

## **NSW Education Standards Authority**

2019 HIGHER SCHOOL CERTIFICATE EXAMINATION

# Earth and Environmental Science

## General Instructions

- Reading time 5 minutes
- Working time 3 hours
- Write using black pen
- · Draw diagrams using pencil
- Calculators approved by NESA may be used
- A Geological Time Scale is provided at the back of this paper

## Total marks: 100

#### Section I – 20 marks (pages 2–15)

- Attempt Questions 1–20
- Allow about 35 minutes for this section.

## Section II - 80 marks (pages 17–36)

- Attempt Questions 21–35
- Allow about 2 hours and 25 minutes for this section

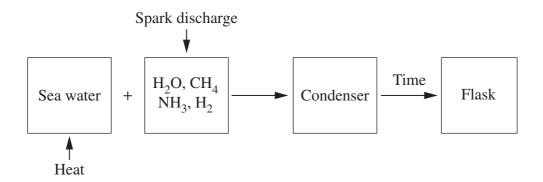
## **Section I**

## 20 marks Attempt Questions 1–20 Allow about 35 minutes for this section

Use the multiple-choice answer sheet for Questions 1–20.

- 1 In which of the following are all the resources renewable?
  - A. Timber, water, wind
  - B. Tidal energy, oil, timber
  - C. Water, solar radiation, coal
  - D. Solar radiation, water, uranium
- 2 Which of the following would have the greatest immediate impact on biodiversity?
  - A. Air pollution
  - B. Habitat destruction
  - C. Human population growth
  - D. Infrastructure development
- 3 Human activity is most likely to be a contributing factor in the occurrence of which of the following natural disasters?
  - A. Earthquakes
  - B. Lahars
  - C. Landslides
  - D. Tsunamis

- 4 To gather evidence for climate variation, a dendrochronologist studies
  - A. isotope ratios in corals.
  - B. gas bubbles in ice cores.
  - C. the annual growth rings of trees.
  - D. species depicted in Aboriginal art sites.
- 5 The flow chart summarises a historically important experiment.



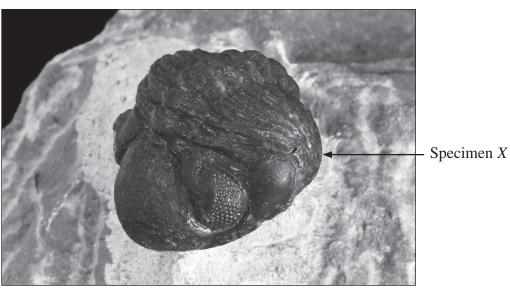
What was one of the products in the flask?

- A. Proteins
- B. Amino acids
- C. Eukaryotic cells
- D. Photosynthetic cells
- 6 Which statement is scientifically correct and consistent with the panspermia hypothesis?
  - A. Extraterrestrial objects brought complex life forms to Earth.
  - B. NASA has found evidence that primitive life existed on Mars.
  - C. Organic molecules from outer space were brought to Earth on meteorites.
  - D. The ancestral DNA for primitive plants was brought to Earth from outer space.

- Which of the following is an example of a geological hazard?
  - A. A cyclone approaching the Australian coastline
  - B. An active volcano that poses a threat to life and property
  - C. An earthquake that has affected thousands of people and caused enormous damage
  - D. A tsunami that wipes out coastal communities causing damage and loss of human life
- 8 In June 1991, Mt Pinatubo in the Philippines erupted, producing ash-rich volcanic plumes that reached a height of more than 40 km.

Which of the following decreased as a result of the eruption?

- A. Rainfall on Mt Pinatubo
- B. Aerosols in the stratosphere
- C. Carbon dioxide levels in the ocean
- D. Solar radiation reaching Earth's surface
- 9 The picture shows a fossil trilobite (specimen X).

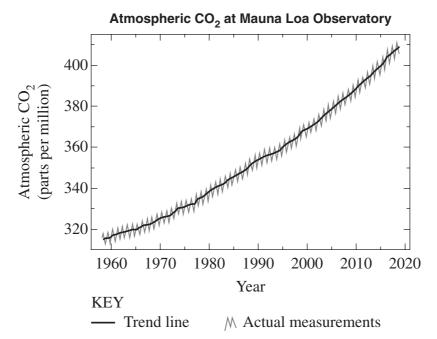


Replacement image. Original image awaiting copyright.
© FossilEra/Matt Heaton

What type of fossil is specimen *X*?

- A. Cast
- B. Mould
- C. Trace fossil
- D. Organic fossil

10 The graph shows data from the Mauna Loa Observatory, Hawaii, recording variations in atmospheric carbon dioxide.

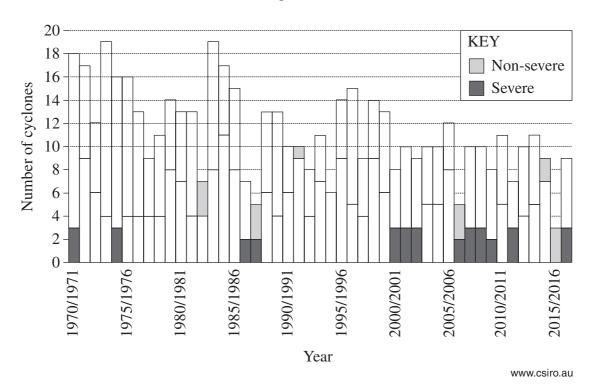


National Oceanic and Atmospheric Administration, US Department of Commerce

What causes the 'sawtooth' fluctuations in the graph?

- A. Seasonal changes in the rate of photosynthesis
- B. Data taken at intervals rather than continuously
- C. Monthly changes in the combustion of fuel for heating
- D. Random volcanic eruptions occurring throughout the northern hemisphere

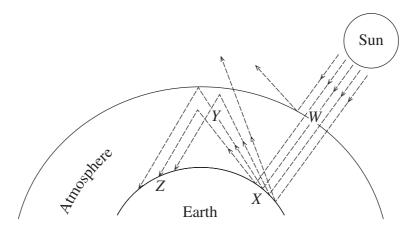
11 The graph shows the number of severe and non-severe tropical cyclones from 1970–2017 which have occurred in the Australian region.



What conclusion is supported by data in the graph?

- A. The total number of cyclones is decreasing.
- B. The severity of cyclones has consistently decreased over time.
- C. The number of both severe and non-severe cyclones has not changed over time.
- D. The number of non-severe cyclones is decreasing while the number of severe cyclones is increasing.

12 The diagram shows a model of solar energy transformations occurring in the atmosphere, producing the greenhouse effect.



**KEY** 

W	X	Y	Z
Solar radiation enters the atmosphere	Majority of solar radiation is absorbed by Earth's surface and then re-emitted as infrared radiation	Some infrared radiation escapes but most is trapped by the atmosphere	Reabsorption of trapped infrared radiation by Earth's surface

Which statement correctly explains the 'enhanced' greenhouse effect?

- A. Increased melting of ice caps increased the reflection of solar radiation from the surface at *X*.
- B. Increased ozone levels led to greater absorbance of solar radiation by Earth's surface at *X*.
- C. A hole in the ozone layer decreased the solar radiation being reflected by the atmosphere at *W*.
- D. Increased carbon dioxide levels have increased the trapping of infrared radiation in the atmosphere at *Y*.

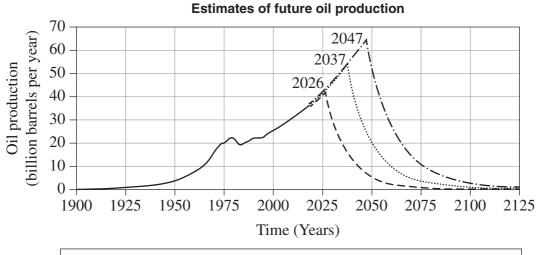
13	A company discovered an ore body after prospecting in an area of NSW. The flow chart shows subsequent stages of the proposed mine.
	Due to copyright restrictions, this material cannot be displayed.
	Source is accessible at

Which row in the table correctly identifies the appropriate stage for undertaking each activity?

https://www.superfund.arizona.edu/learning-modules/tribal-modules/copper/mine-life-cycle

	Activity					
	Submission of an Environmental Impact Statement	Collection and propagation of indigenous plants	Consultation with traditional owners			
A.	Planning	Development	All stages			
B.	Development	All stages	Development			
C.	All stages	Planning	Extraction			
D.	Planning	Extraction	All stages			

14 The graph shows future oil production based on estimates of three rates of oil recovery from known reserves.



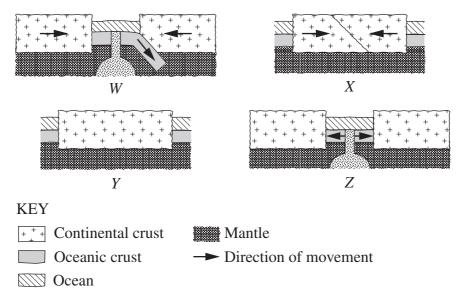
KEY
—— Historical rate of oil production
Predicted rate of oil production based on a high recovery
Predicted rate of oil production based on a medium recovery
Predicted rate of oil production based on a low recovery

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What is the most valid conclusion that can be drawn from the data in the graph?

- A. By 2025 oil production will be in rapid decline.
- B. By 2100 there will be no oil reserves remaining.
- C. By 2080 oil production will be less than 10 billion barrels of oil per year.
- D. By 2060 oil production will be reduced to 20% of the 2019 production levels.

During the Permian period, the supercontinent Pangaea formed during a plate tectonic supercycle. The diagram shows four stages of the plate tectonic supercycle.

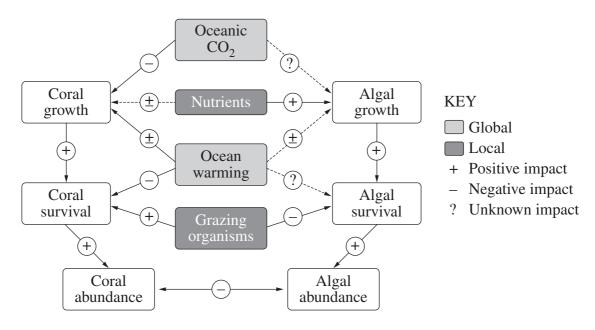


Creative Commons, Philip J Heron – A Simplified 'Wilson Cycle'

Which sequence shows the correct order of the stages that resulted in the formation of Pangaea?

- A. W, X, Y, Z
- B. Z, W, X, Y
- C. X, Z, W, Y
- D. Y, X, W, Z

16 The diagram is one model showing the influence of oceanic conditions on coral reef systems.

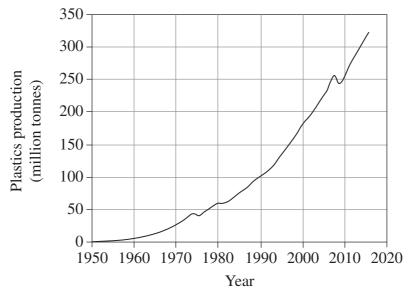


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According to the model, which of the following is a likely consequence of changing ocean conditions?

- A. A change in pH from 8.2 to 8 which will lead to a reduction in coral survival and a reduction in algal growth
- B. An increase of 5% in nutrients which will lead to an increase in coral growth and a decrease in algal abundance
- C. An atmospheric temperature increase of 2°C which will lead to an increase in coral abundance and an increase in algal abundance
- D. An increase in the population of grazing organisms which will lead to an increase in coral abundance and a decrease in algal survival

17 The graph shows world plastics production from 1950 to 2020.



China Plastic & Rubber Journal (www.adsalecprj.com)

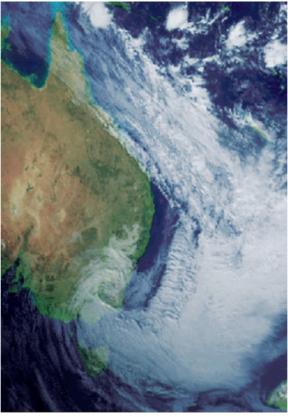
By what percentage did plastics production increase between 1990 and 2010?

- A. 150%
- B. 200%
- C. 250%
- D. 300%

Which combination of plate boundary and volcanic feature would result in both effusive volcanic eruptions and shallow focus earthquakes?

	Plate boundary	Volcanic feature
A.	Ocean–continent divergent	Shield volcano
B.	Ocean-ocean convergent	Stratovolcano
C.	Ocean–continent convergent	Stratovolcano
D.	Continent–continent divergent	Continental rift volcano

## 19 The satellite image shows a 2007 weather event.



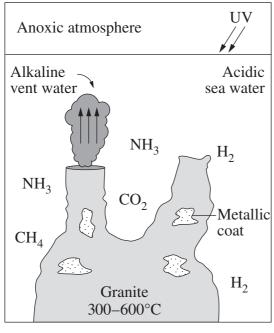
© Australian Government Bureau of Meteorology

Which sequence explains this event?

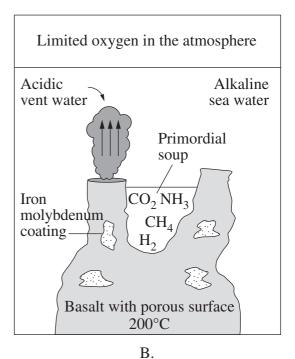
- A. Warmer than normal ocean temperatures  $\rightarrow$  moist air rises  $\rightarrow$  low air pressure system
- B. Colder than normal ocean temperatures  $\rightarrow$  dry air falls  $\rightarrow$  low air pressure system
- C. Warmer than normal ocean temperatures  $\rightarrow$  moist air rises  $\rightarrow$  high air pressure system
- D. Colder than normal ocean temperatures  $\rightarrow$  dry air falls  $\rightarrow$  high air pressure system

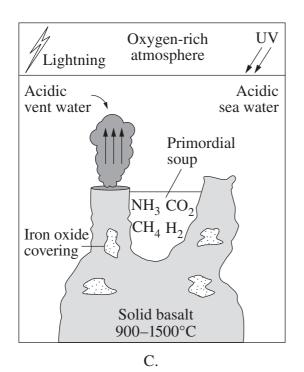
20 A recent theory for the origin of life on Earth suggests that the simple organic precursor molecules for amino acids and proteins were formed at black smokers.

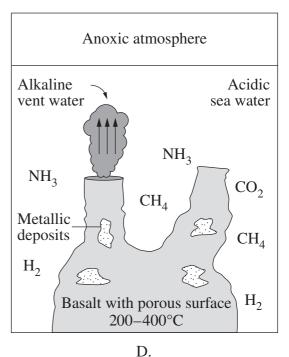
Which diagram best represents this theory?



A.







NOT TO SCALE

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# Earth and Environmental Science

# **Section II Answer Booklet**

		Cei	ntre	Nun	nber
		Stuc	lent	Nun	nber

80 marks
Attempt Questions 21–35
Allow about 2 hours and 25 minutes for this section

#### Instructions

- Write your Centre Number and Student Number at the top of this page.
- Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response.
- Show all relevant working in questions involving calculations.
- Extra writing space is provided at the back of this booklet.
   If you use this space, clearly indicate which question you are answering.

Please turn over

# Question 21 (5 marks)

Assess the sustainability of processes used by Aboriginal Peoples or Torres Strait Islander Peoples as resource managers. Use examples to support your answer.					
10					

Question 22 (5 marks)	
Construct a flow diagram to summarise the processes used to manage different type of household solid waste.	es

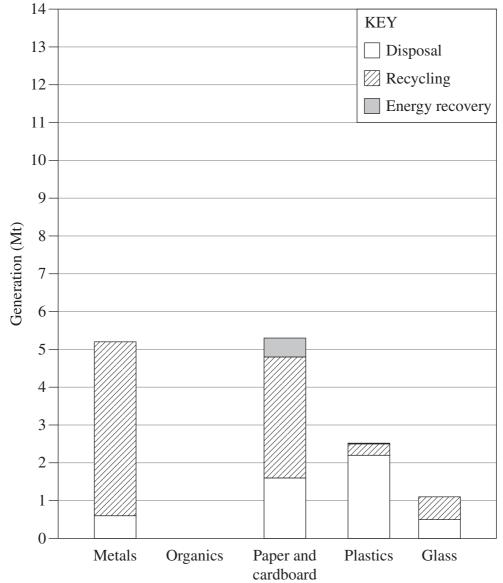
#### Question 23 (8 marks)

The table gives information about the generation and the reuse of some materials in Australia in 2016.

	Metals	Organics	Paper and cardboard	Plastics	Glass
Generation (Mt)	5.2	12.8	5.3	2.5	1.1
Energy recovery (Mt)	0.0	1.4	0.5	0.02	0.0
Recycling (Mt)	4.6	5.2	3.2	0.3	0.6
Disposal (Mt)	0.6	6.2	1.6	2.2	0.5

(a) Complete the graph for Organics using information in the table.





© Australian Government Department of the Environment and Energy

Question 23 continues on page 21

-20-

#### Question 23 (continued)

In the table on page 20, the recovery rates of different classes of materials are given as 'Energy recovery' and 'Recycling' rates. 'Energy recovery' is where the material is converted into some form of energy and reused in this fashion, whereas 'Recycling' is where the material is reused to make new products.

The percentage total recovery (PTR) can be calculated as

$$PTR = \frac{Energy \ recovery \ (Mt) + Recycling \ (Mt)}{Generation \ (Mt)} \times \frac{100}{1}$$

(b) Complete the table by adding the missing data for Organics and Plastics and calculate the PTR (to one decimal place) for Organics and Plastics.

Material class	Energy recovery (Mt)	Recycling (Mt)	Generation (Mt)	PTR (%)
Metals	0.0	4.6	5.2	88.5
Organics				
Paper and cardboard	0.5	3.2	5.3	69.8
Plastics				
Glass	0.0	0.6	1.1	54.5

(c)	Identify the material with the lowest percentage total recovery (PTR) and justify a strategy to improve its recovery rate.	3

#### **End of Question 23**

2

#### Question 24 (8 marks)

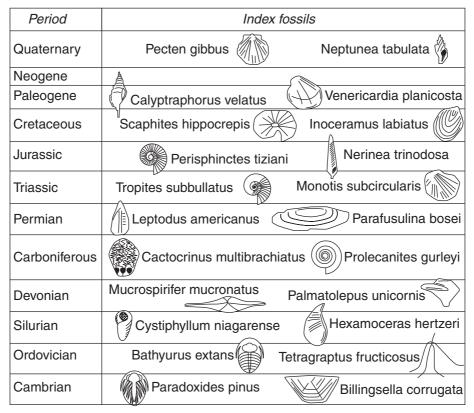
The diagram shows the relationship between various geological units in a study area.

Diagram 1 - Block diagram of a study area

Unit 1 **KEY** Unit 2 Dolerite Unit 3 Limestone Unit 4 **Basalt** Unit 5 NOT TO Unit 6 **SCALE** Shale Unit 7 Sandstone Unit 8 Granite Unit 9 Muddy limestone Unit 10

Table 1 shows marine index fossils for various geological periods. Graph 1 is a section of a potassium–argon decay curve. A Geological Time Scale is provided at the back of this paper.

Table 1 - Marine index fossils

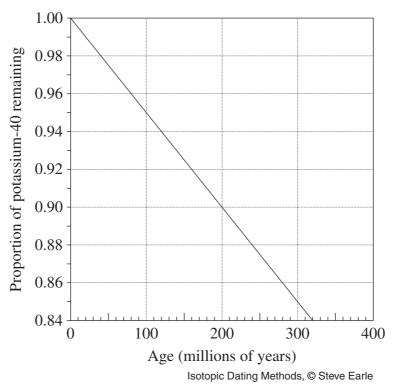


Public Domain, United States Geological Survey (USGS), http://pubs.usgs.gov/giv/geotime/fossiis.html

#### Question 24 continues on page 23

Question 24 (continued)

Graph 1 - Section of a potassium-argon decay curve



(a) Complete the table by adding the missing data.

4

Unit	Lithology	An index fossil	Proportion potassium-40 remaining	Geological Period	Absolute age in millions of years
1			0.99		
2	Basalt		0.96	Cretaceous	80
3	Sandstone	Perisphinctes tiziani		Jurassic	
4	Muddy limestone			Triassic	
5					
6	Muddy limestone			Triassic	
7					
8		Cystiphyllum niagarense			
9	Shale	Tetragraptus fructicosus		Ordovician	
10	Granite		0.865	Permian	

Question 24 continues on page 24

# Question 24 (continued)

(b)	What is the likely age of Unit 7? Give reasons for your answer.

**End of Question 24** 

<b>Question 25</b> (2 m	narks)					
How can the relia	ability of the	data from a	first-hand i	investigation be	tested?	2
			•••••••			
Question 26 (4 m	narks)					
The graph shows and the relative a					-	4
100% - 1% -	\		, <u>.</u>	Oxygen	-100%	2
Atmospheric Concentration 2 100 ppm - 10-4 ppm - 10-6 ppm - 10-6 ppm - 10-8	Carbon d	lioxide \			-1% -1000 ppm	Atmospheric CO <sub>2</sub> concentration
st 10 <sup>-2</sup> ppm - 10 <sup>-4</sup> ppm -		,		Relative	-100 ppm -10 ppm	osphe
₩ 5 10 <sup>-6</sup> ppm - 10 <sup>-8</sup> ppm -				deposition of BIF	-1 ppm -0.1 ppm	Atmo co
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_	4.0	3.0	2.0	1.0	0	
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Explain how the time. Use information	_			_	ydrosphere over	
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## Question 27 (3 marks)

The average abundance of iridium in meteorites is 0.5 ppm and the average abundance of iridium in general crustal rocks is less than 0.001 ppm.
How can the iridium content of BOTH meteorites and Earth's crust be used to support the theory that the end-Cretaceous mass extinction was caused by a meteorite impact?

Question 28 (4 marks)	
Explain how BOTH tsunamis and lahars are produced.	4

Please turn over

Question 29 (7 marks)
Evaluate technologies used in meteorology to predict extreme weather events. 7

<b>Ouestion</b>	30	(7	marks	١
Oucsuon	JU	( /	marks	,

(a)	Account for the difference in the depth at which earthquakes originate at divergent and convergent boundaries.	3

(b) Compare the effects of explosive and effusive volcanism on BOTH the biosphere and atmosphere.

Bios	phere
Explosive volcanism	Effusive volcanism
Atmo	sphere
Explosive volcanism	Effusive volcanism

4

# Question 31 (4 marks)

CO <sub>2</sub> when Earth's history has shown the planet has undergone several periods of increasing levels of atmospheric CO <sub>2</sub> ?

# Question 32 (5 marks)

(a)	Explain how oceans become acidified.	3
(b)	Describe ONE effect of ocean acidification.	2

Please turn over

# Question 33 (6 marks)

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	lain how scientists can interpret past environments from the study of mentary rocks. Support your answer using examples.
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# Question 34 (3 marks)

Assess the increases.	use of	ONE geo-	engineering	strategy in	mitigating	global temper	rature
••••••	•••••	•••••	•••••	•••••			•••••

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## Question 35 (9 marks)

anthropogenic environmental problems facing Australia AND developing management strategies to minimise the effects of these problems. Use examples to support your answer.

Question 35 continues on page 35

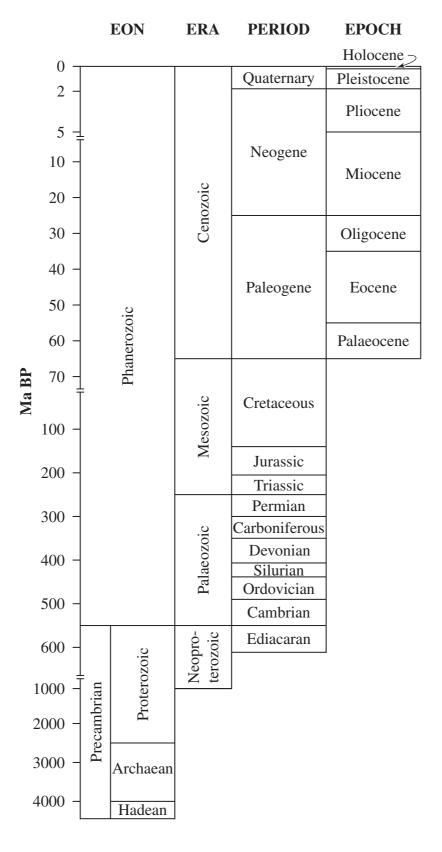
Question 35 (continued)

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# Earth and Environmental Science

# **Geological Time Scale**



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