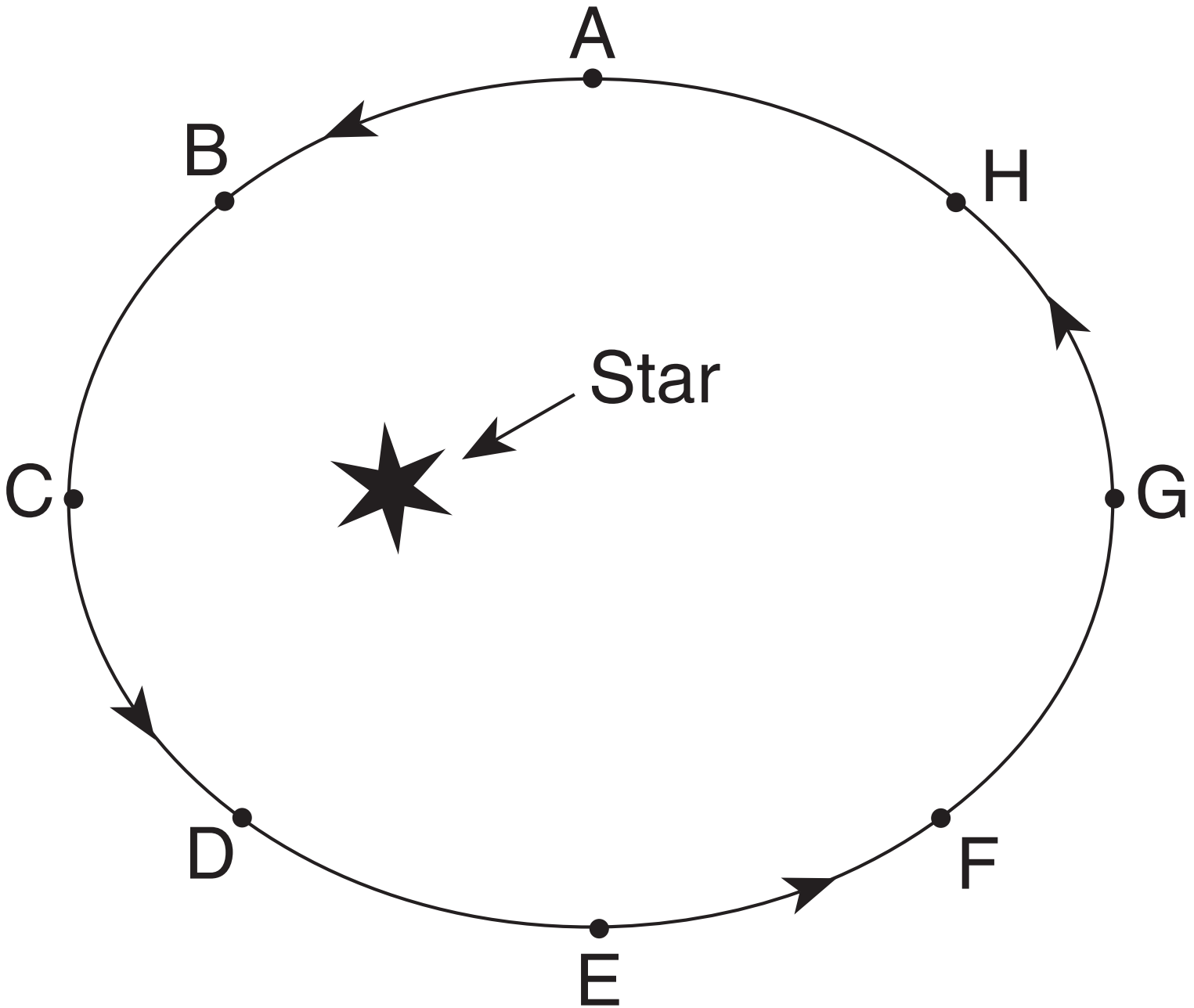

Ceiling of room
Pivotal point
of attachment
Swinging
pendulum
Floor
Ring of pegs

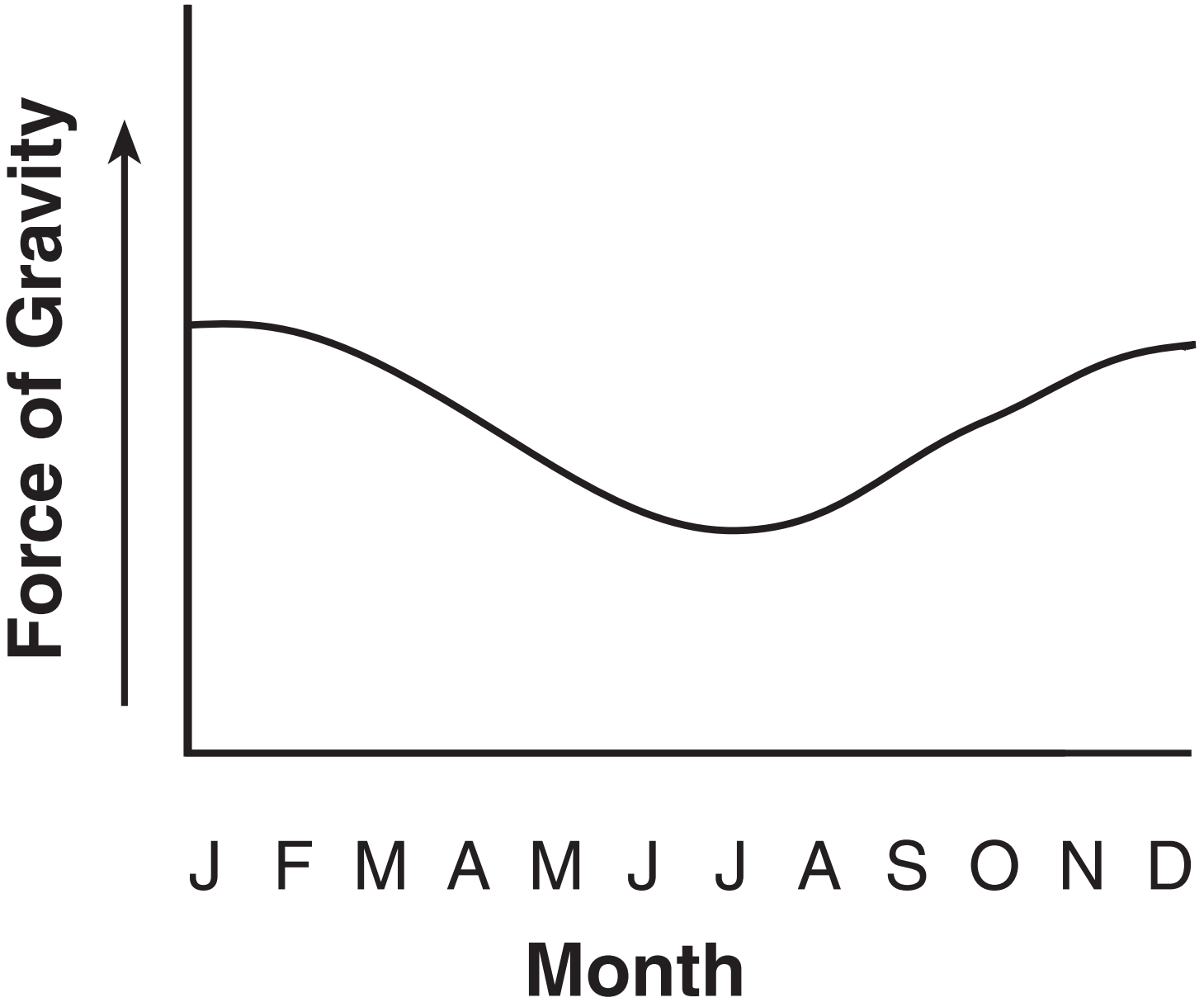


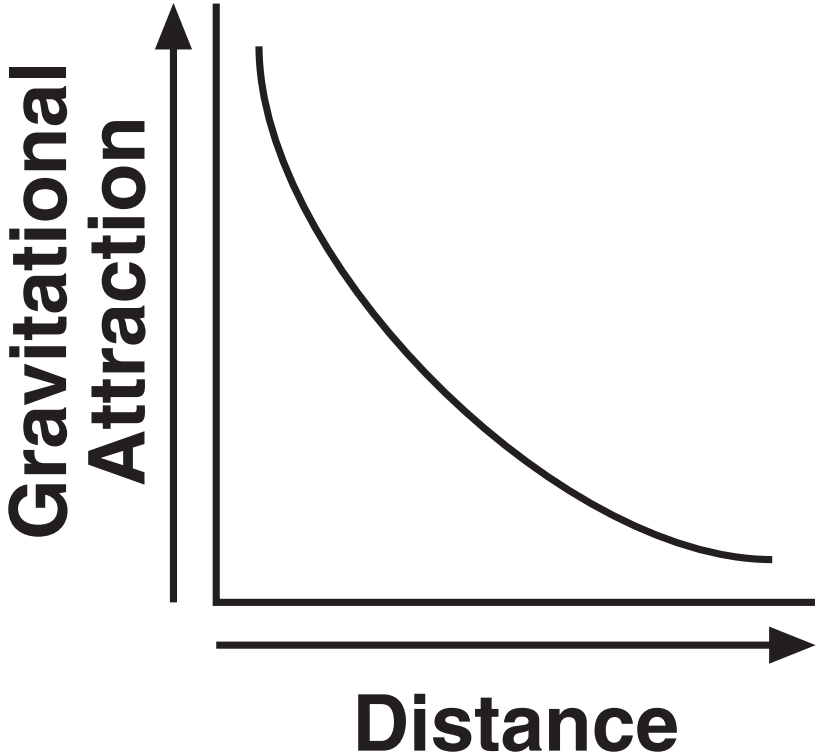

Swing
Apparent
change in
pendulum
direction
0
2
4
6
8 hours
Floor

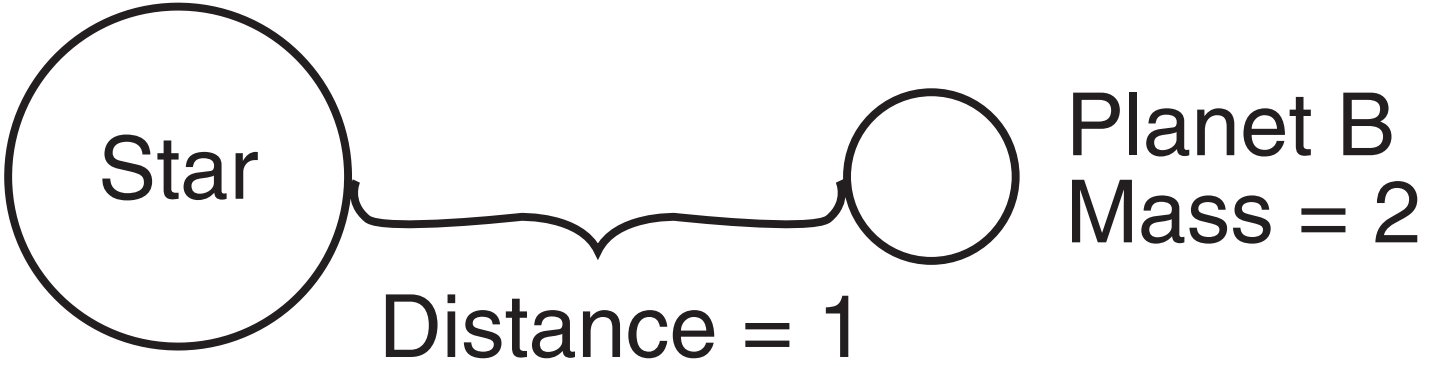

Stick
Pail
Weight
Stool

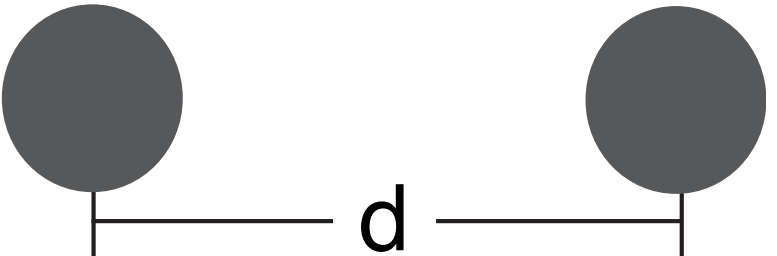

Swing
Wire 200 feet long
0
2
4
6
8 hours
Steel
ball
Floor


A
B
H
Star
C
G
D
F
E


Force of Gravity
J F M A M J J A S O N D
Month


Gravitational Attraction
Distance


Star
Planet B
Mass = 2
Distance = 1

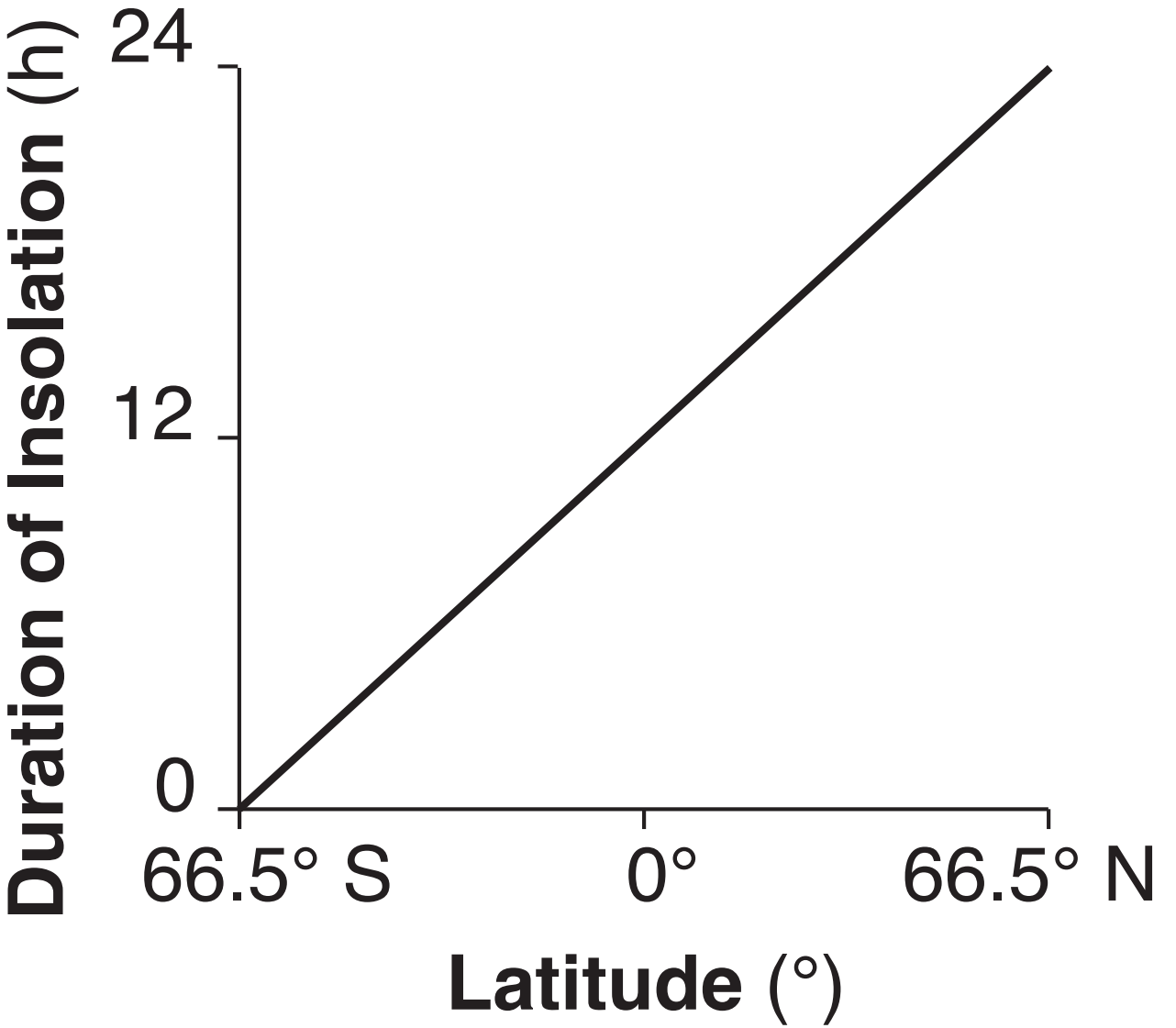

d

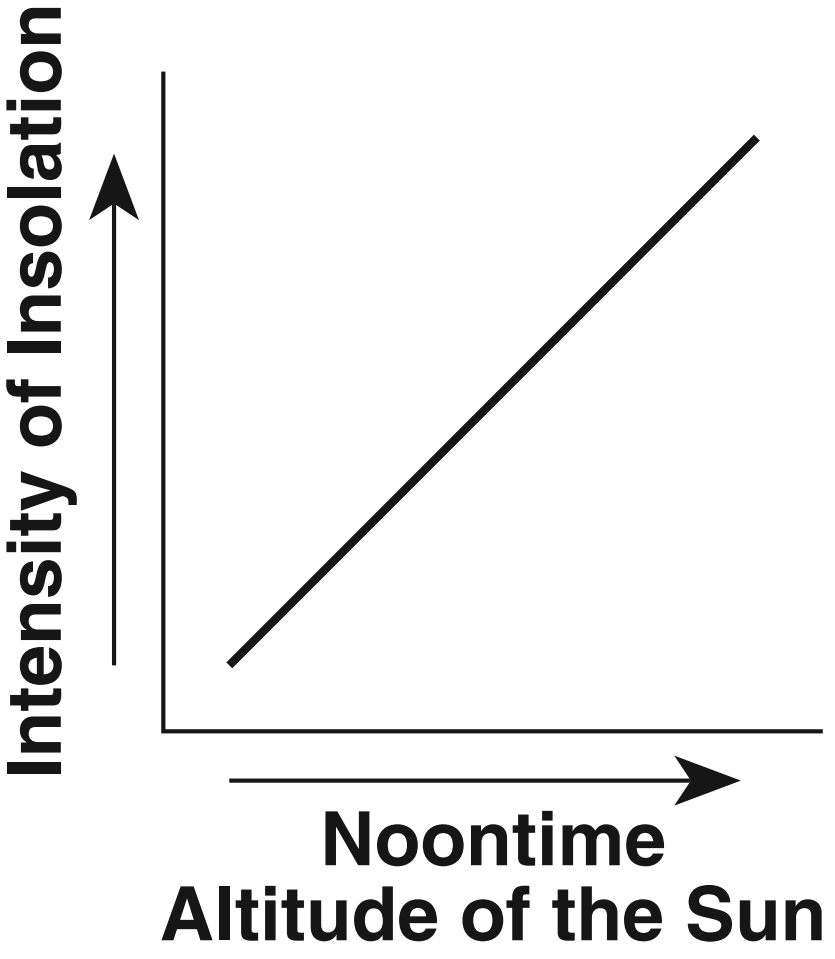
## Data Table

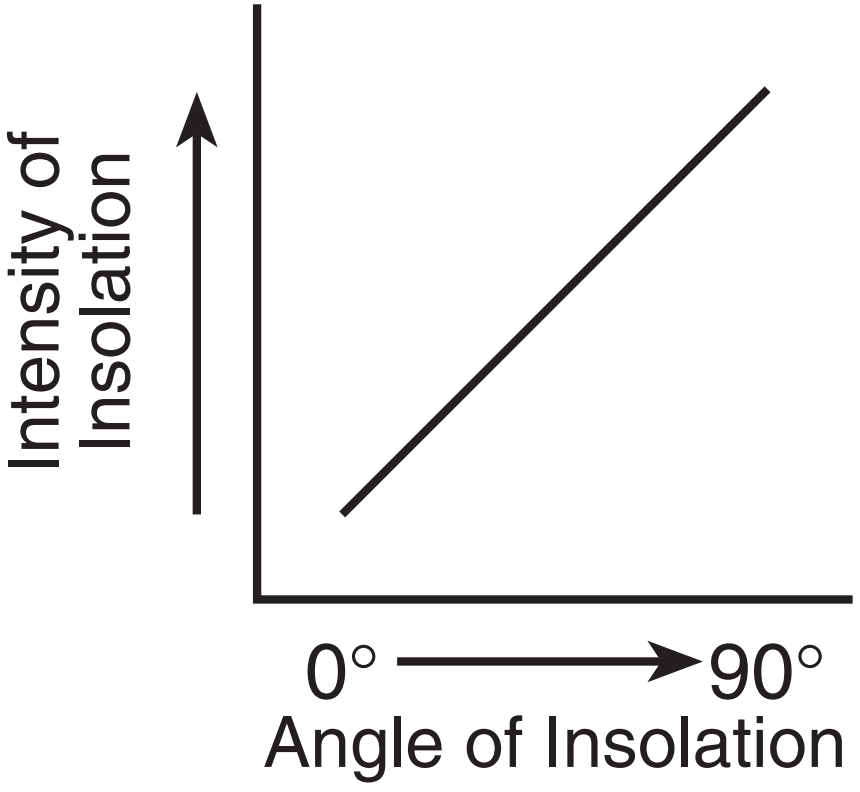
| Date | Hours of Daylight | Altitude of the Sun at Noon (°) |
|---|---|---|
| January 21 | 9.5 | 32.3 |
| February 21 | 10.8 | 40.1 |
| March 21 | 12.0 | 47.3 |
| April 21 | 13.7 | 55.1 |
| May 21 | 14.8 | 62.5 |
| June 21 | 15.3 | 70.4 |
| July 21 | 14.8 | 63.3 |
| August 21 | 13.7 | 55.5 |
| September 21 | 12.1 | 47.7 |
| October 21 | 10.8 | 39.9 |
| November 21 | 9.5 | 32.1 |
| December 21 | 9.0 | 24.4 |

## Data Table

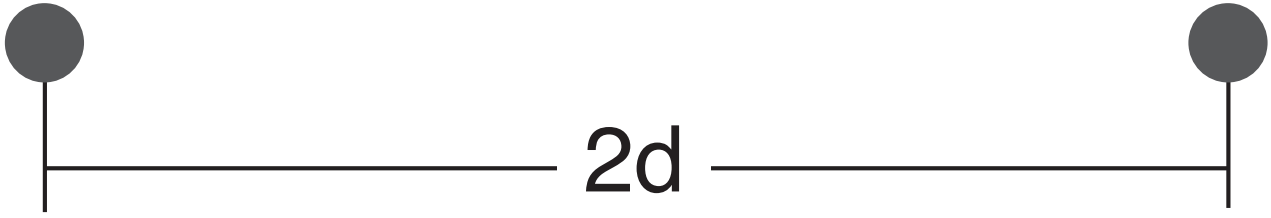
| **City** | **Latitude** (°N) | **Duration of Daylight** (hr) |
|---|---|---|
| Panama City, Panama | 9 | 11.6 |
| Mexico City, Mexico | 19 | 11.0 |
| Tampa, Florida | 28 | 10.4 |
| Memphis, Tennessee | 35 | 9.8 |
| Winnipeg, Canada | 50 | 8.1 |
| Churchill, Canada | 59 | 6.3 |
| Fairbanks, Alaska | 65 | 3.7 |

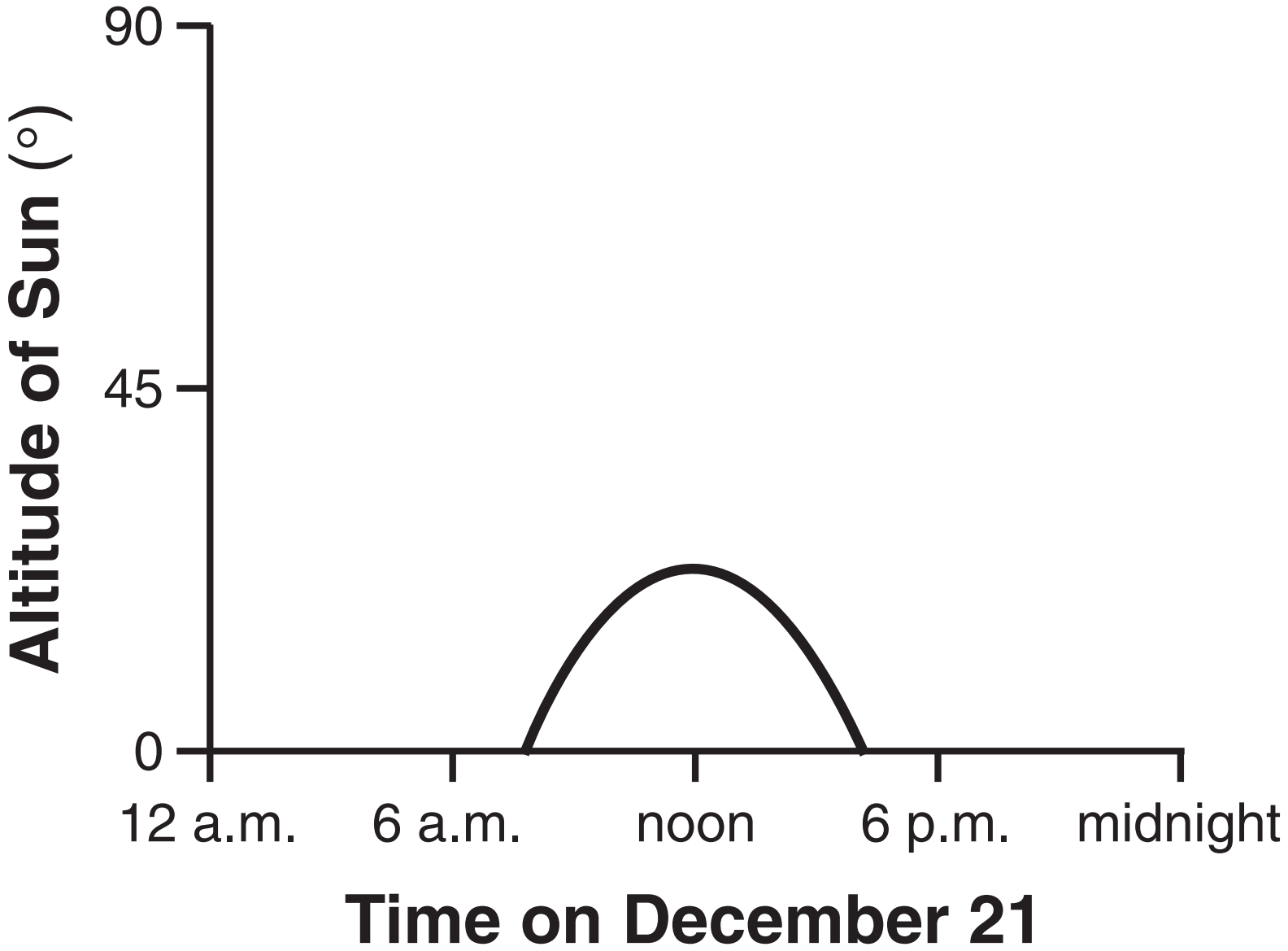

Duration of Insolation (h)
24
12
0
66.5° S
0°
66.5° N
Latitude (°)

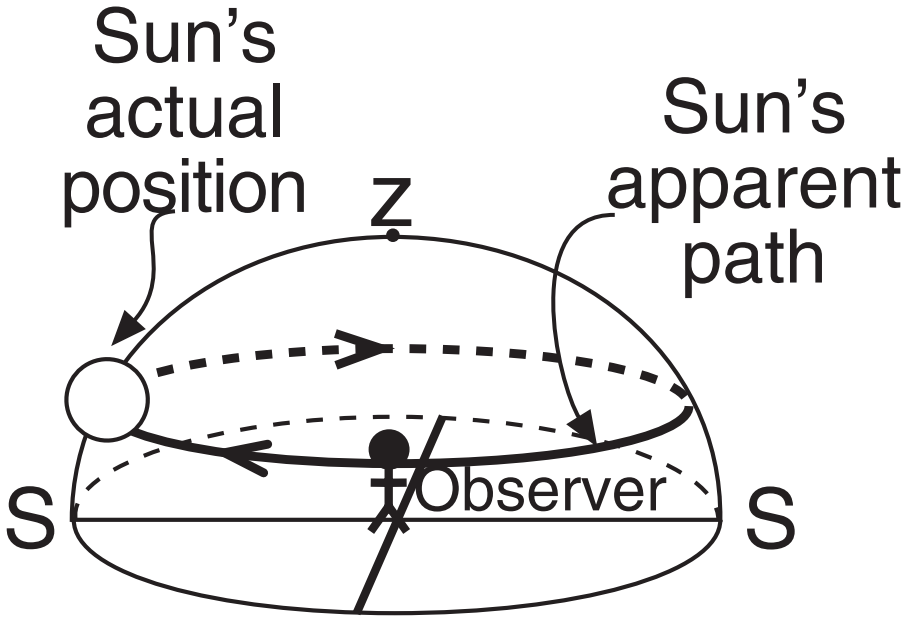

Intensity of Insolation
Noontime
Altitude of the Sun

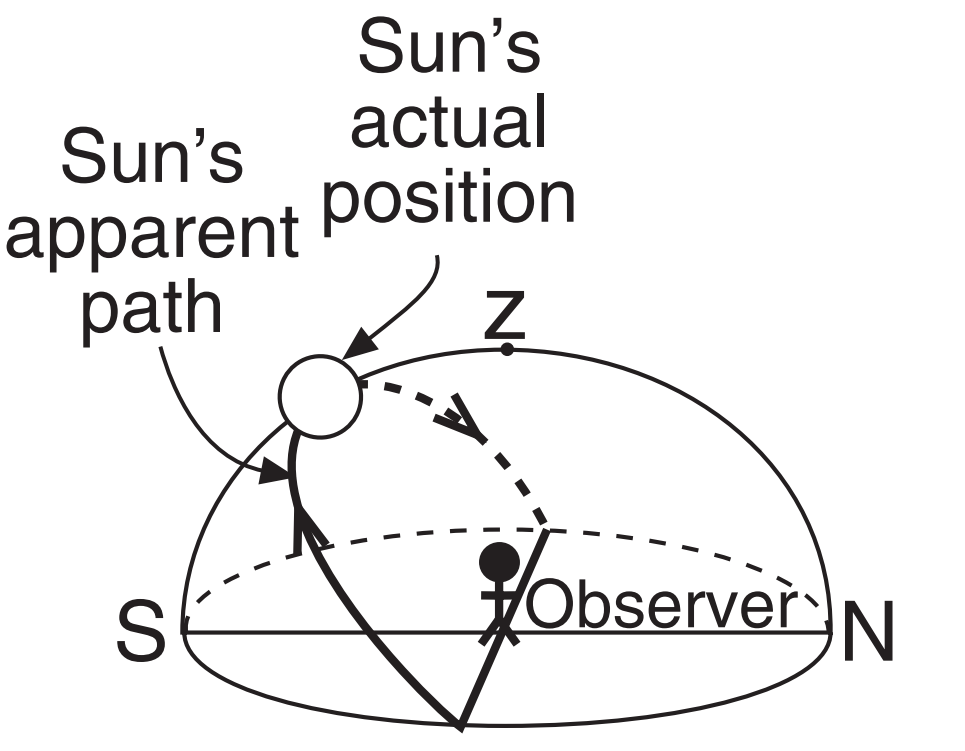

Intensity of Insolation
0°
90°
Angle of Insolation

| **Latitude** | **Day 1 Duration of Insolation** (hours) | **Day 2 Duration of Insolation** (hours) | **Day 3 Duration of Insolation** (hours) |
|---|---|---|---|
| 90° N | 24 | 12 | 0 |
| 80° N | 24 | 12 | 0 |
| 70° N | 24 | 12 | 0 |
| 60° N | $18\frac{1}{2}$ | 12 | $5\frac{1}{2}$ |
| 50° N | $16\frac{1}{4}$ | 12 | $7\frac{3}{4}$ |
| 40° N | 15 | 12 | 9 |
| 30° N | 14 | 12 | 10 |
| 20° N | $13\frac{1}{4}$ | 12 | $10\frac{3}{4}$ |
| 10° N | $12\frac{1}{2}$ | 12 | $11\frac{1}{2}$ |
| 0° | 12 | 12 | 12 |

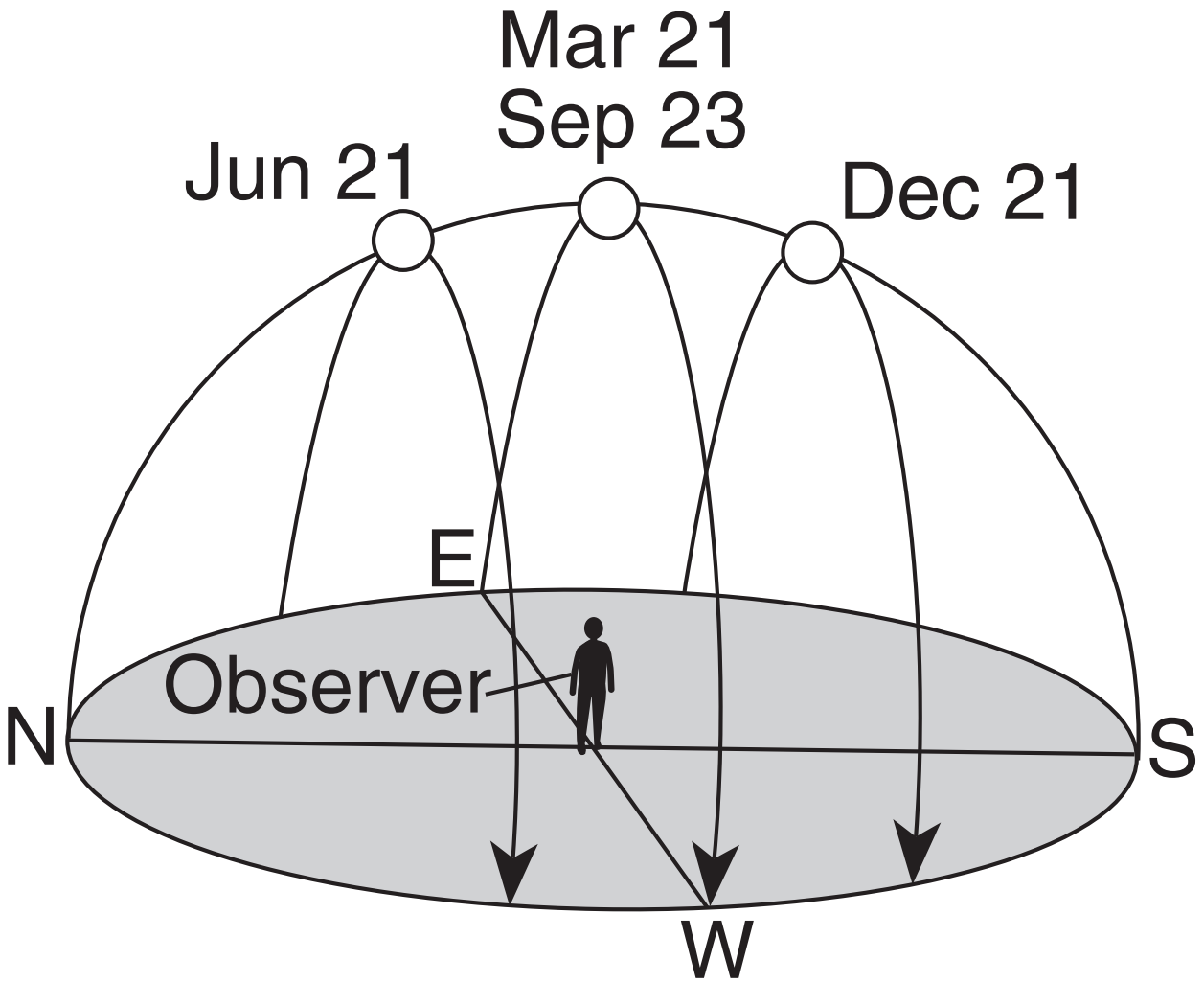

2d


90
45
0
Altitude of Sun (°)
12 a.m.
6 a.m.
noon
6 p.m.
midnight
Time on December 21

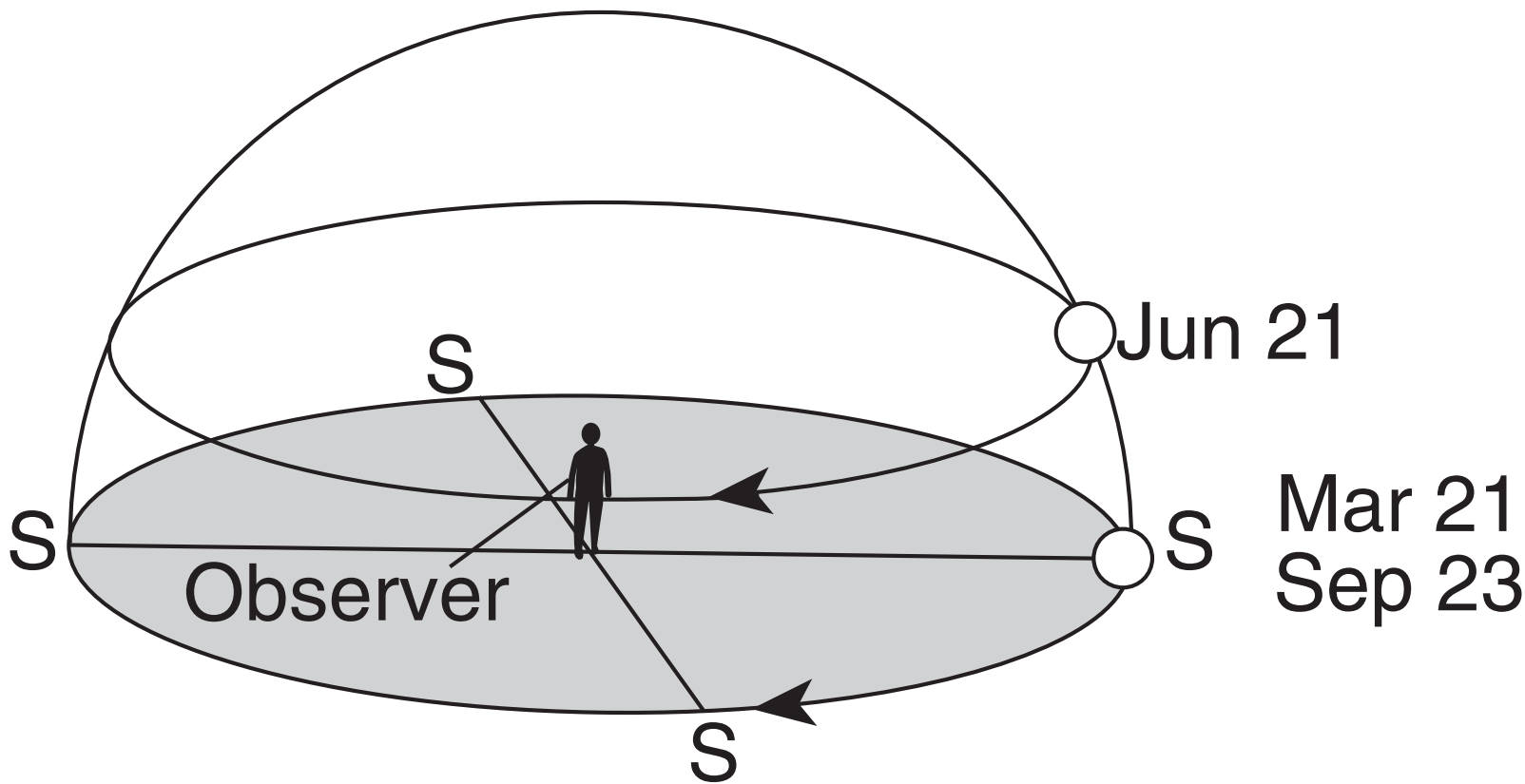

Sun's
actual
position
Z
Sun's
apparent
path
Observer
S
S


Sun's
actual
position
Sun's
apparent
path
Z
Observer
S
N

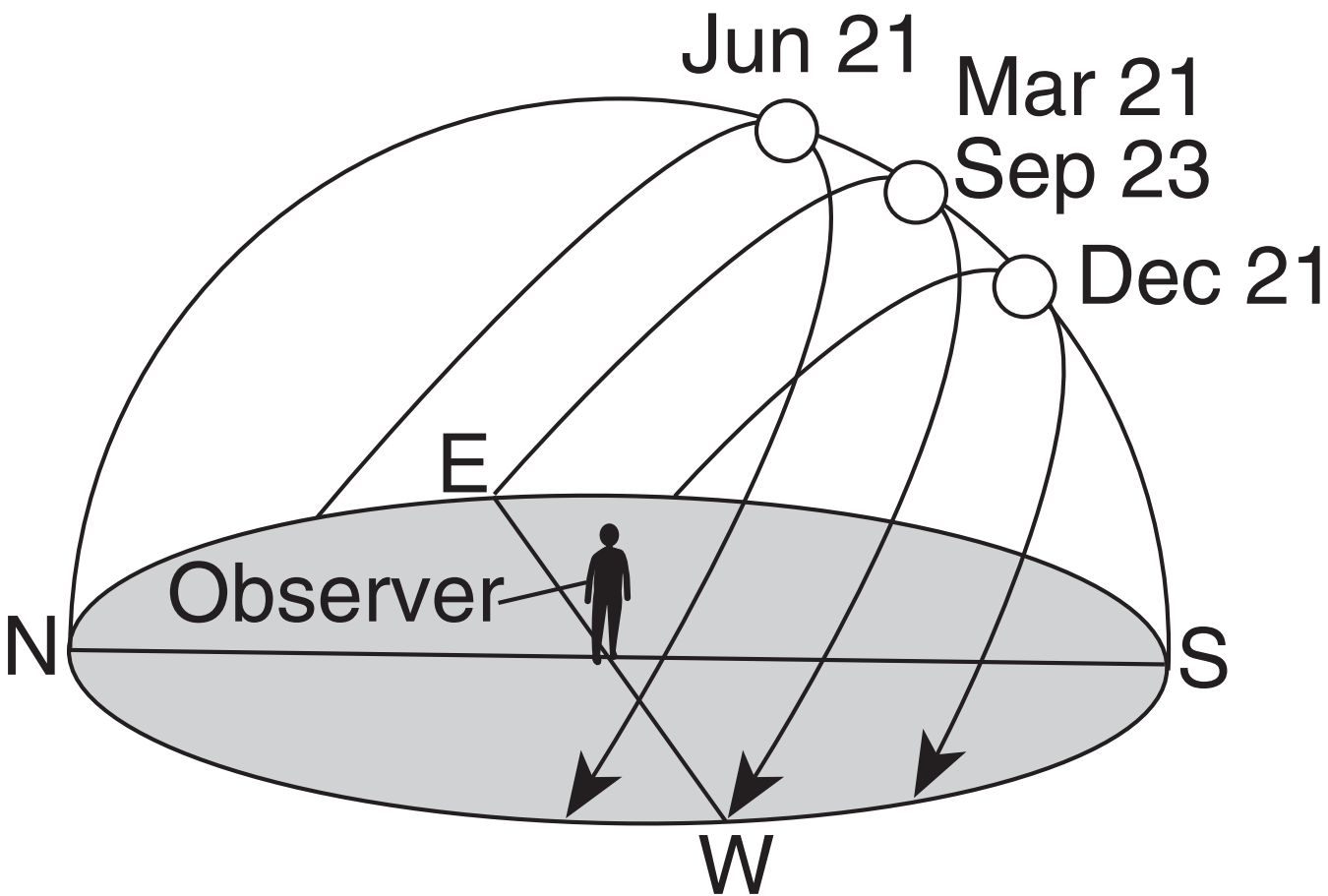
# Location A

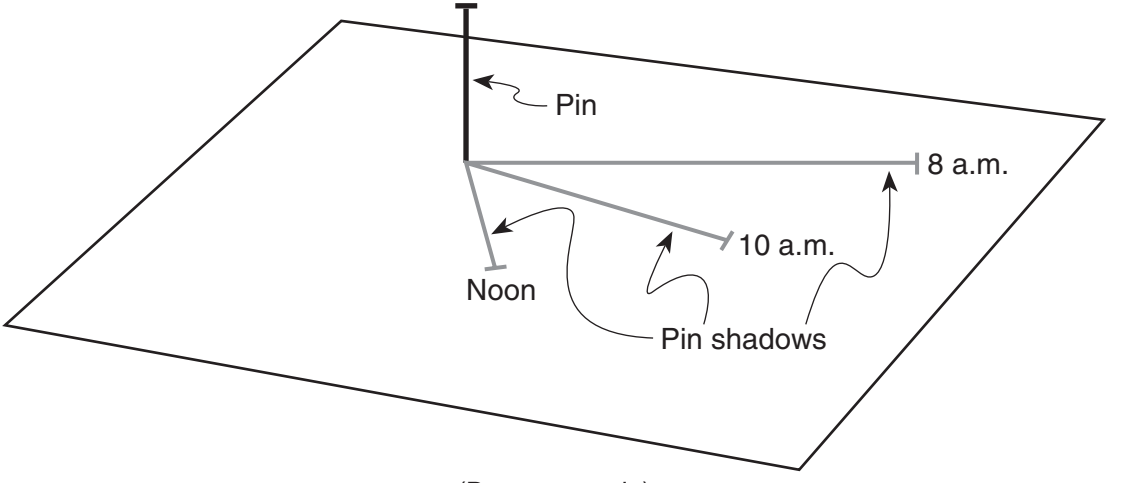


# Location C

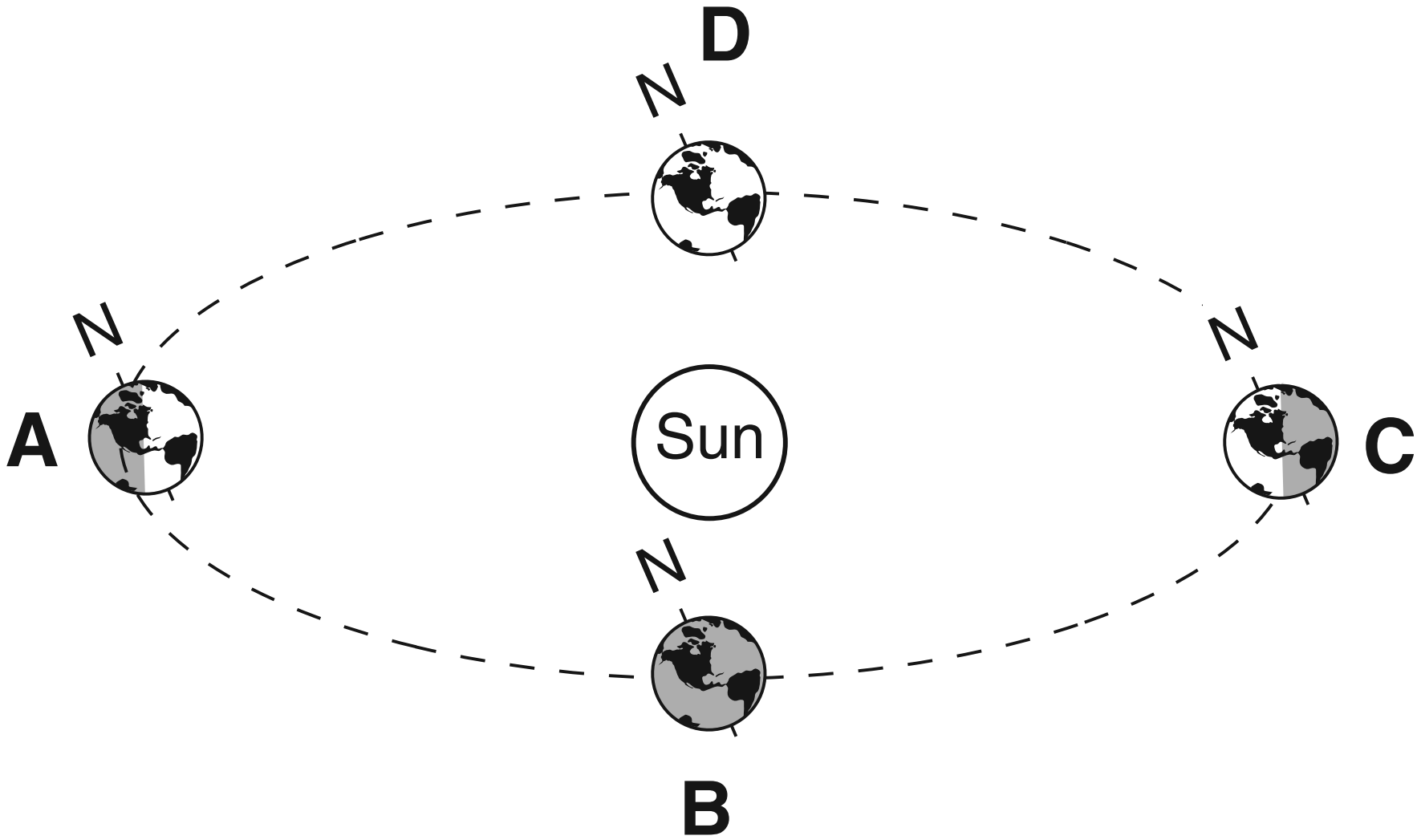


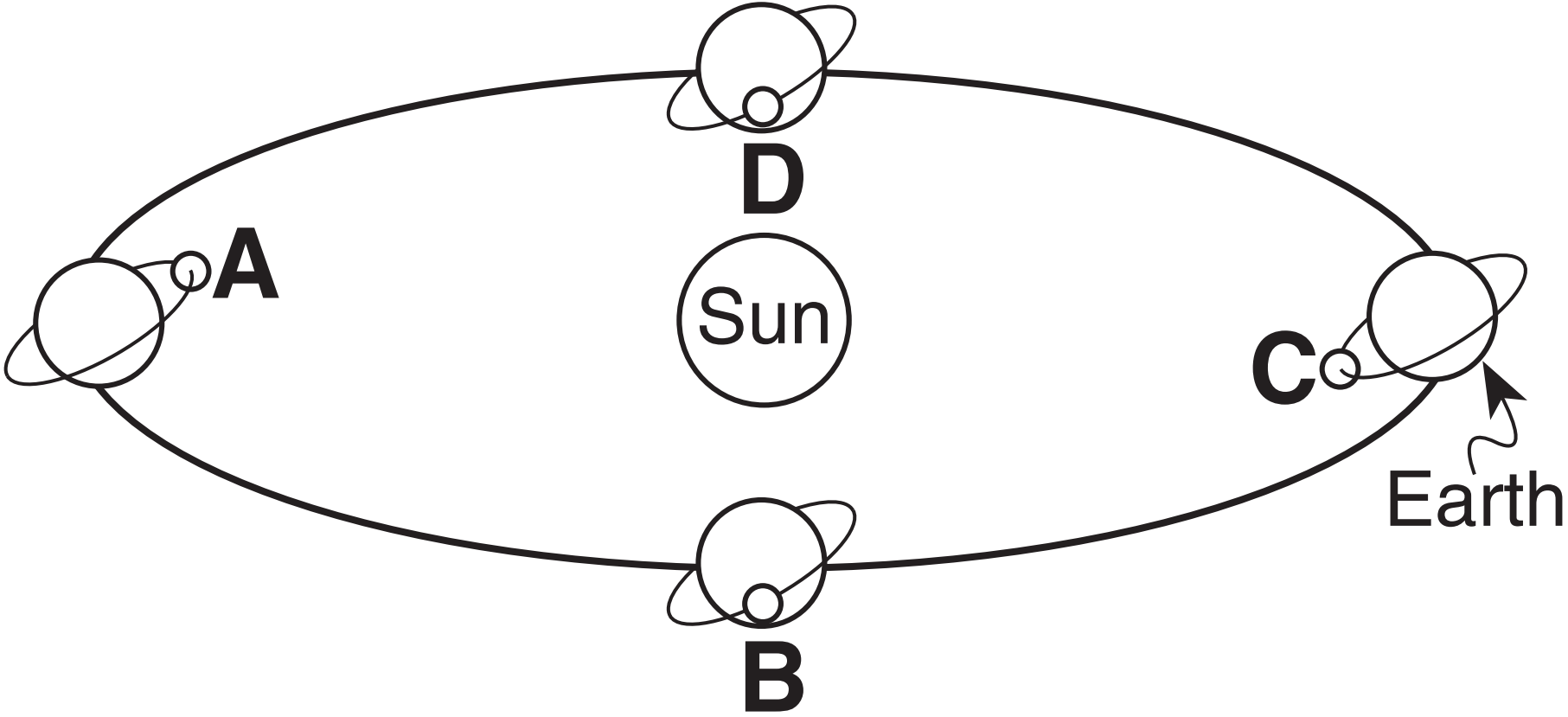
# Location B



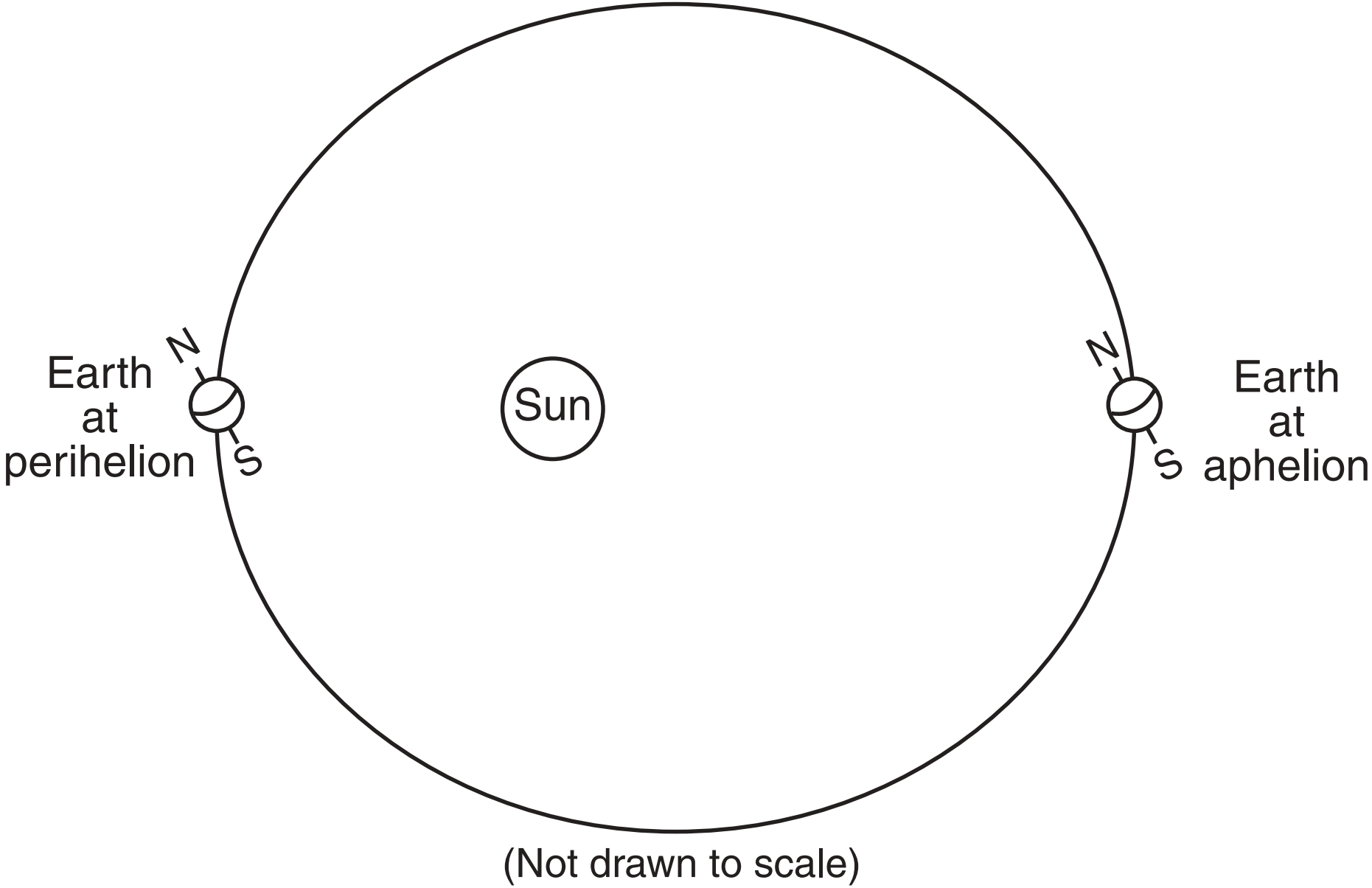


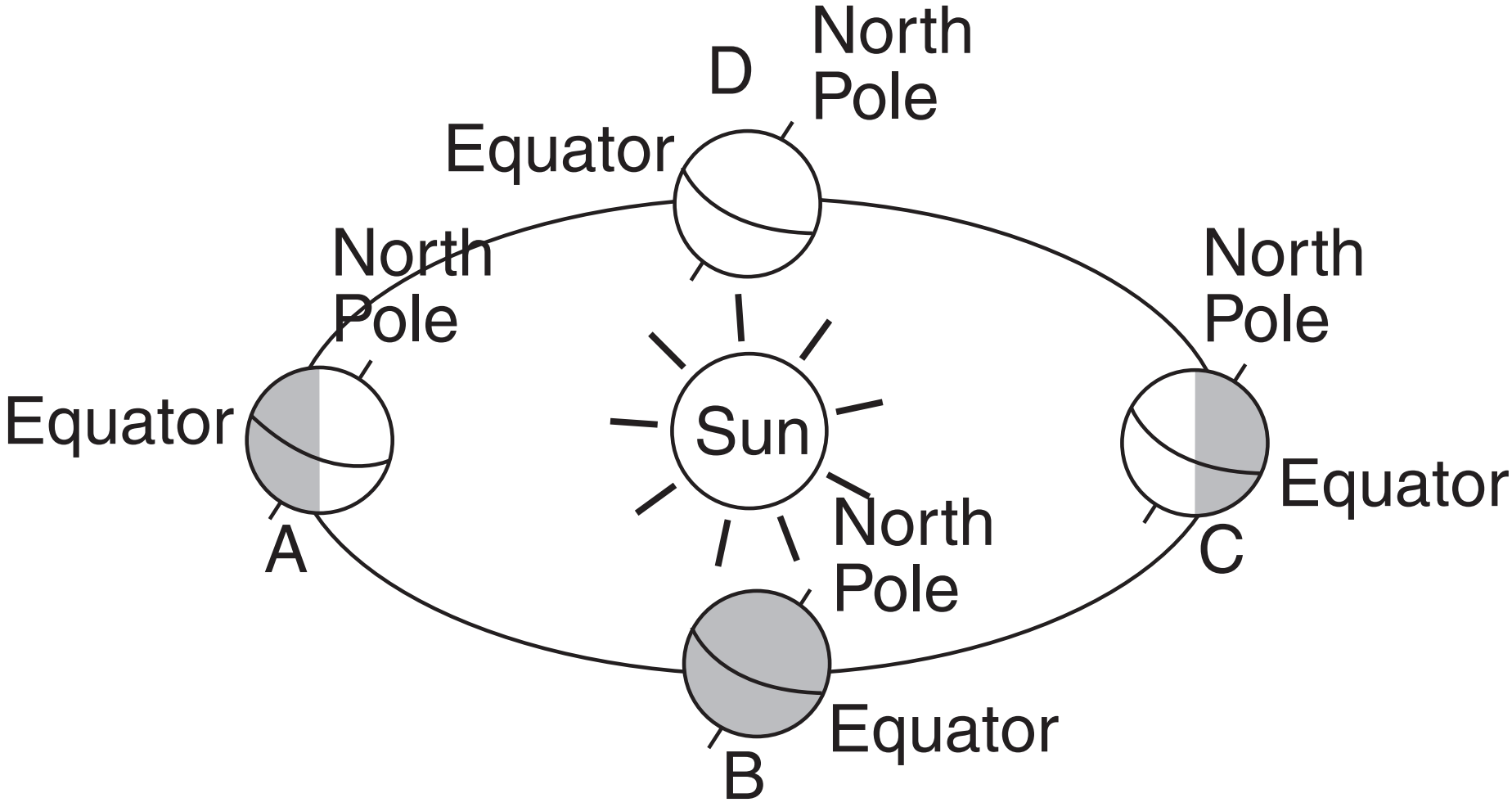

(Drawn to scale)


D
N
A
N
Sun
N
C
N
B

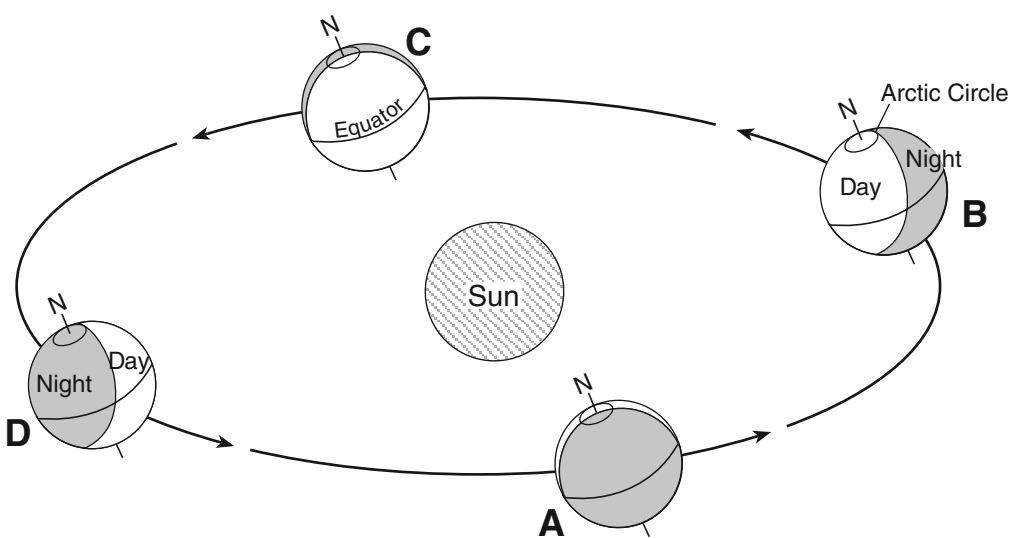


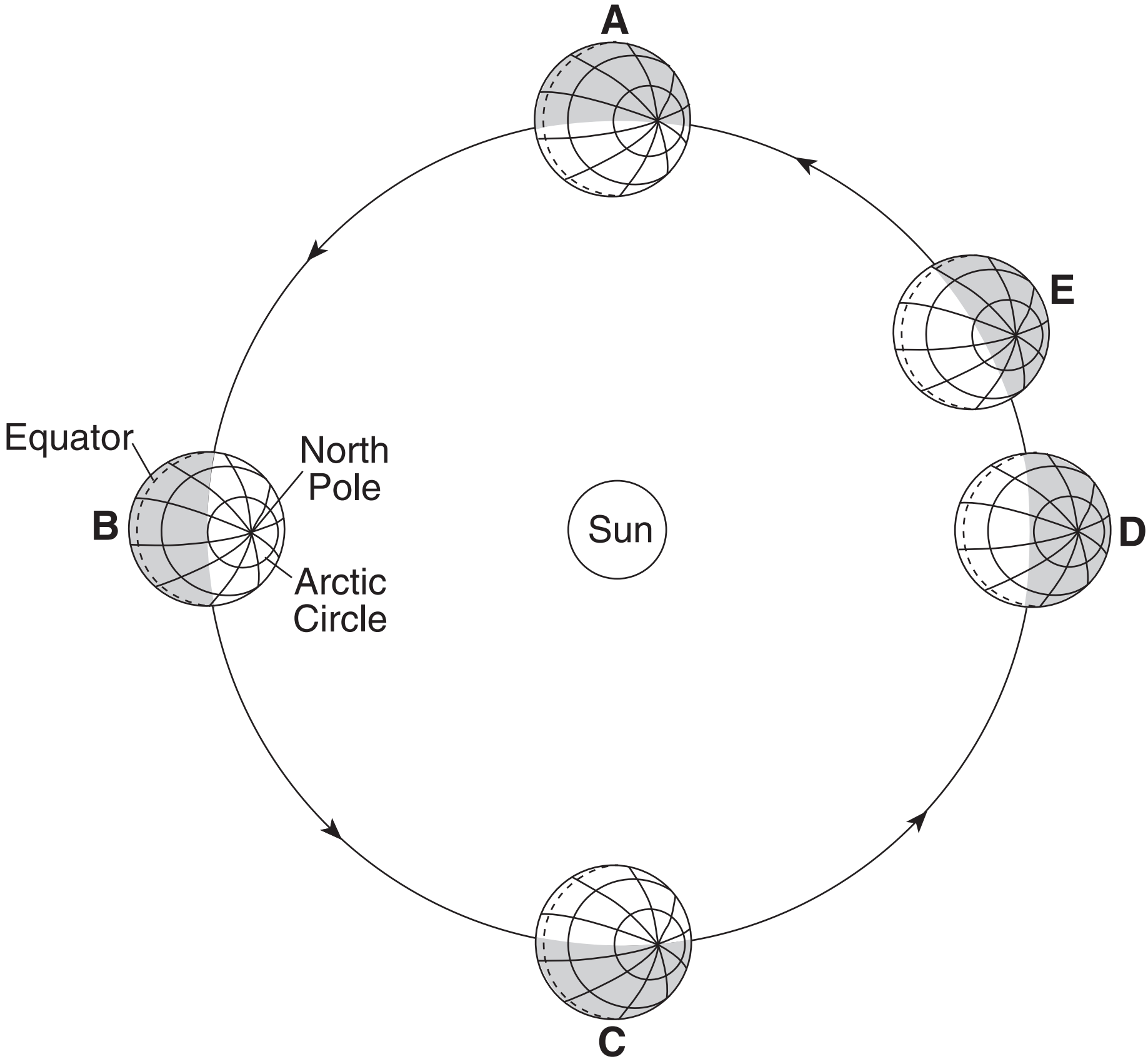

(Not drawn to scale)

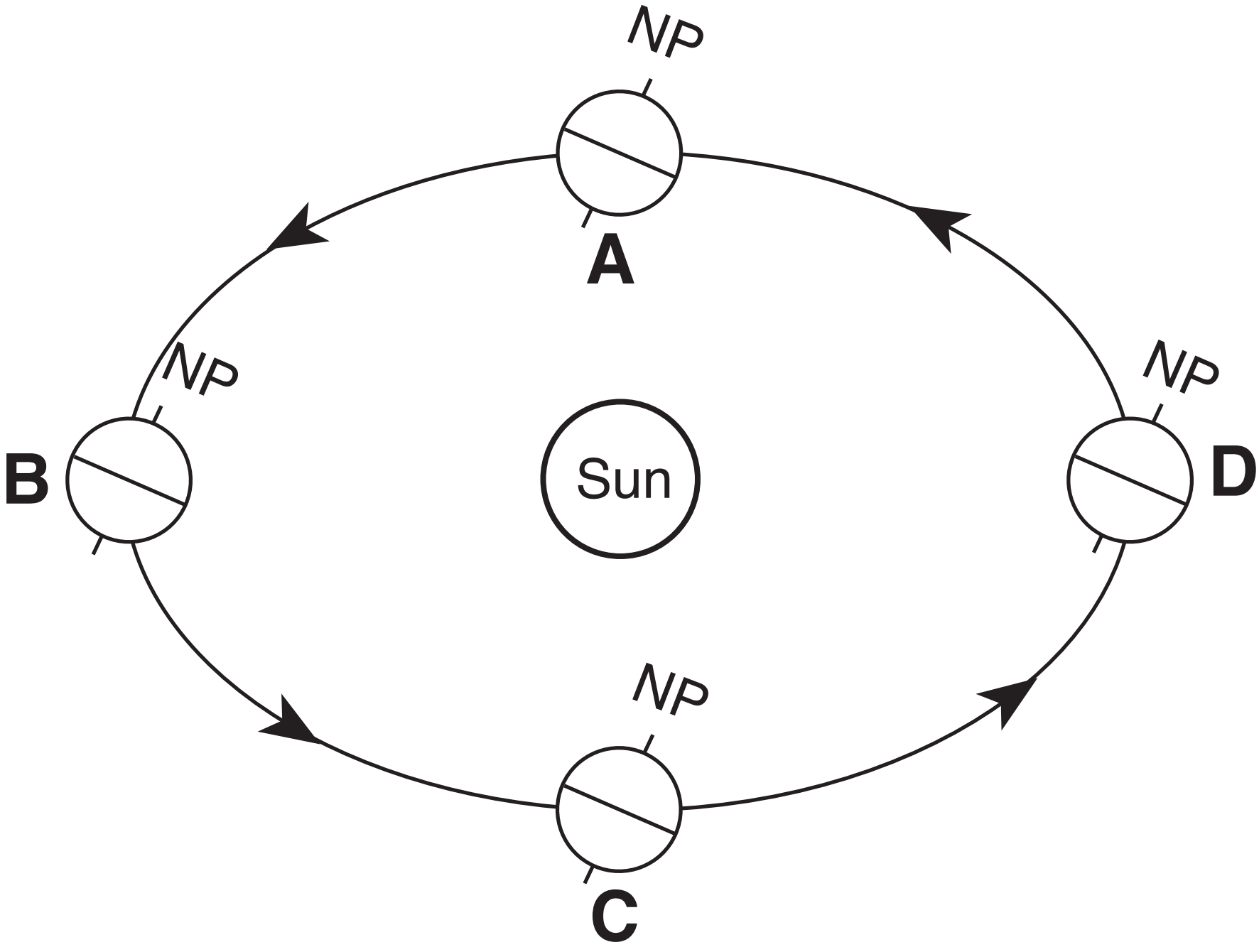

Earth
at
perihelion
N
S
Sun
N
S
Earth
at
aphelion
(Not drawn to scale)

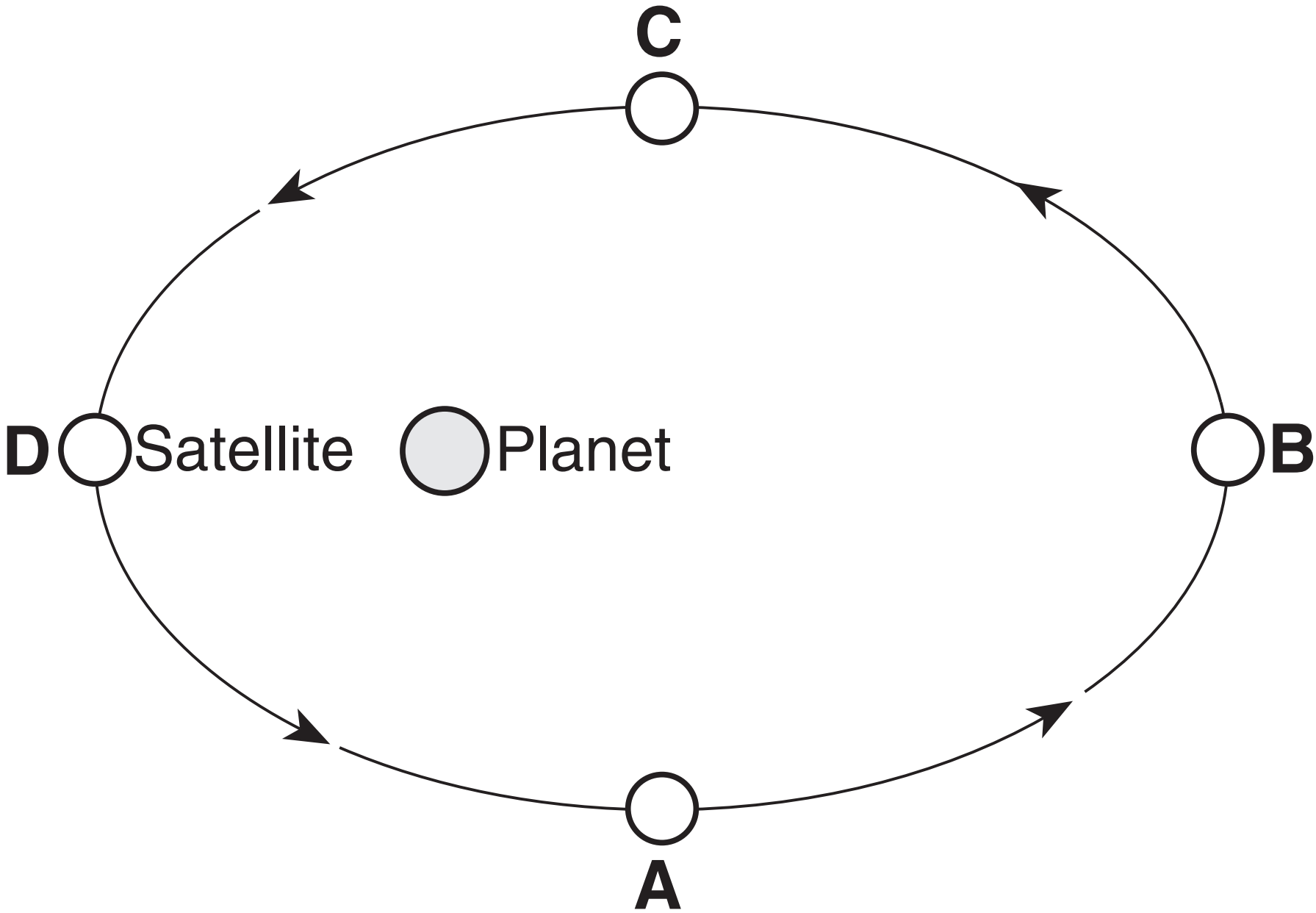



(Not drawn to scale)

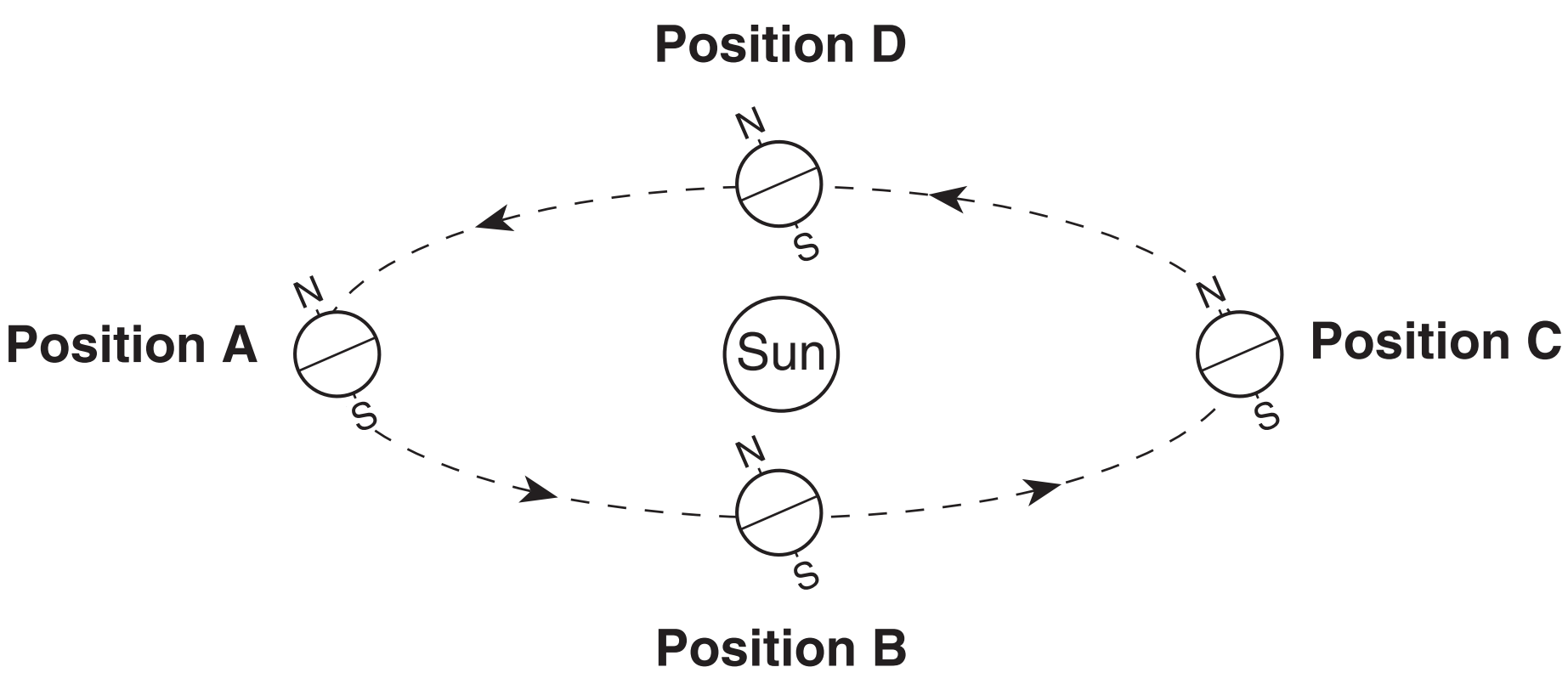

N
C
Equator
Arctic Circle
N
Night
Day
B
Sun
N
Night
Day
D
N
A

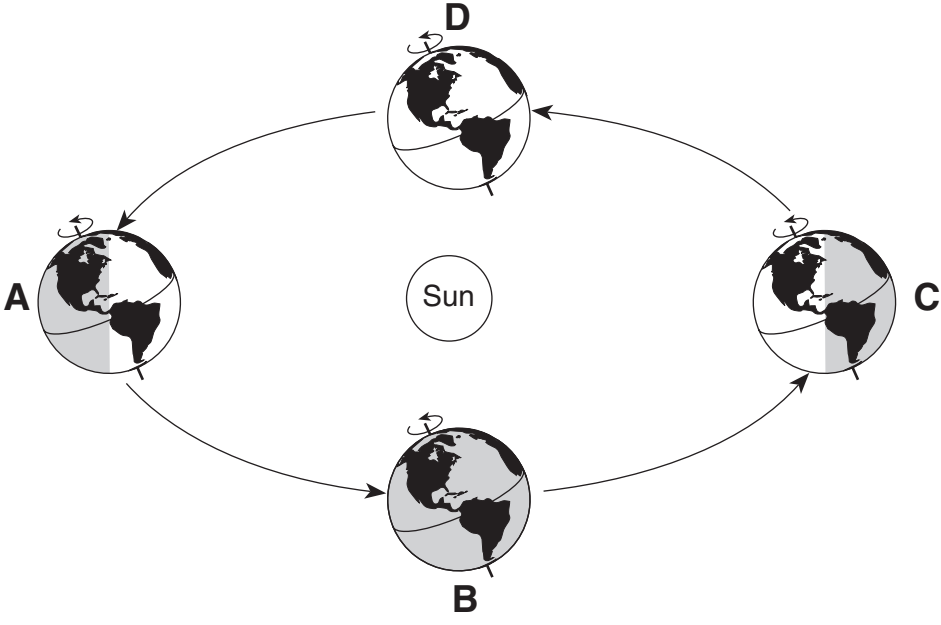

A
B
C
D
E
Equator
North Pole
Arctic Circle
Sun

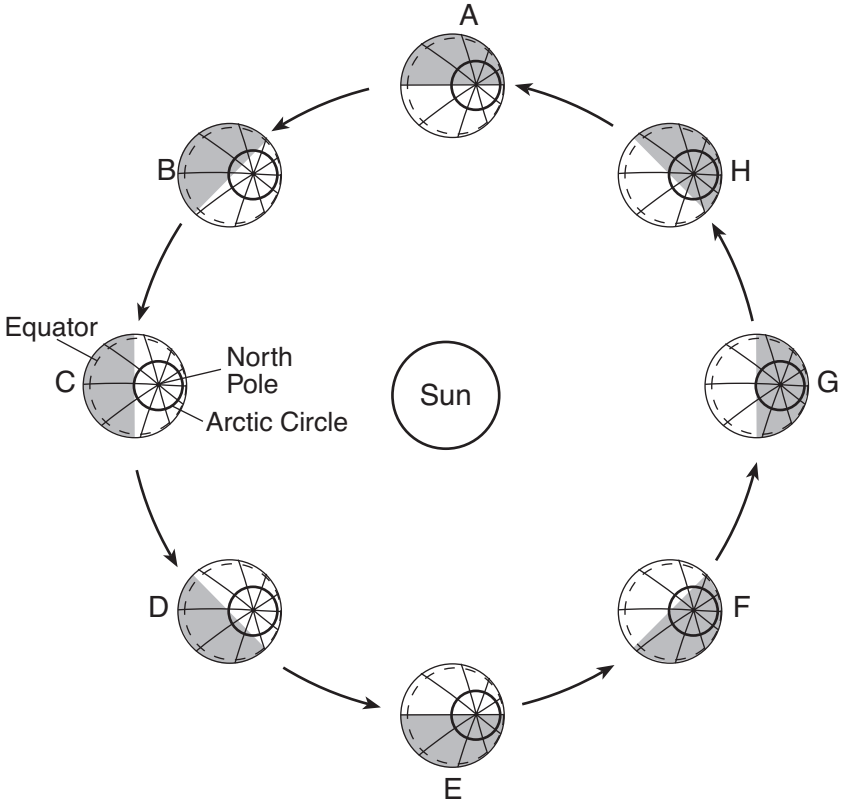

NP
A
NP
B
Sun
NP
D
NP
C

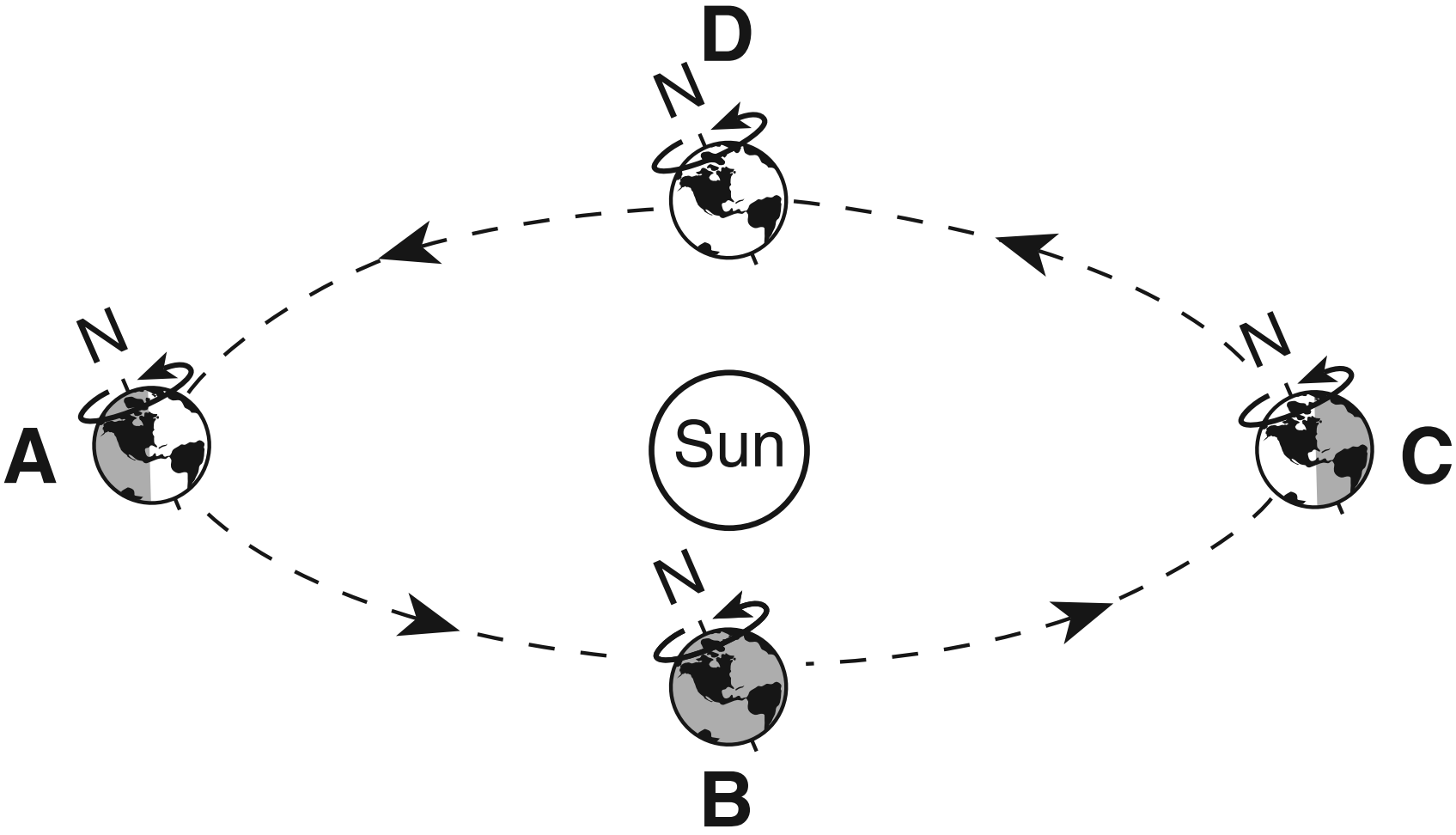


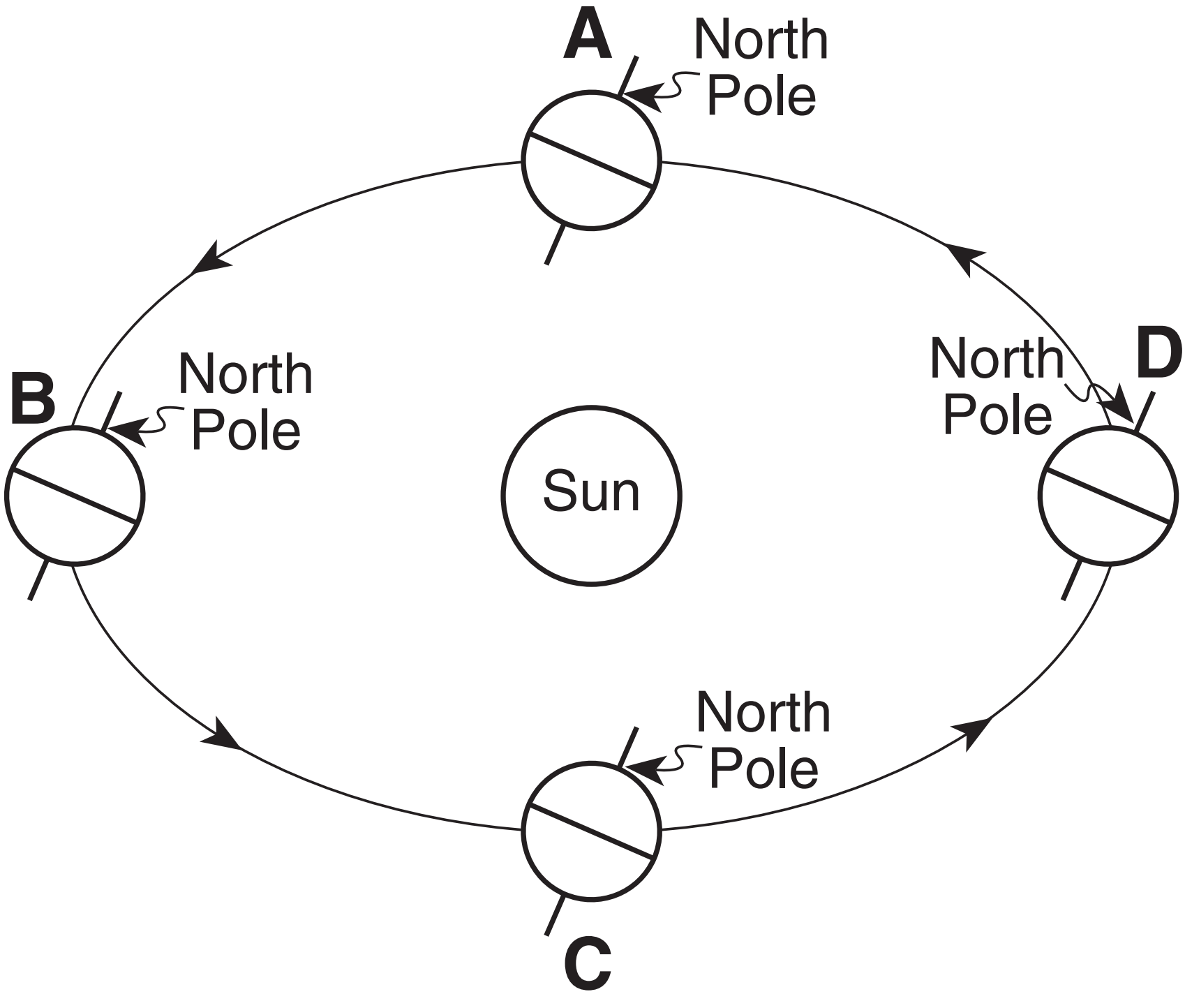

(Not drawn to scale)

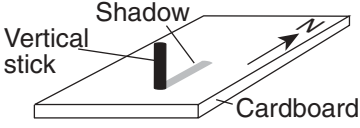
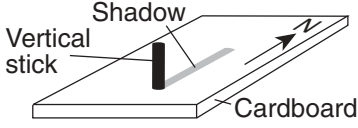
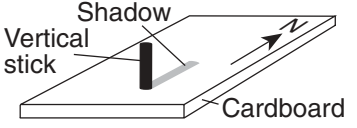

Position D
N
S
Position A
N
S
Sun
N
S
Position C
N
S
Position B

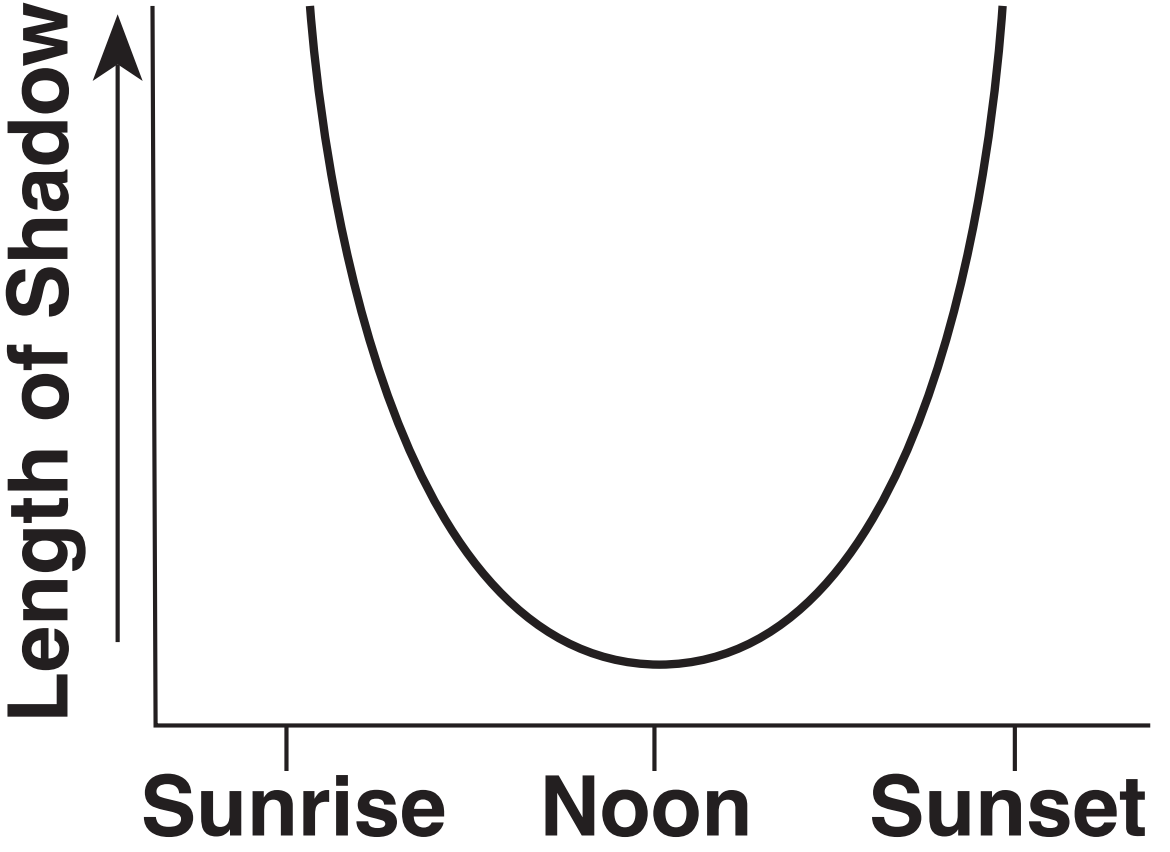

D
A
Sun
C
B

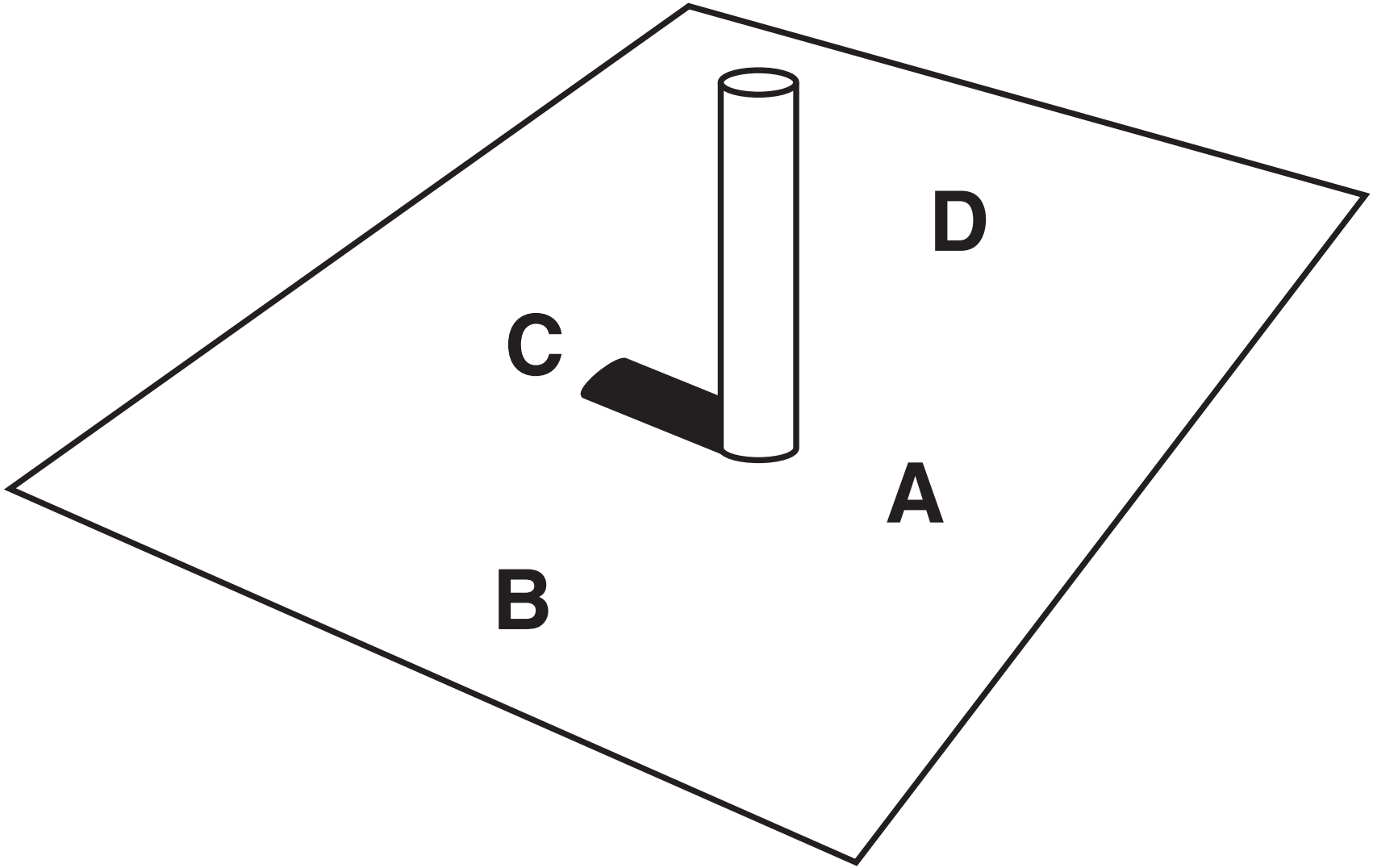

A
B
C
D
E
F
G
H
Equator
North Pole
Arctic Circle
Sun

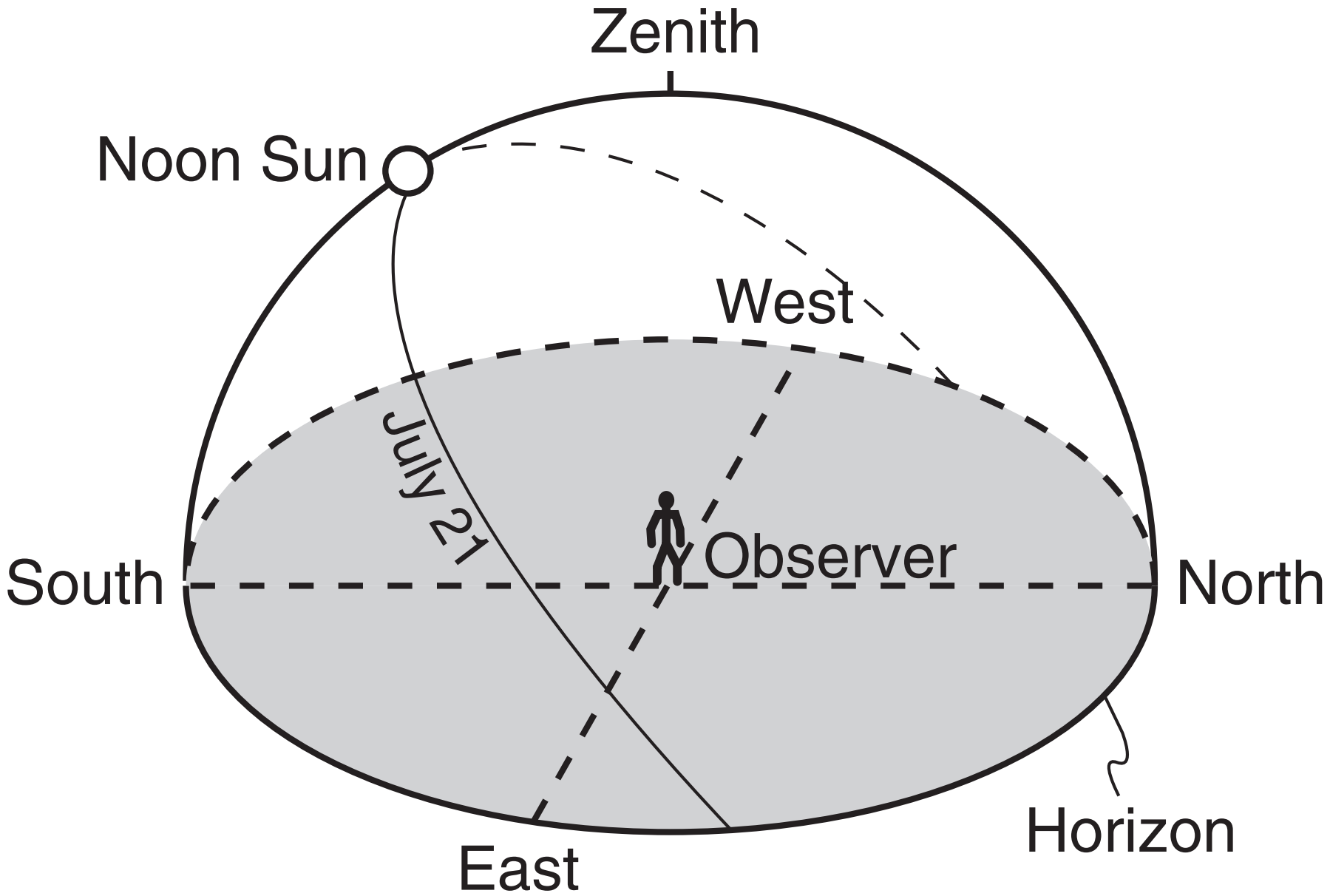

D
N
A
N
Sun
C
N
N
B

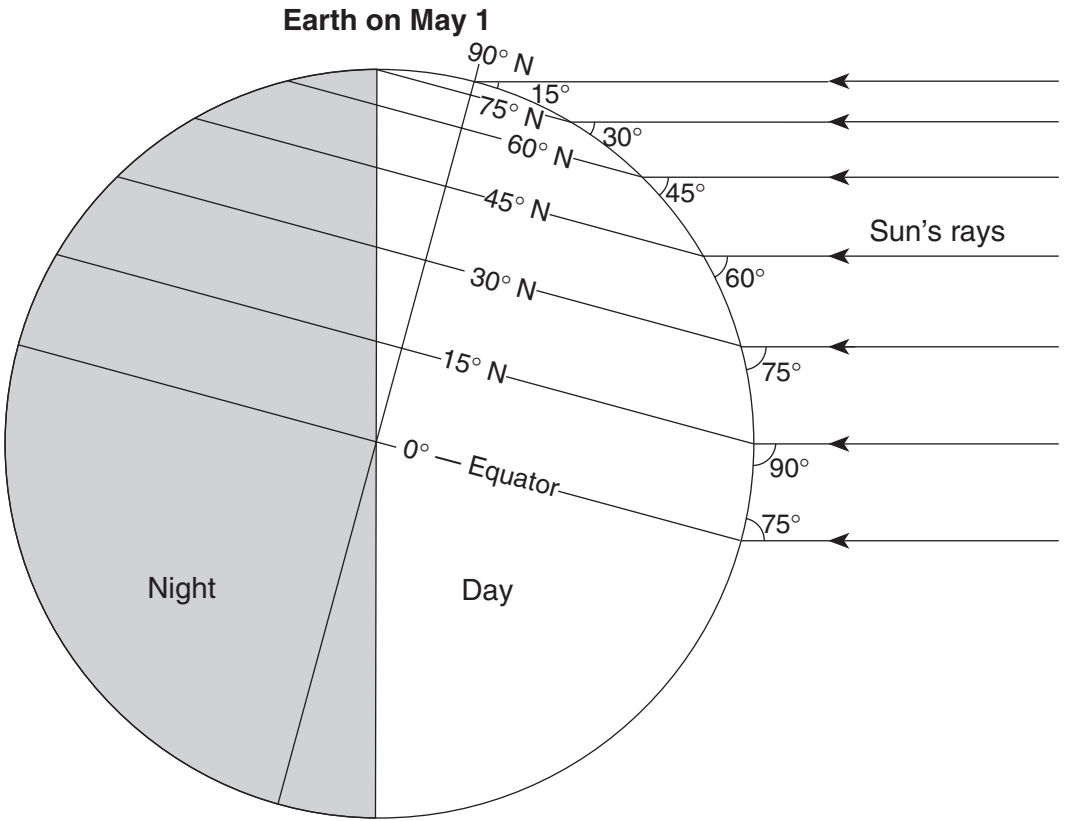

A
North Pole
B
North Pole
Sun
North Pole
D
North Pole
C

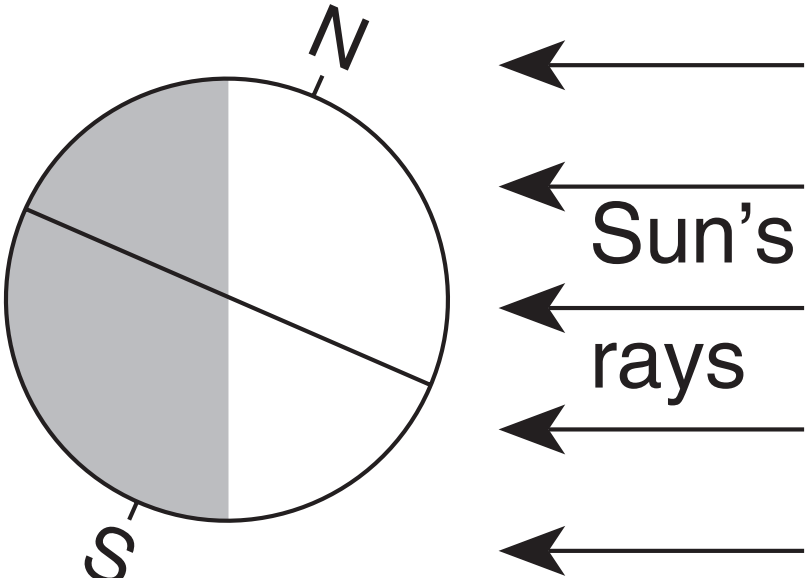
| Diagram I | Diagram II | Diagram III |
| --- | --- | --- |
| September 23 | December 21 | March 21 |
|  |  |  |
| Shadow length = 10 cm | Shadow length = 17.5 cm | Shadow length = 10 cm |

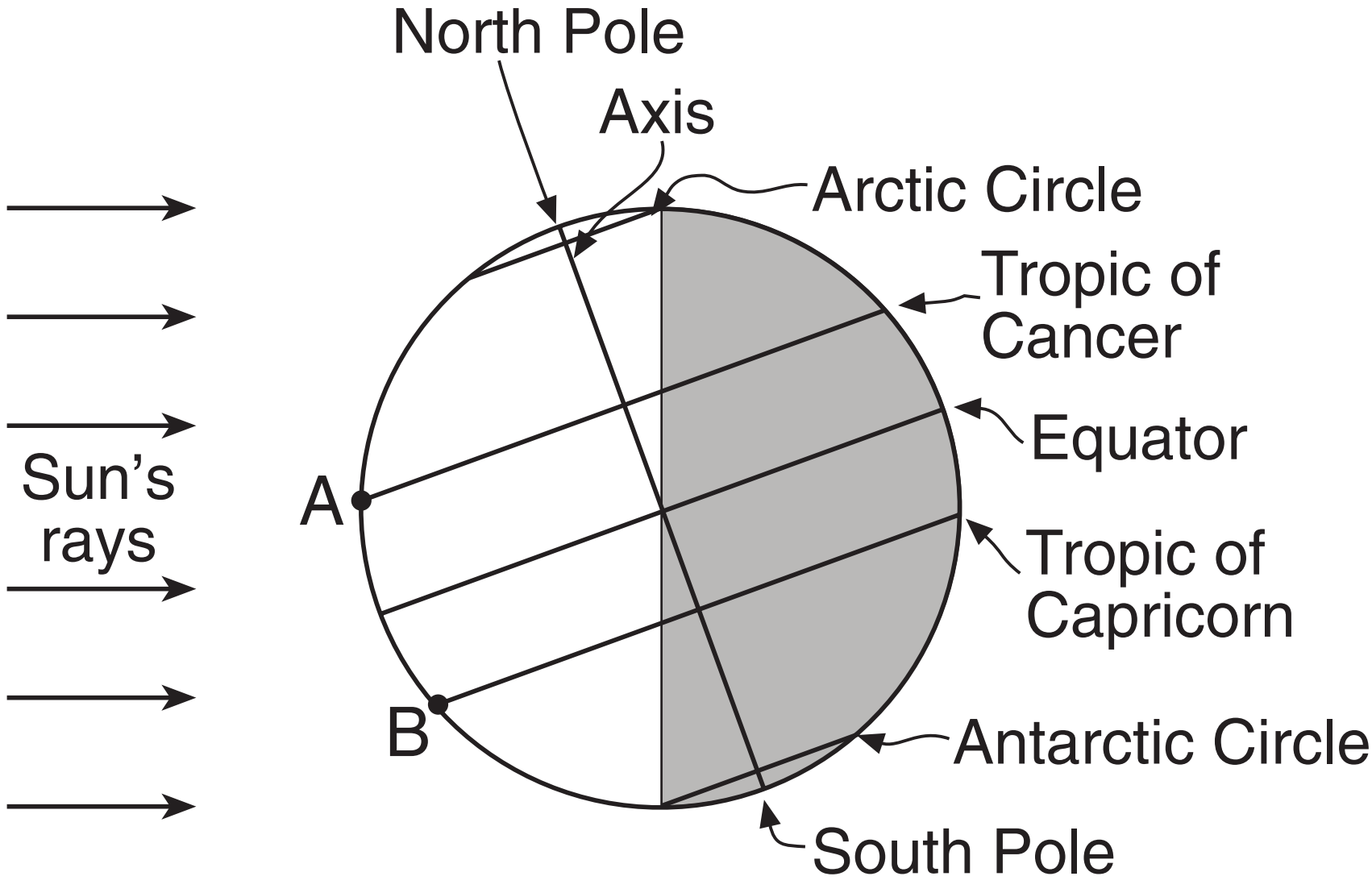

Length of Shadow
Sunrise
Noon
Sunset

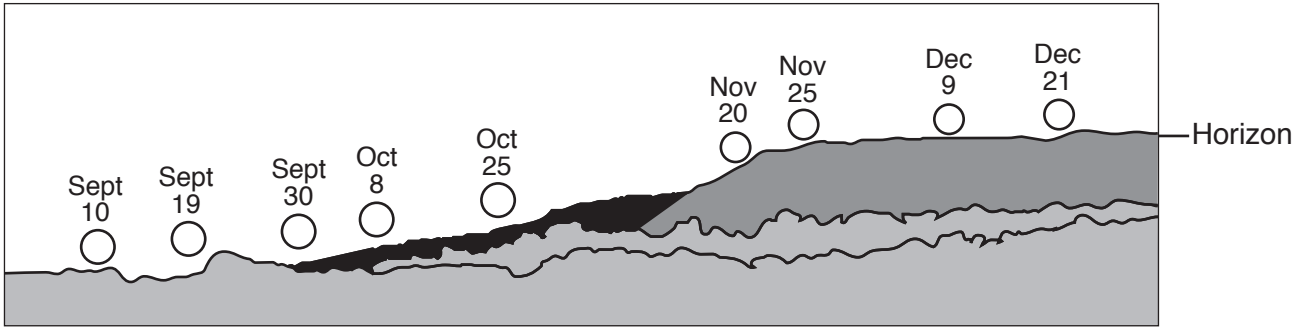

D
C
A
B

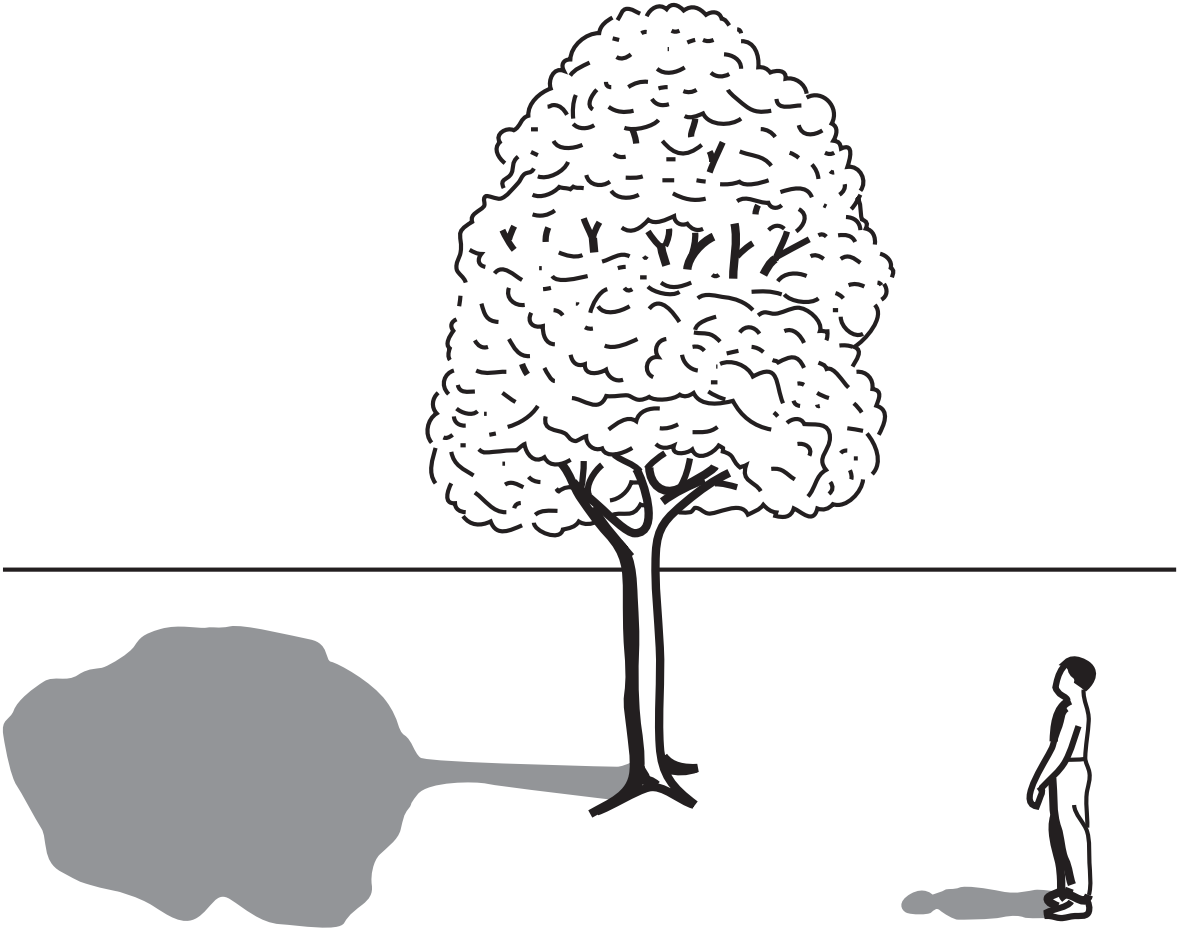

Zenith
Noon Sun
West
July 21
Observer
South
North
East
Horizon

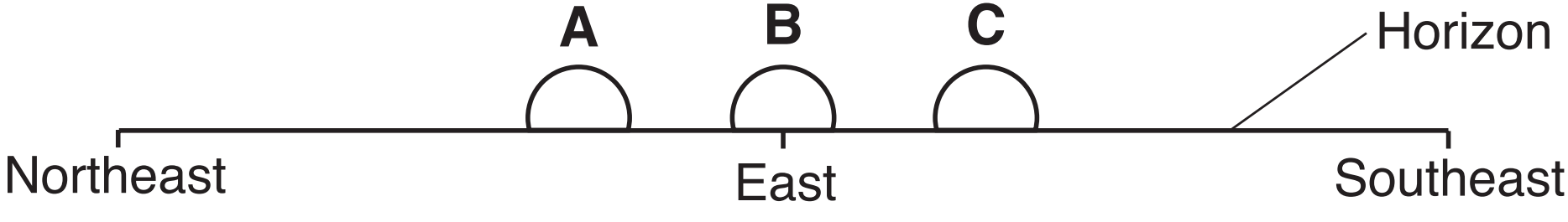

Earth on May 1
90° N
15°
75° N
30°
60° N
45°
45° N
Sun's rays
60°
30° N
75°
15° N
90°
0° — Equator
75°
Night
Day


N
S
Sun's
rays


North Pole
Axis
Arctic Circle
Tropic of Cancer
Equator
Tropic of Capricorn
Antarctic Circle
South Pole
Sun's rays
A
B

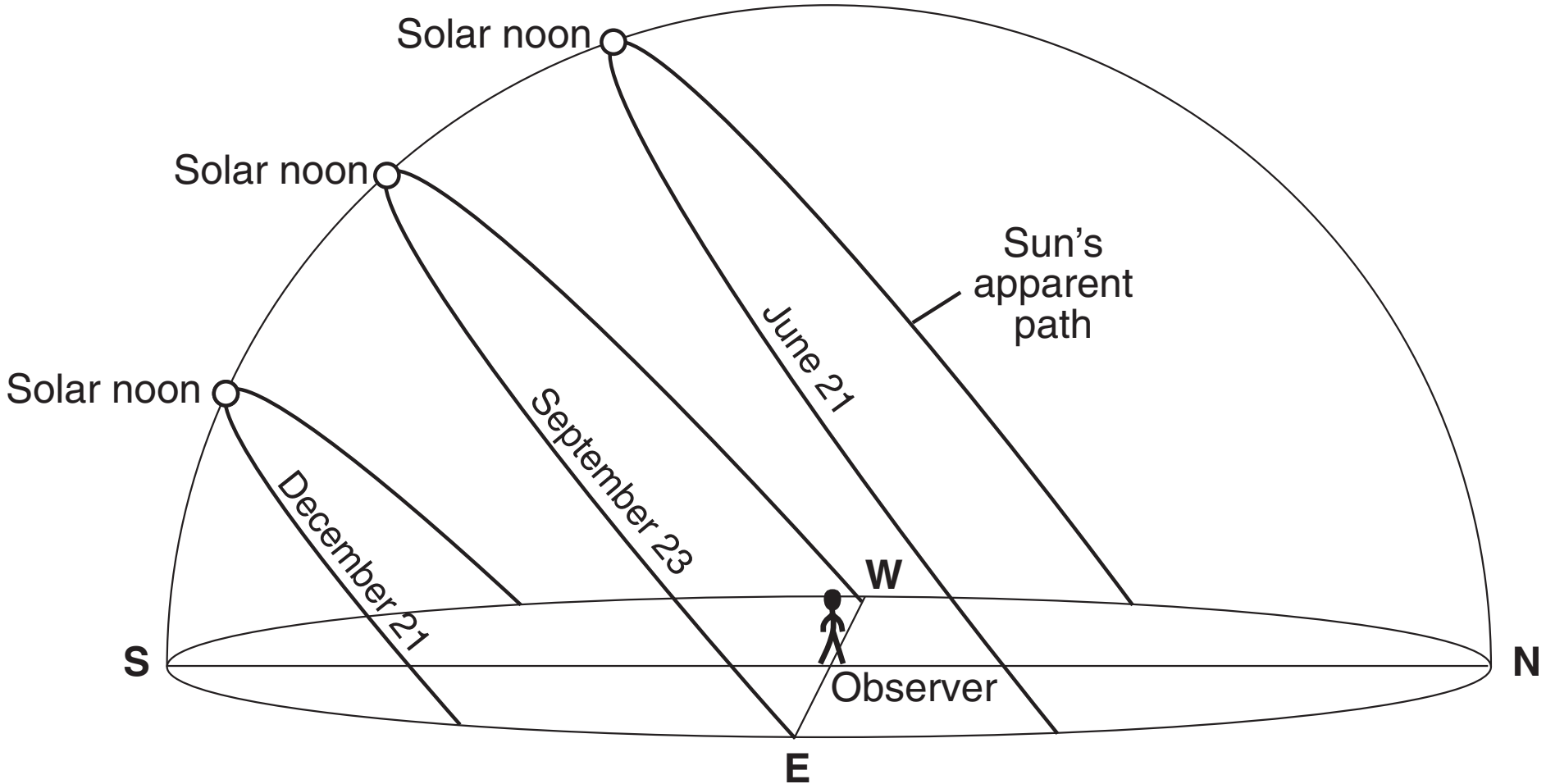

Sept 10
Sept 19
Sept 30
Oct 8
Oct 25
Nov 20
Nov 25
Dec 9
Dec 21
Horizon

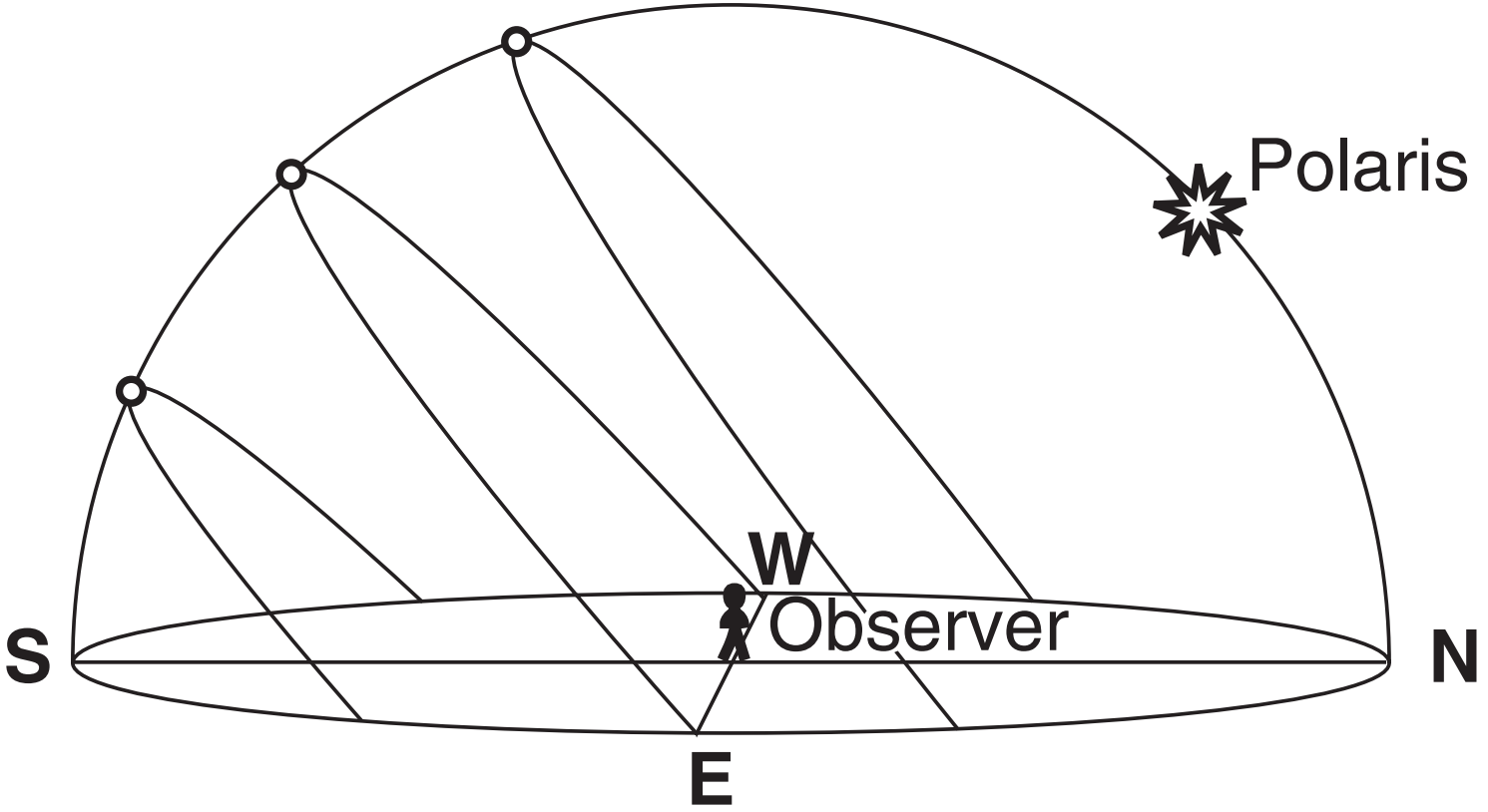


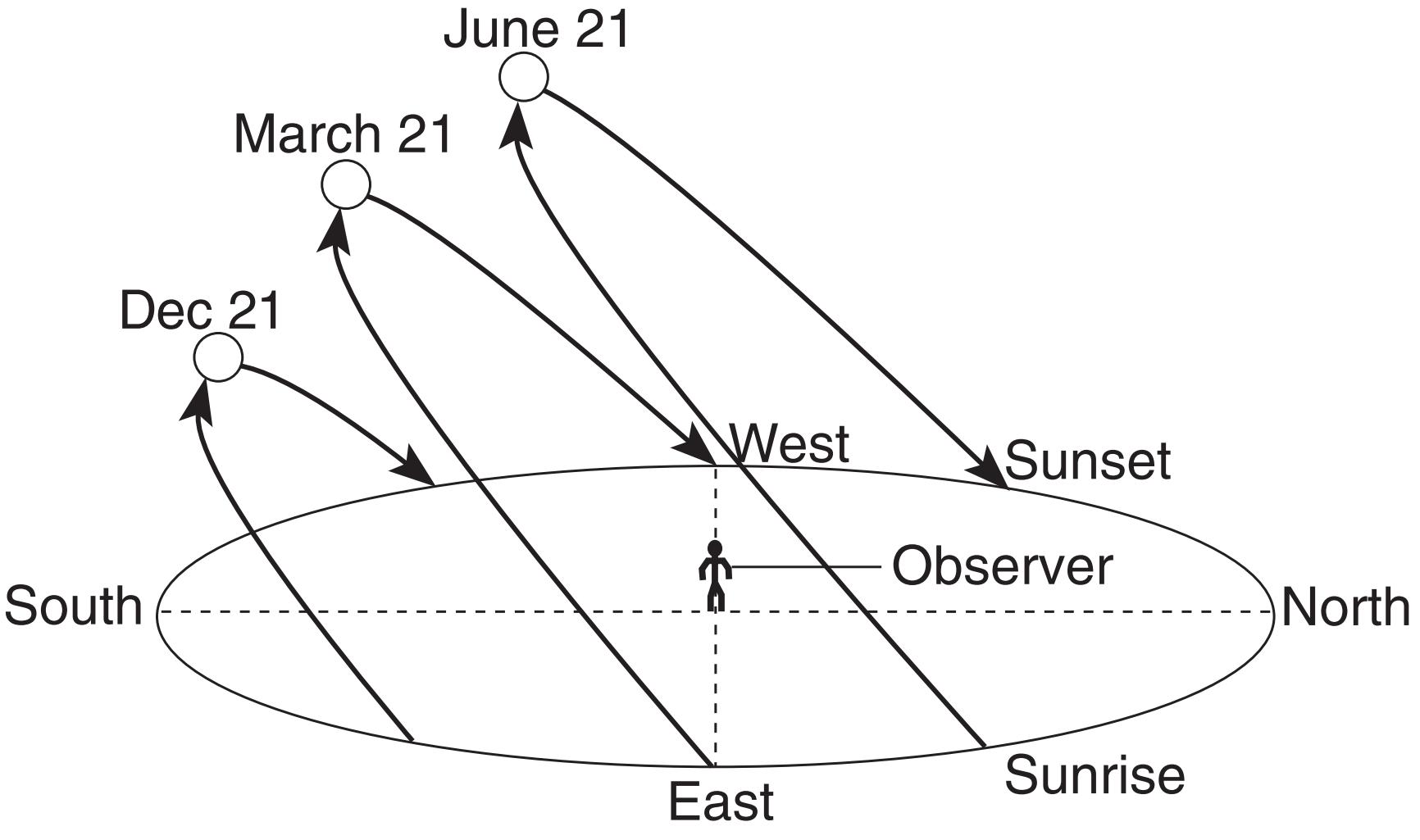

A
B
C
Horizon
Northeast
East
Southeast

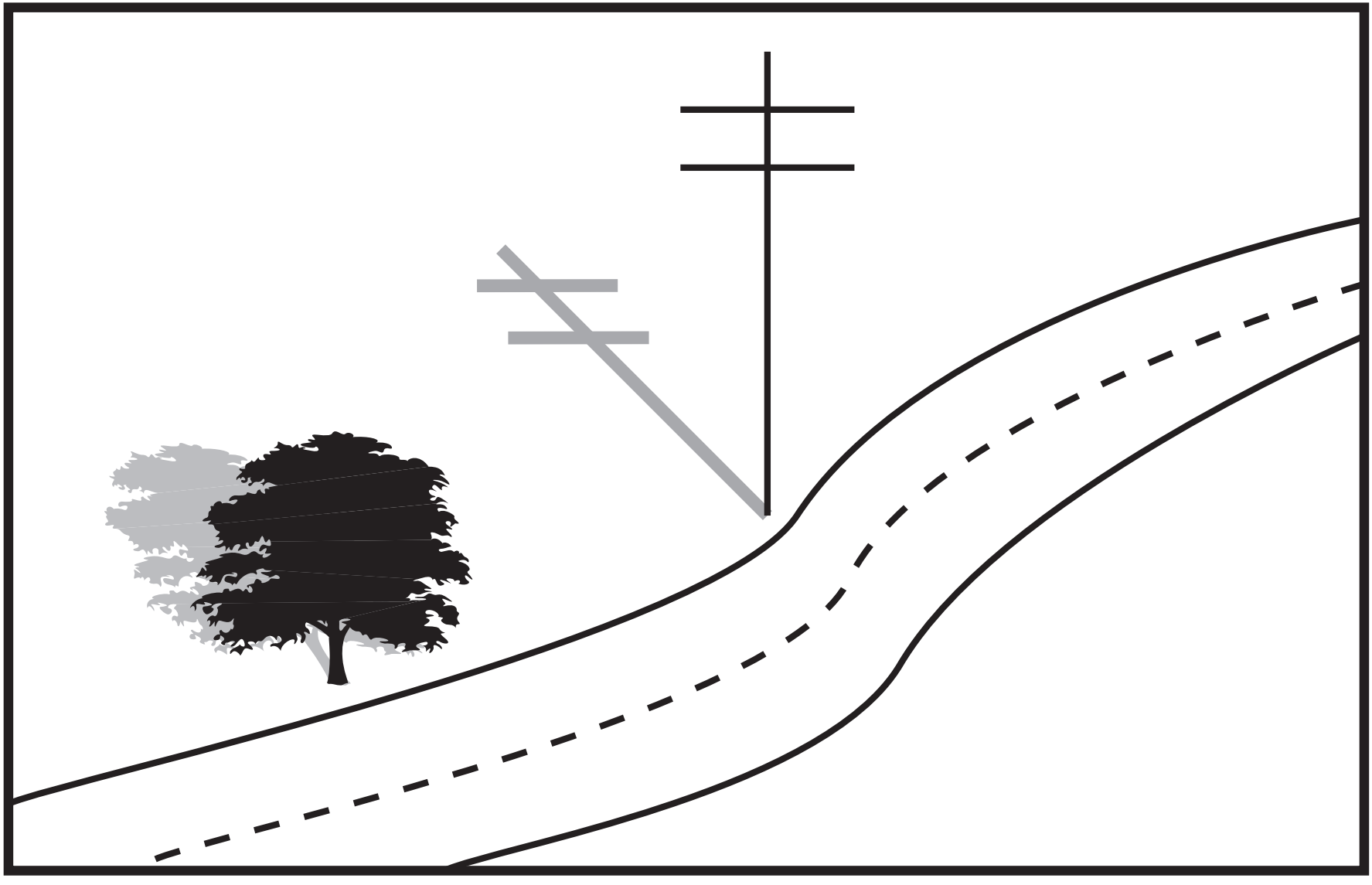
# Data Table

| Latitude | Azimuths of Sunrise and Sunset | Letter Code |
|---|---|---|
| 30° N | sunrise 69° | A |
| | sunset 291° | B |
| 40° N | sunrise 66° | C |
| | sunset 294° | D |
| 50° N | sunrise 61° | E |
| | sunset 299° | F |
| 60° N | sunrise 51° | G |
| | sunset 309° | H |

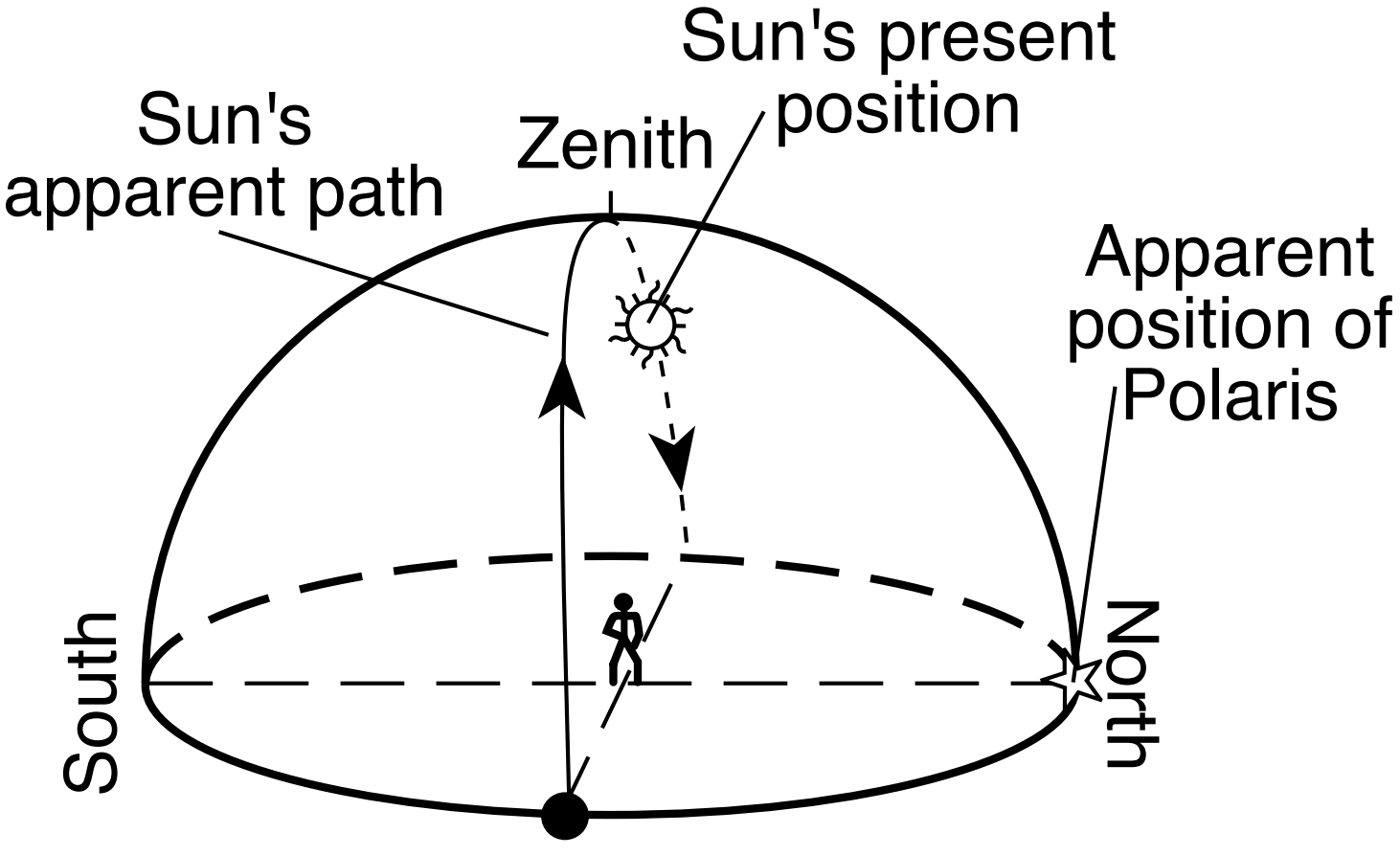

Solar noon
Solar noon
Solar noon
Sun's apparent path
June 21
September 23
December 21
W
S
N
E
Observer

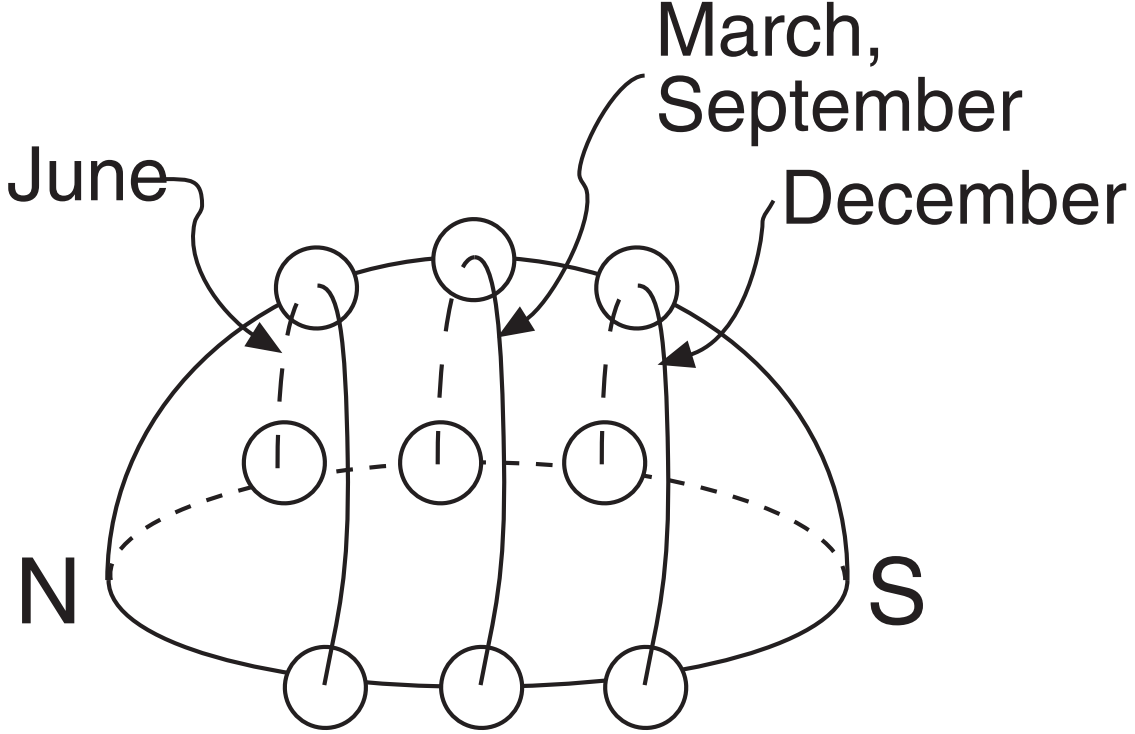

Polaris
W
Observer
S
N
E

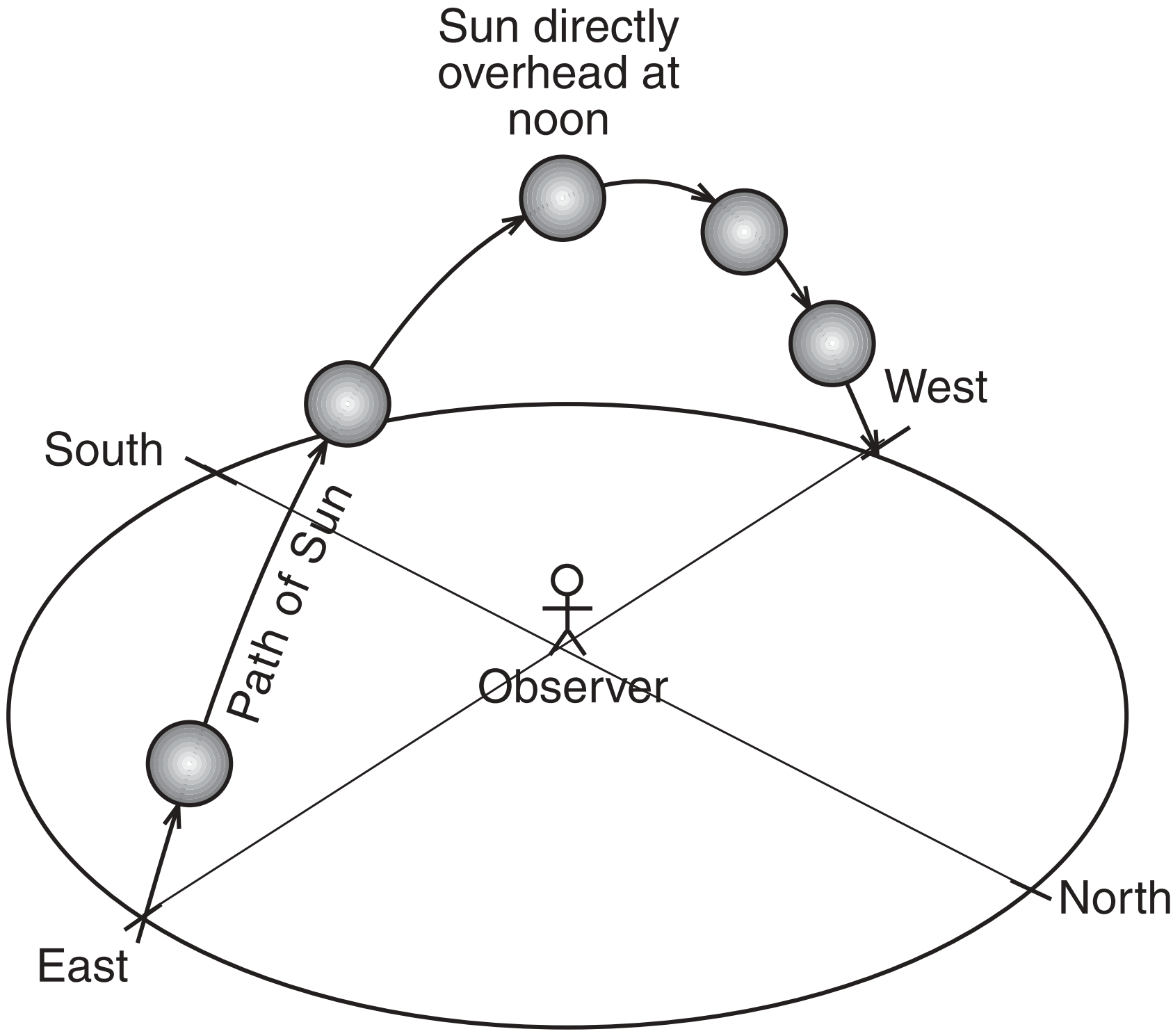

June 21
March 21
Dec 21
West
Sunset
Observer
South
North
East
Sunrise

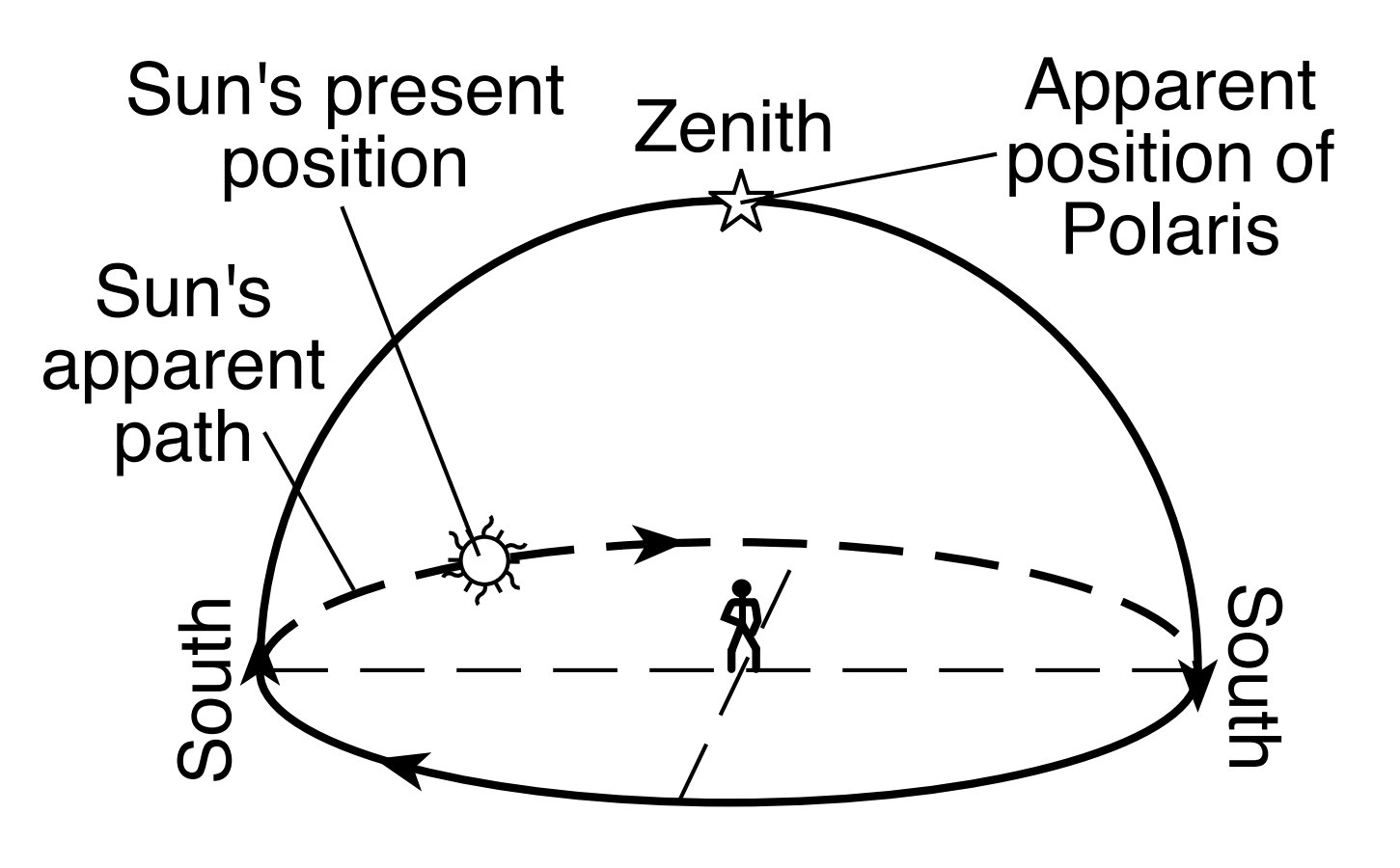


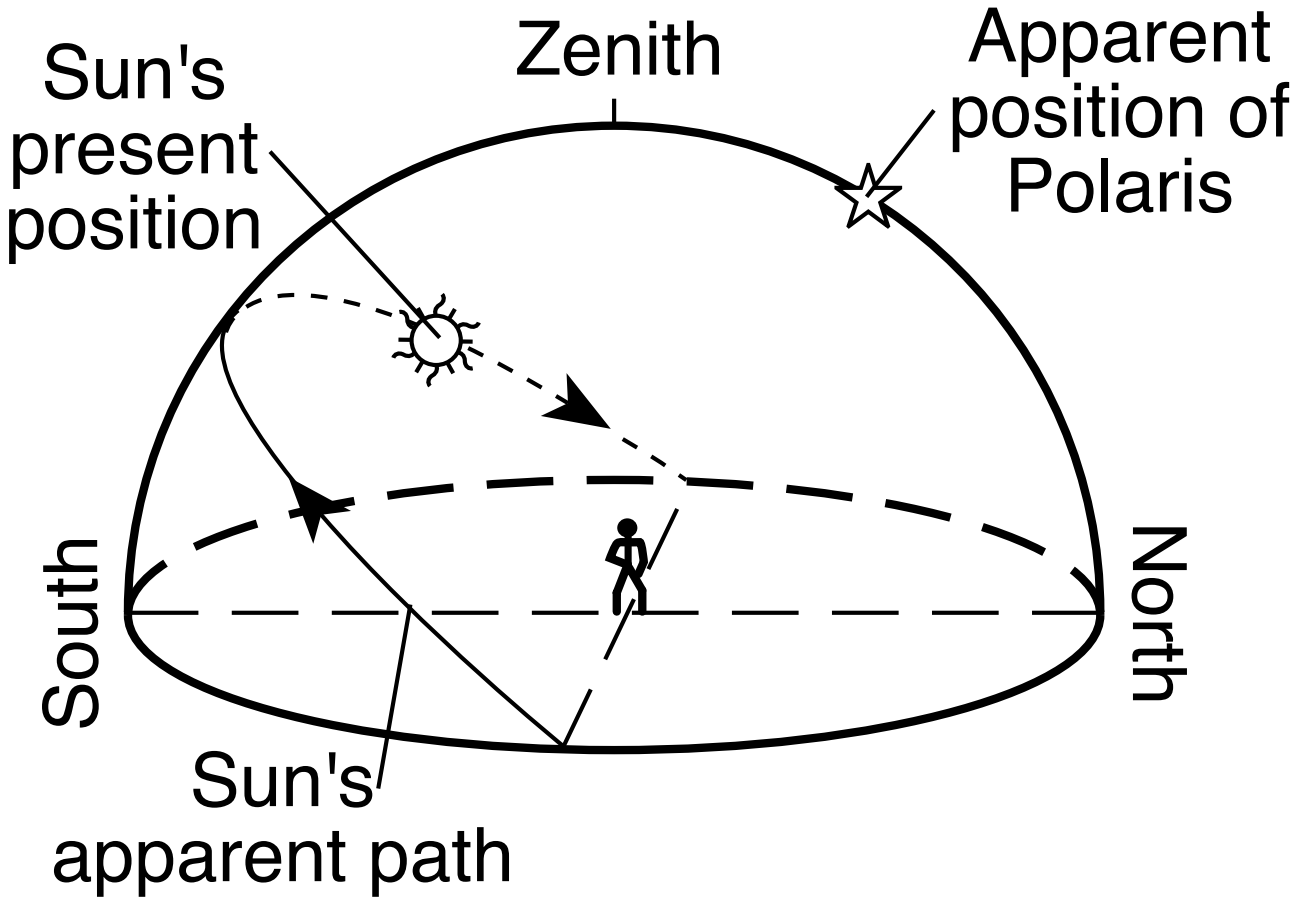
Shadow Cast on March 21

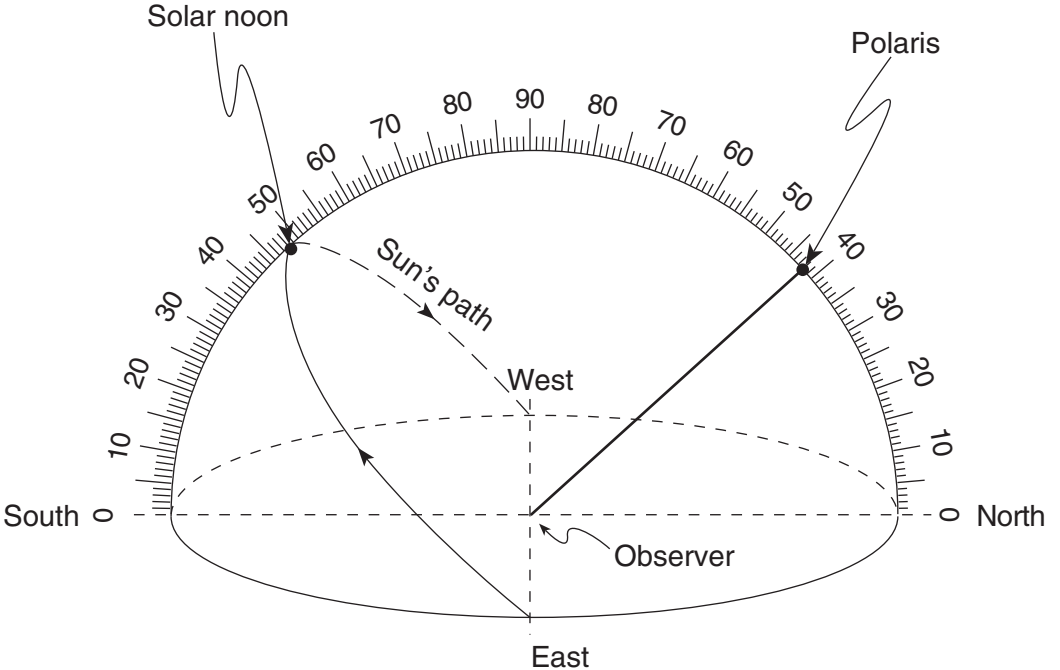

Sun's present position
Sun's apparent path
Zenith
Apparent position of Polaris
South
North

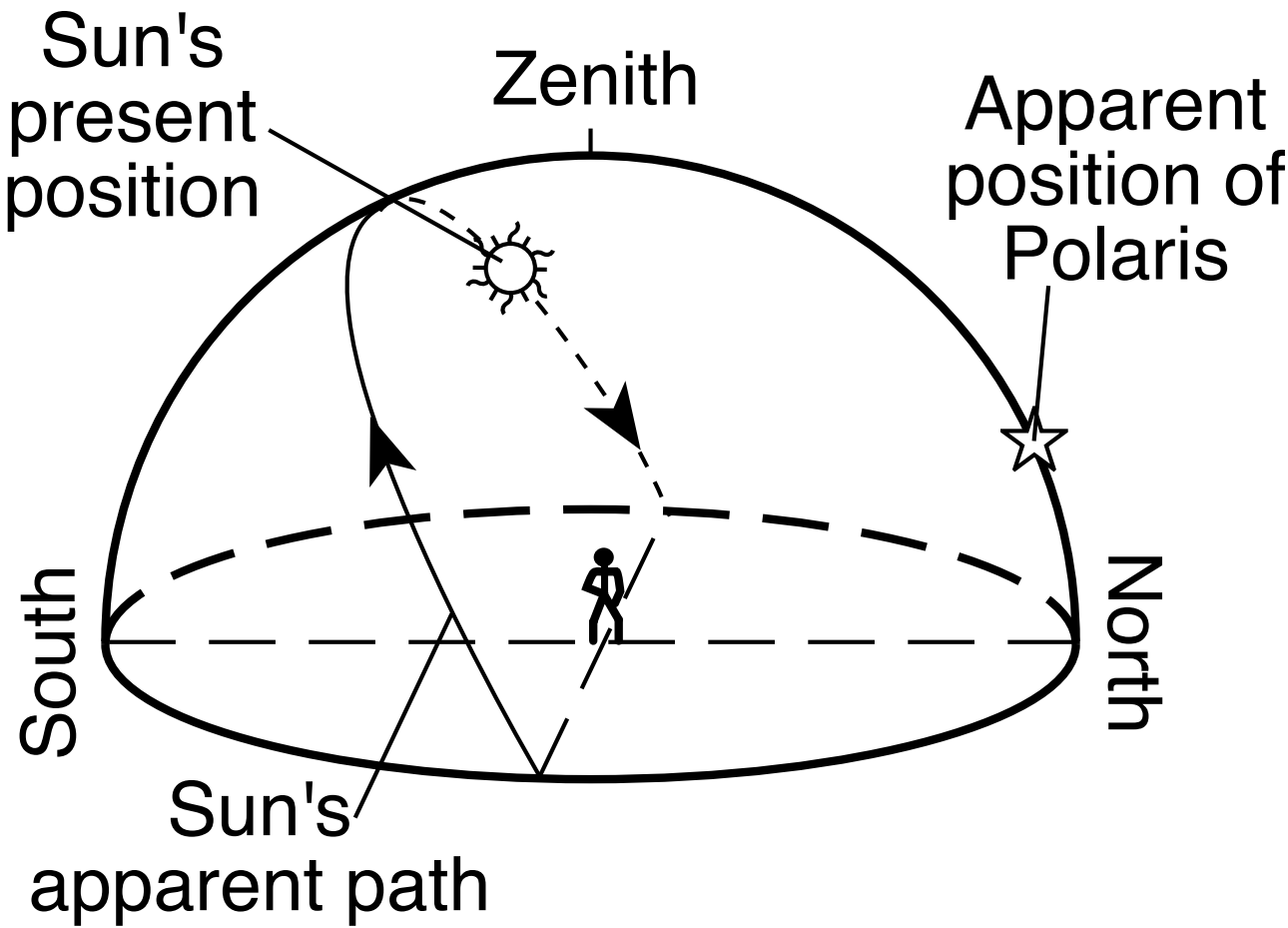

March,
September
June
December
N
S

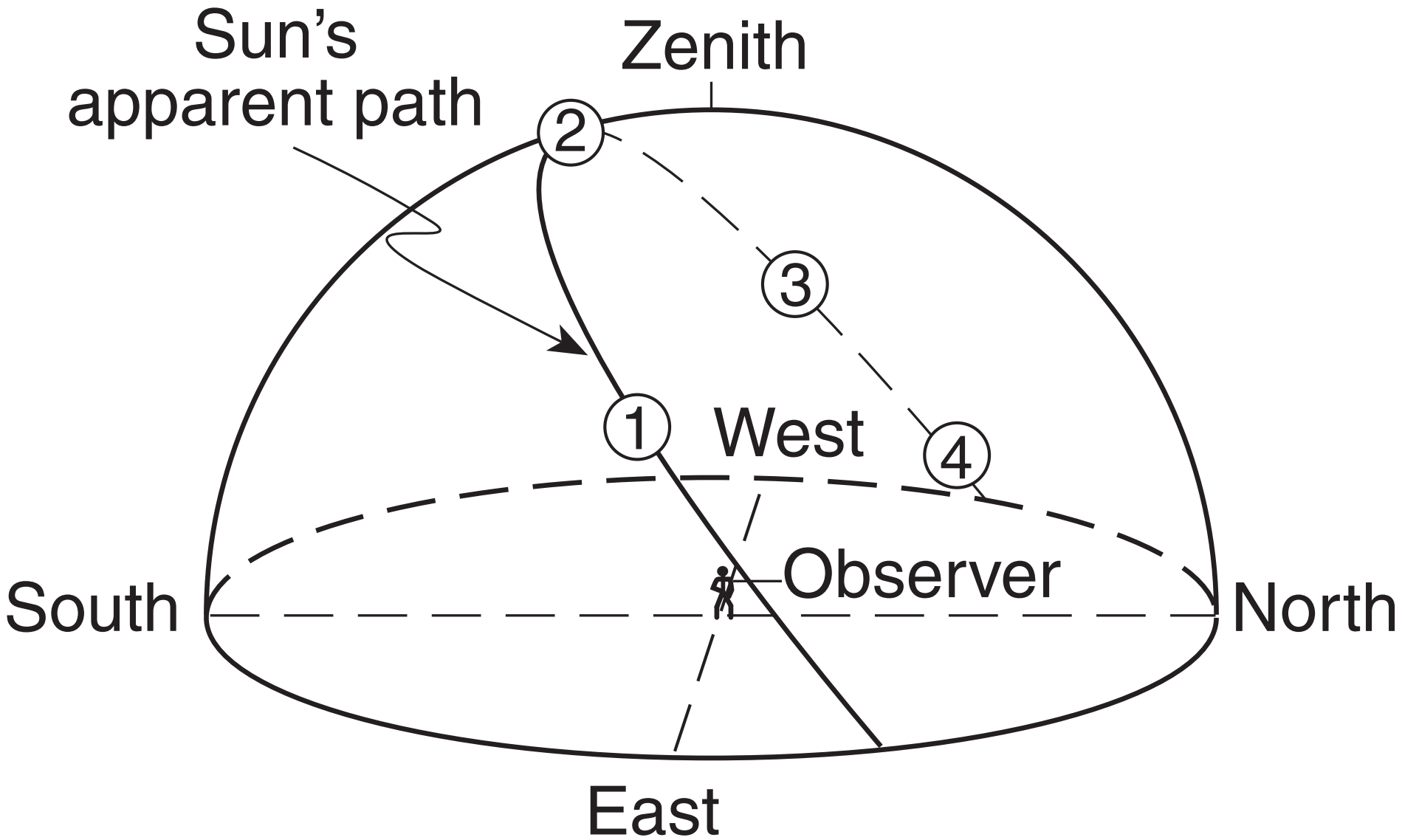

Sun directly overhead at noon
West
South
Path of Sun
Observer
East
North

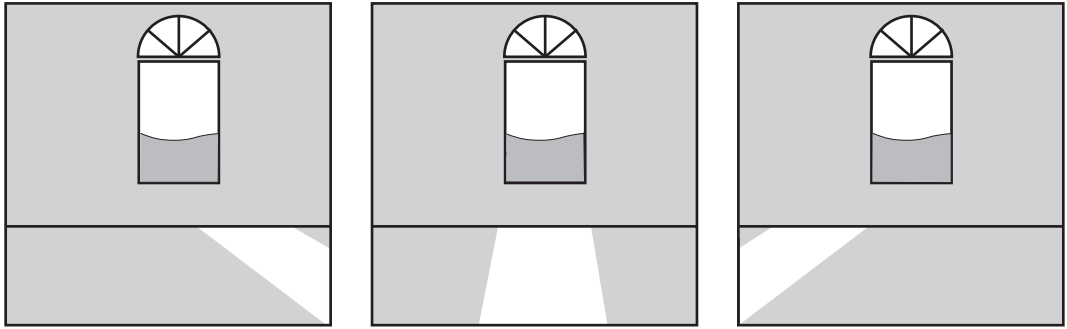

Sun's present position
Zenith
Apparent position of Polaris
Sun's apparent path
South
South

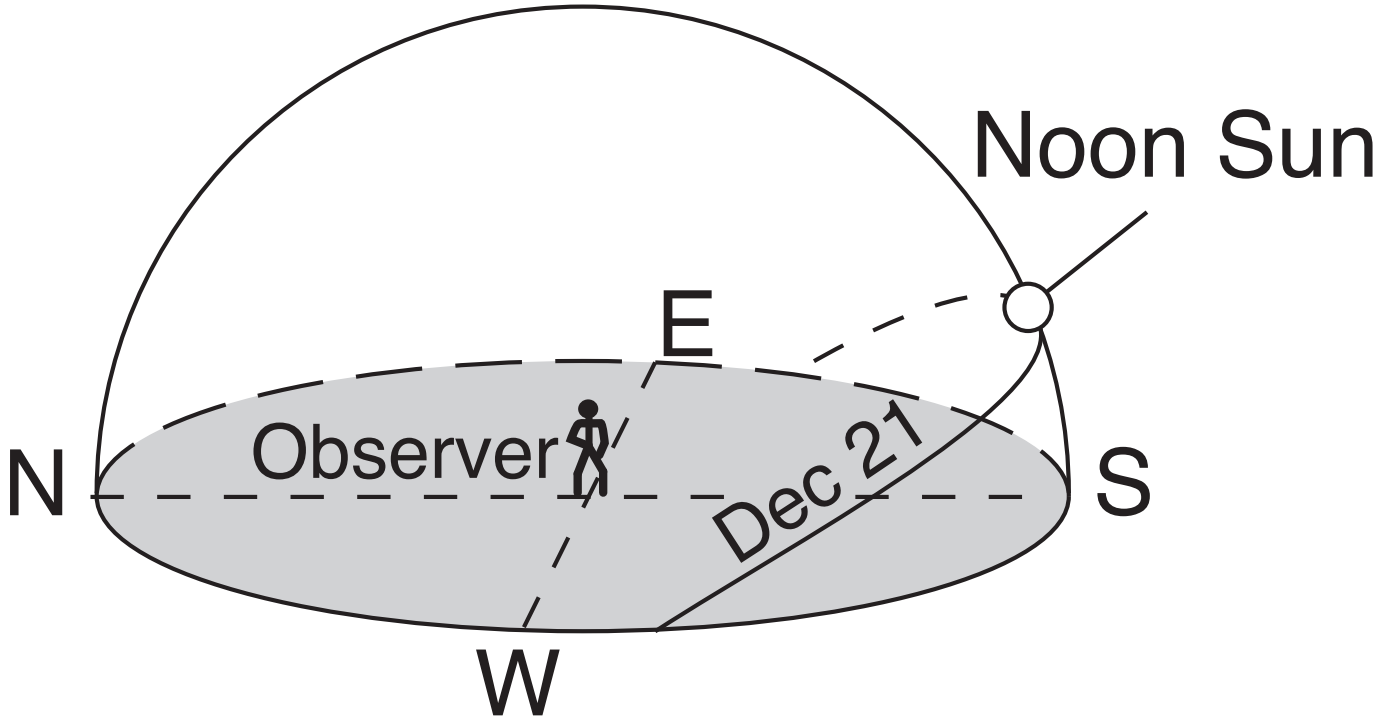

Sun's
present
position
Zenith
Apparent
position of
Polaris
South
North
Sun's
apparent path

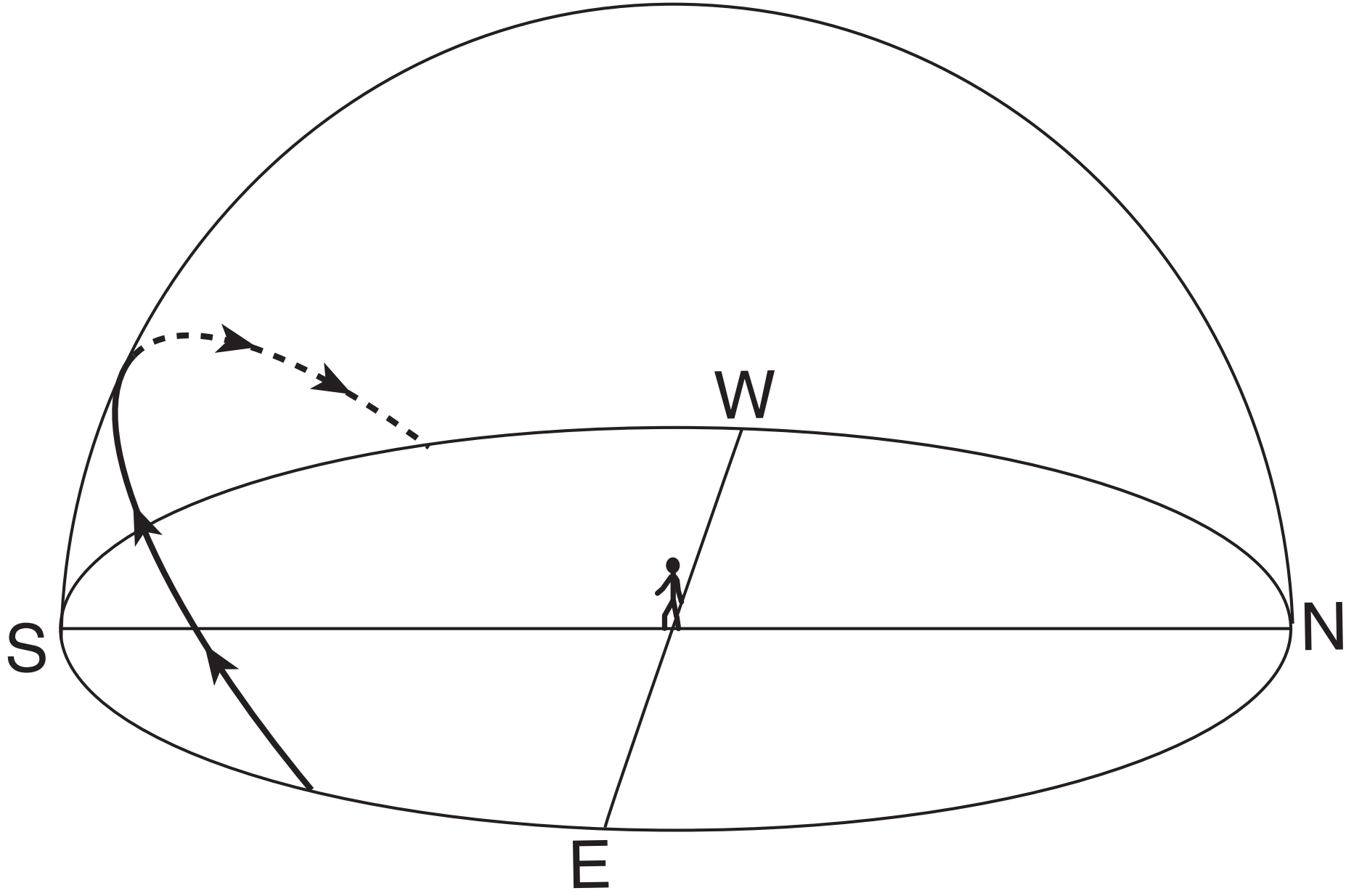

Solar noon
Polaris
90
80
80
70
70
60
60
50
50
40
40
30
30
20
20
10
10
0
0
Sun's path
West
South
North
Observer
East

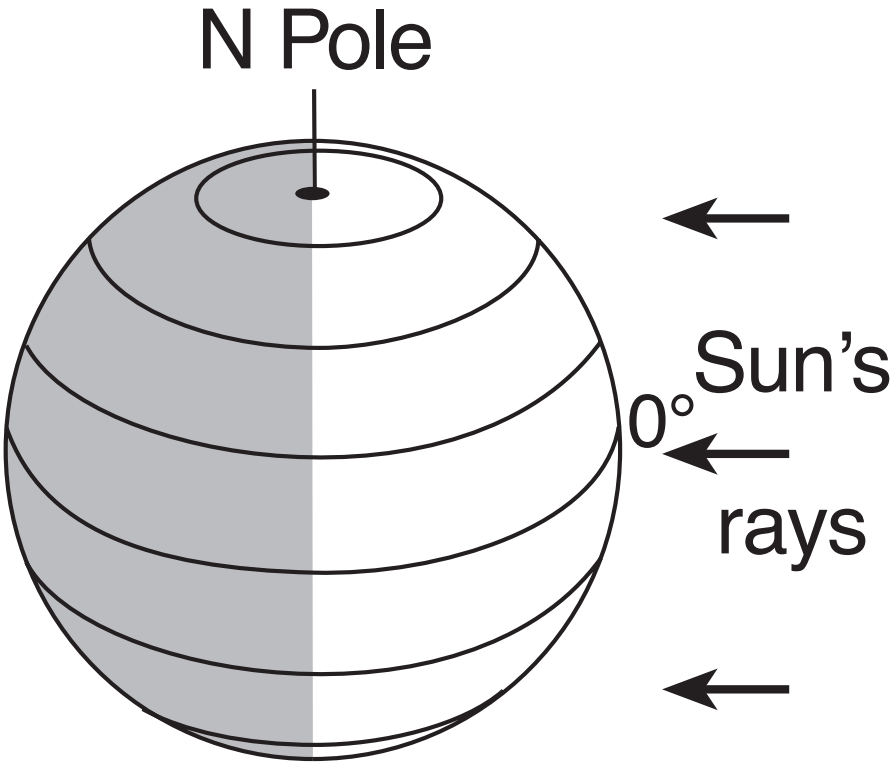

Sun's present position
Zenith
Apparent position of Polaris
South
North
Sun's apparent path

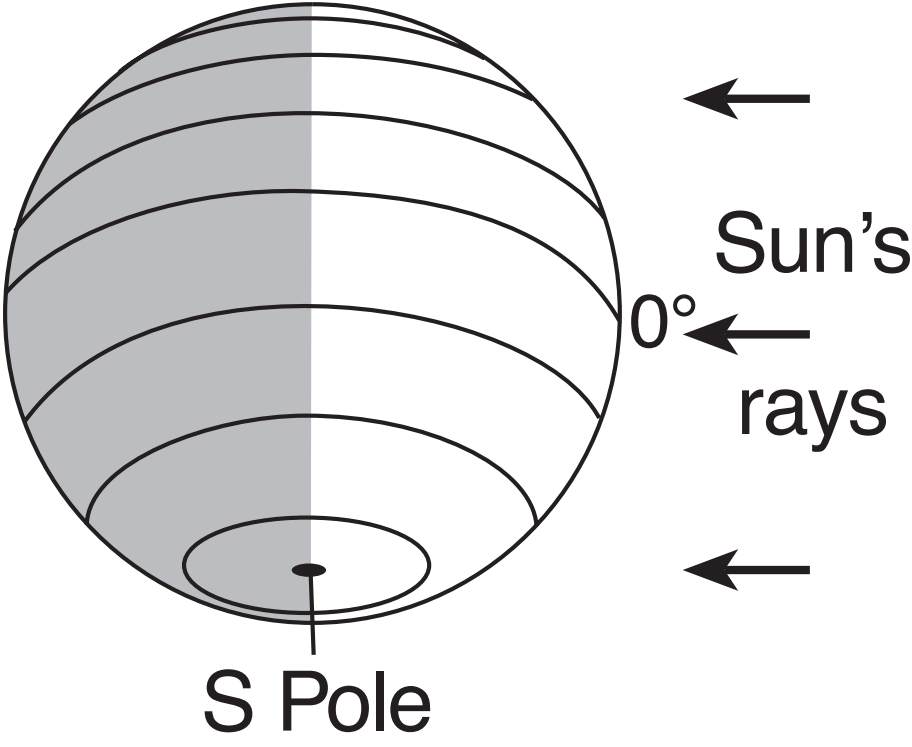

Sun's
apparent path
Zenith
2
3
1
West
4
Observer
South
North
East

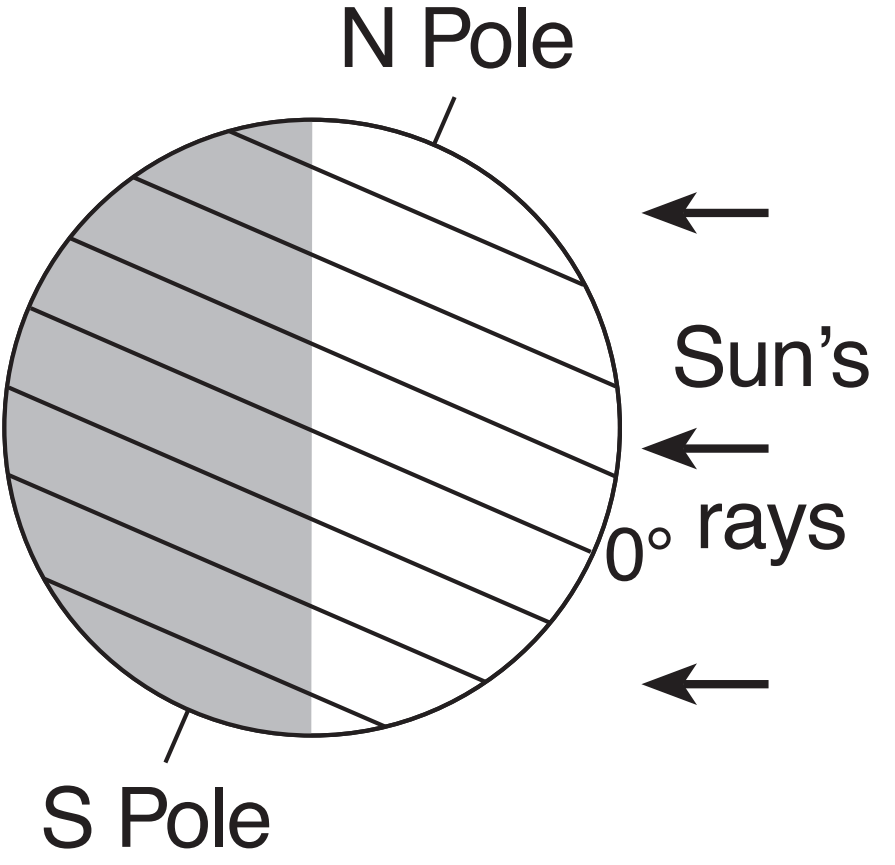

Sunrise
Noon
Sunset

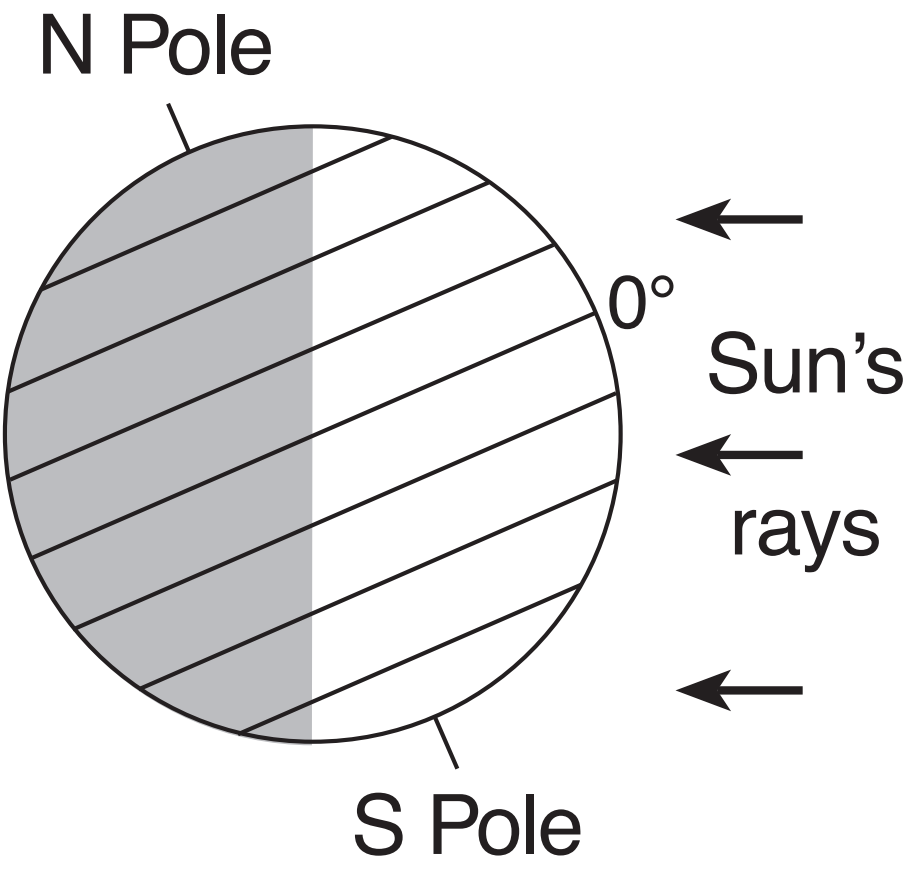

Noon Sun
E
N
Observer
S
Dec 21
W

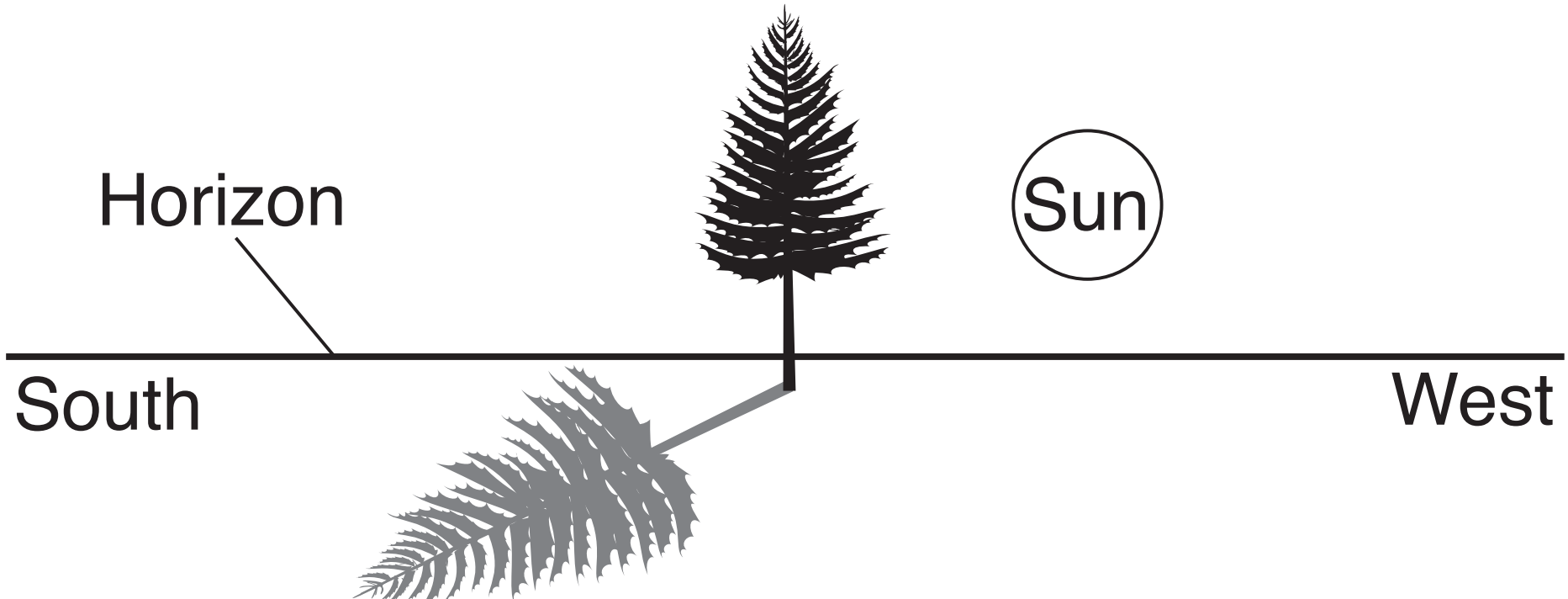

W
S
N
E

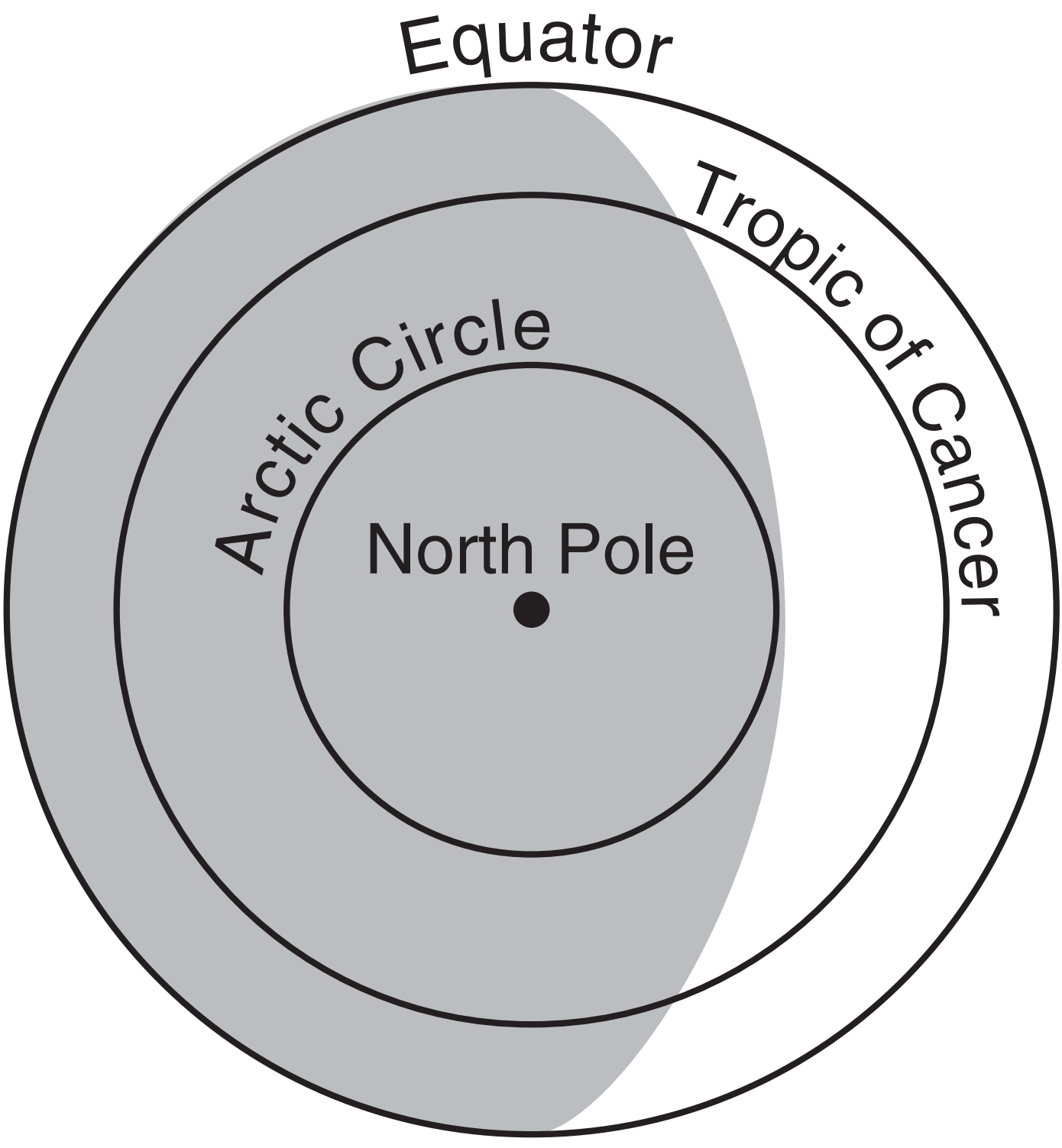

N Pole
0°
Sun's
rays

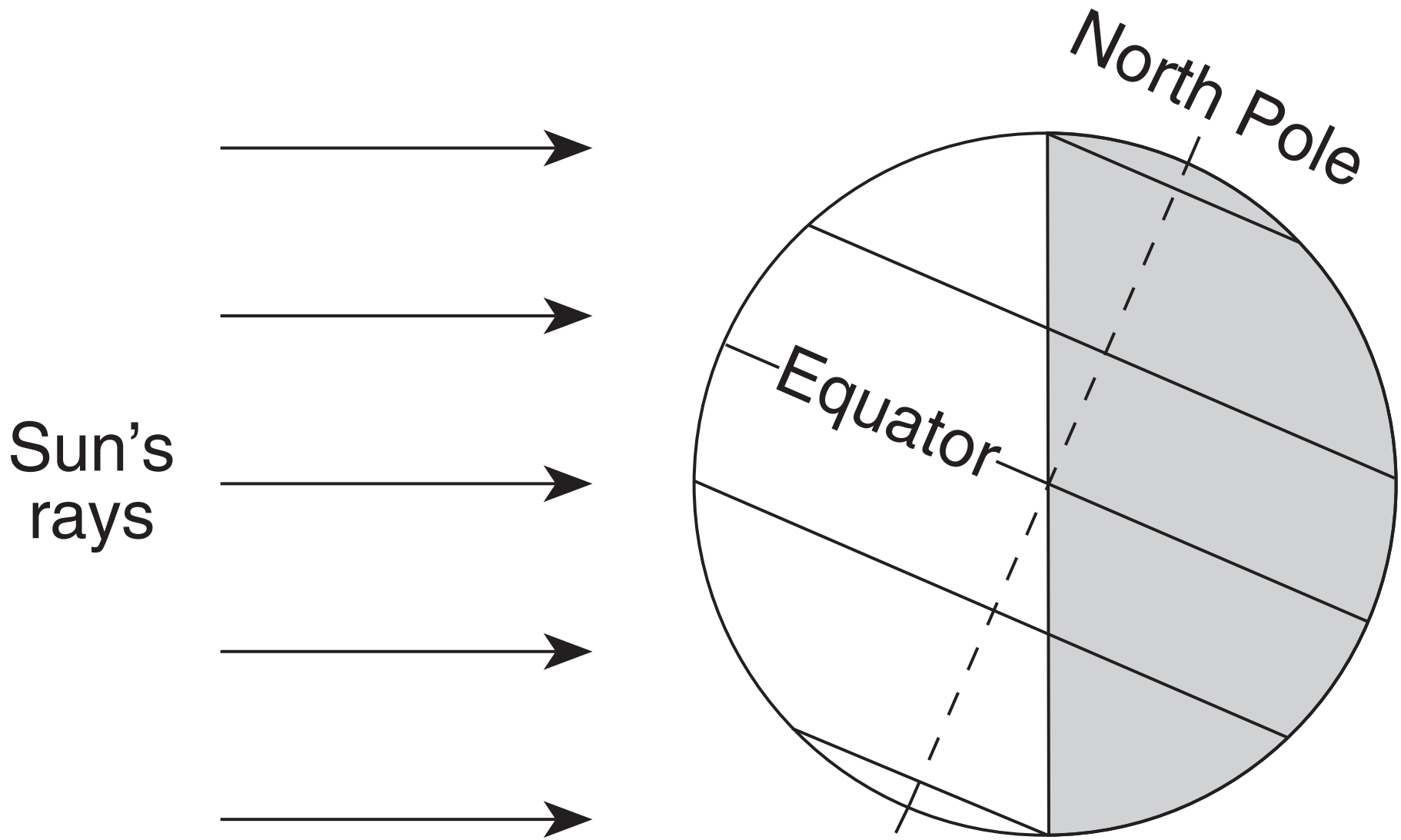

Sun's
0°
rays
S Pole

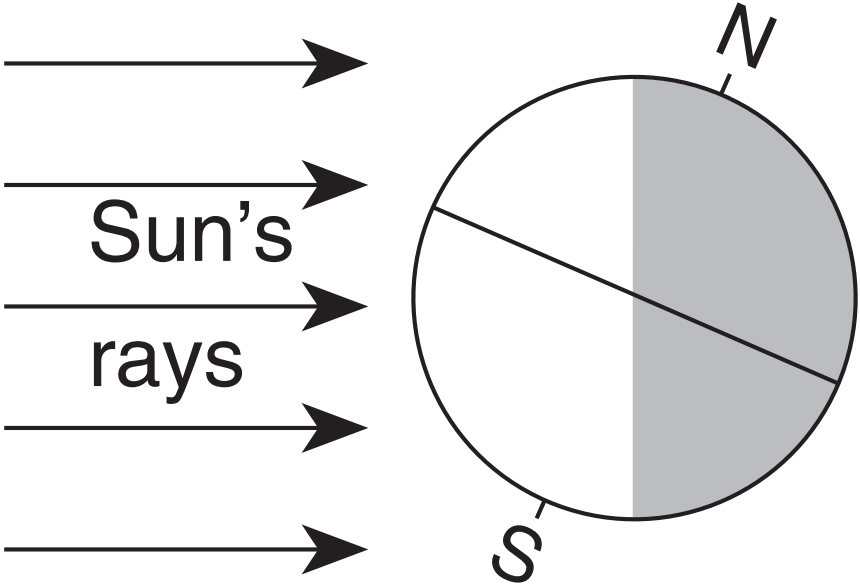

N Pole
Sun's
0° rays
S Pole

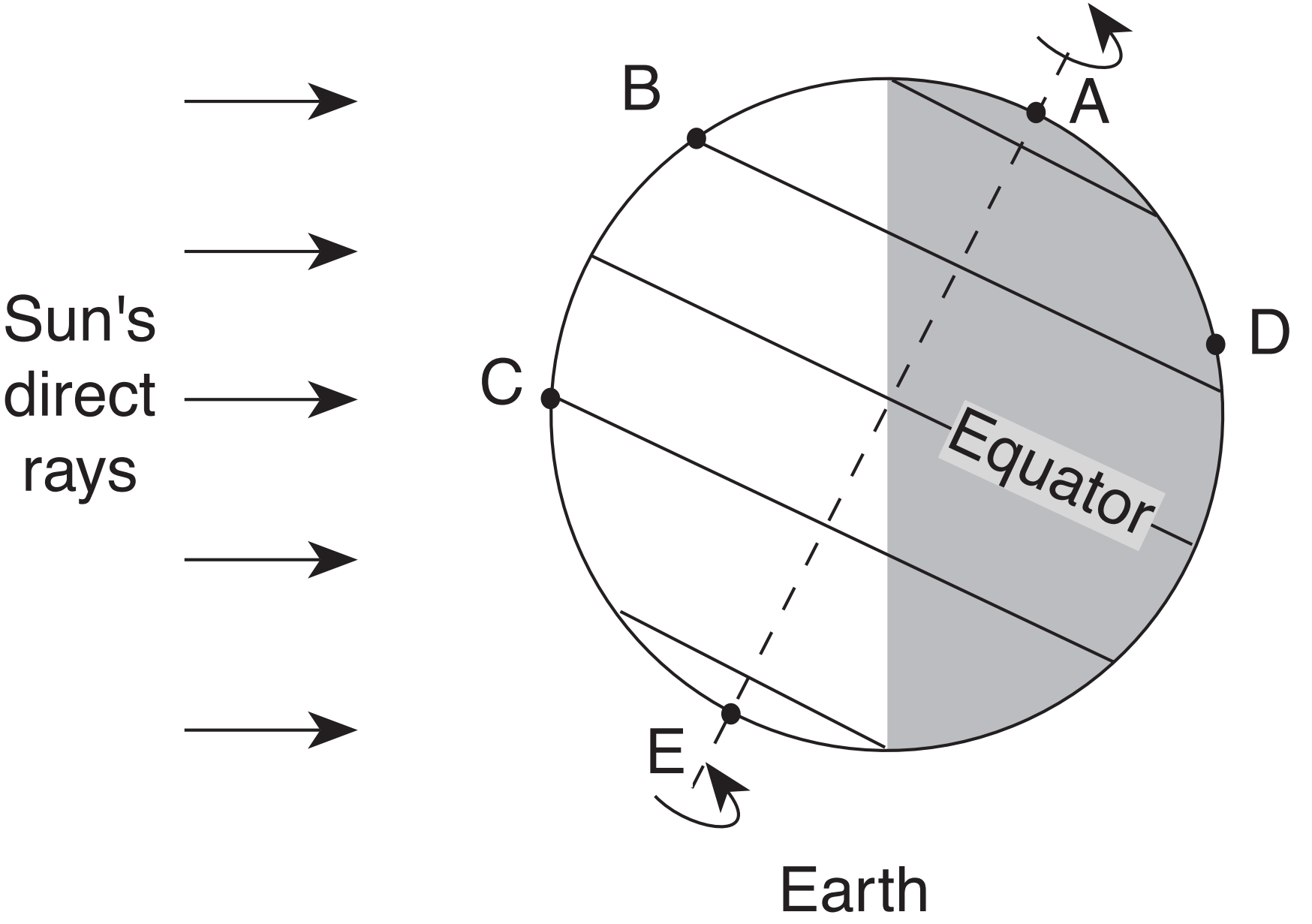

N Pole
0°
Sun's
rays
S Pole

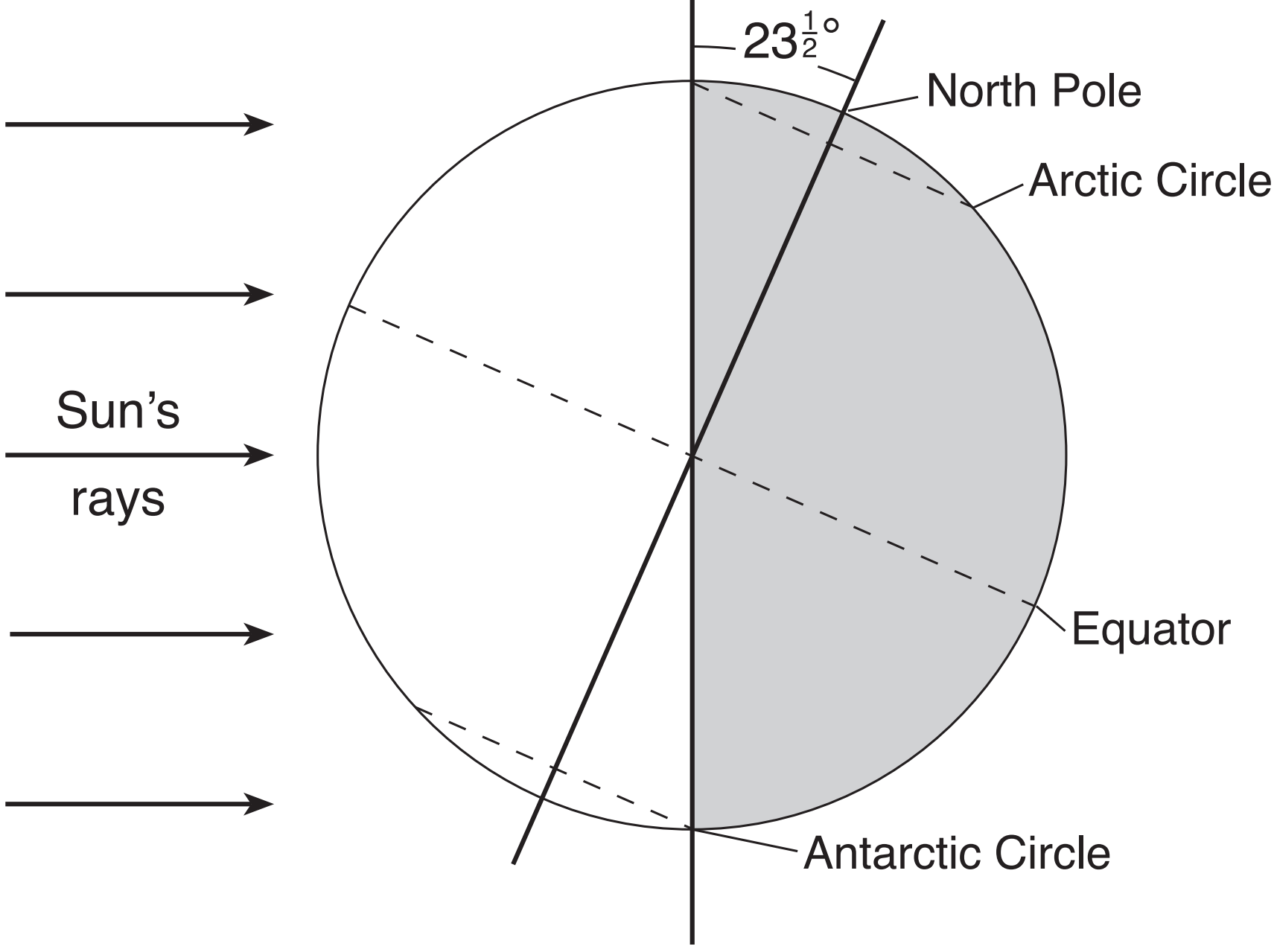

Horizon
Sun
South
West

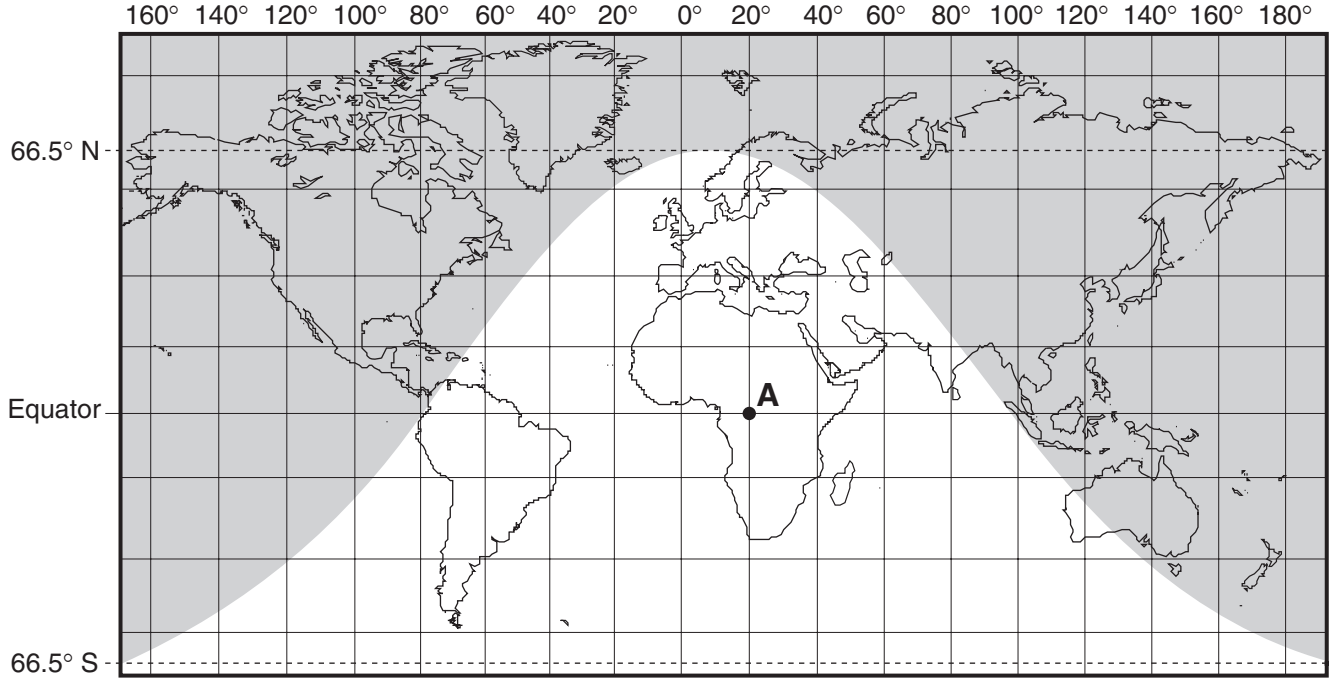

Equator
Tropic of Cancer
Arctic Circle
North Pole

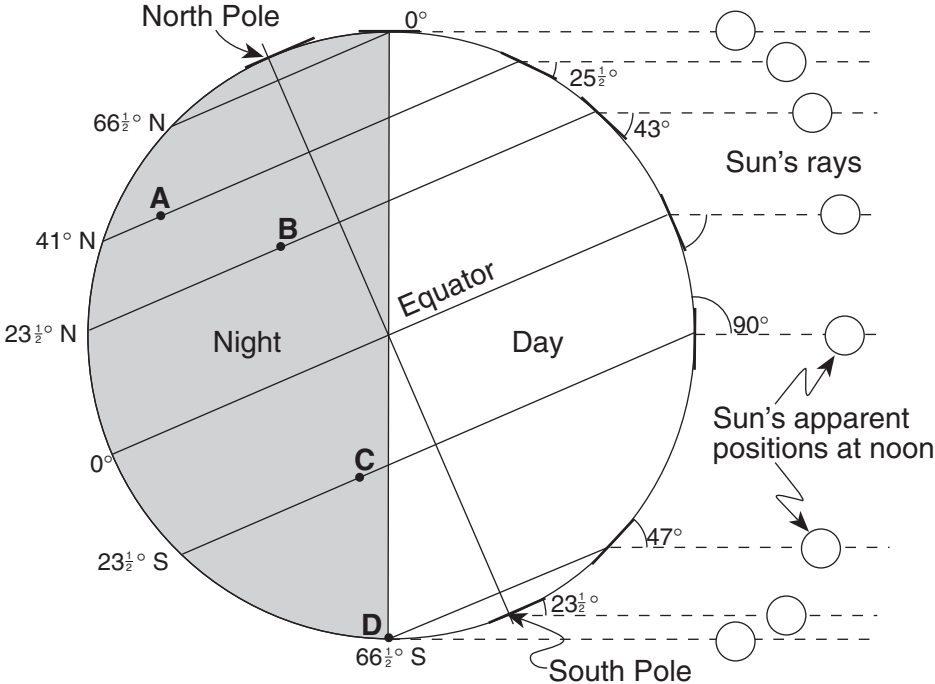

North Pole
Equator
Sun's rays


Sun's
rays
N
S


Sun's
direct
rays
A
B
C
D
E
Equator
Earth


$23\frac{1}{2}°$
North Pole
Arctic Circle
Sun's
rays
Equator
Antarctic Circle


160° 140° 120° 100° 80° 60° 40° 20° 0° 20° 40° 60° 80° 100° 120° 140° 160° 180°
66.5° N
Equator
66.5° S
A




(Not drawn to scale)