Earth as a System: Energy, Matter, and Life

Standard difficulty · 20 questions · 40 marks · Time: 38 minutes

Name: _____ Date: _____ Score: ____ / 40

Show your working for Sections B and C. Answers are on the last page — try every question first!

Section A — Choose the correct answer — 8 × 1 = 8 marks

1. Of every 100 units of sunlight reaching the Earth, 26 are reflected back to space and 23 are absorbed by the atmosphere. How many are absorbed by the surface?

(a) 77 **(b)** 74 **(c)** 49 **(d)** 51

2. Nitrification is a step in:

(a) the nitrogen cycle **(b)** the water cycle
(c) the carbon and oxygen cycles **(d)** the rock cycle

3. Almost all the energy that drives the Earth's weather and life comes from:

(a) volcanoes **(b)** the Moon
(c) the Sun **(d)** the Earth's core

4. The same 25,200 J of energy is given to 1 kg of water and 1 kg of dry soil. Water needs 4200 J and soil 840 J to warm 1 kg by 1 °C. The soil warms by:

(a) 60 °C **(b)** 11 °C **(c)** 6 °C **(d)** 30 °C

5. At a beach the land is at 39 °C and the sea is at 44 °C. The breeze blows:

(a) not at all **(b)** from the sea to the land
(c) from the land to the sea **(d)** straight upwards only

6. Pumping out too much groundwater mainly:

(a) thins the ozone layer
(b) causes algal blooms that use up the oxygen fish need
(c) pollutes soil and harms sea animals
(d) makes the water table fall

7. Old ice reflects about 50% of sunlight. If 700 W of sunlight falls on each square metre, how much is absorbed per square metre?

(a) 351 W **(b)** 350 W **(c)** 700 W **(d)** 175 W

8. Assertion (A): Ice melting in the Arctic speeds up warming there.
Reason (R): Ice has a high albedo; the darker ocean absorbs more sunlight.

(a) Both A and R are true, and R is the correct explanation of A.
(b) Both A and R are true, but R is not the correct explanation of A.
(c) A is true, but R is false.
(d) A is false, but R is true.

Section B — Short answer — 8 × 2 = 16 marks

9. 28 mm of rain falls on a 470 m^2 school playground. How many litres of water is that? (1 mm on 1 m^2 is 1 litre.)

10. Give two differences between weather and climate.

11. Why is it hotter at the equator than at the poles?

12. How much energy is needed to warm 15 kg of water by 32 °C? (Water needs 4200 J to warm 1 kg by 1 °C.)

13. The plants in a forest capture 7,000 kJ of energy. Using the 10% rule, how much reaches the top carnivores (third consumers)?

14. Name the process in which (a) bacteria turn ammonia into nitrates, (b) nitrogen gas is turned into compounds by bacteria or lightning. Which cycle is each part of?

15. A car gives out 180 g of carbon dioxide per km and is driven 17 km every day. How many kilograms of carbon dioxide is that in a year (365 days)? If a tree absorbs about 25 kg a year, about how many trees would it take to absorb this?

16. Of 100 units of incoming sunlight, 34 are reflected to space and 51 are absorbed by the Earth’s surface. How many units does the atmosphere absorb? What fraction of the sunlight is reflected?

Section C — Word problems — 4 × 4 = 16 marks

17. Describe the carbon cycle.

18. A school roof is 20 m by 20 m. The town gets 1070 mm of rain a year, and the harvesting system collects 75% of the rain falling on the roof. How many litres does it collect in a year, and for how many days would that supply the school's 500 L a day?

19. On a sunny morning, 4 kg of sea water and 4 kg of beach sand each absorb 100,800 J. Water needs 4200 J and sand 840 J to warm 1 kg by 1 °C. Find the temperature rise of each, and explain which way the breeze will blow in the afternoon.

20. Explain: (a) Coastal cities have milder summers than inland cities. (b) Ice melting in the Arctic speeds up warming there.

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Answer key

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Q	Answer	Working
1	**(d) 51**	100 − 26 − 23
2	**(a) the nitrogen cycle**	bacteria turn ammonia into nitrates
3	**(c) the Sun**	—
4	**(d) 30 °C**	ΔT = Q ÷ (m × c) = 25200 ÷ (1 × 840); five times the 6 °C rise of the water
5	**(c) from the land to the sea**	warm air rises over the sea; cooler air flows in from the land
6	**(d) makes the water table fall**	—
7	**(b) 350 W**	50% of 700
8	**(a) Both A and R are true, and R is the correct explanation of A.**	A is true: yes: dark sea water replaces white ice. R is true and explains A.
9	**13,160 L**	470 × 28
10	**Weather is the day-to-day state of the air in a place; climate is the average weather of a place over many years.**	—
11	**Sunlight strikes the equator almost head-on, so its energy falls on a smaller area; at the poles it arrives at a slant and spreads over a larger area.**	—
12	**2,016,000 J**	Q = m × c × ΔT = 15 × 4200 × 32
13	**7 kJ**	10% passes to each next level: 7,000 → 700 → 70 → 7 kJ; the herbivores (e.g. deer) get 700 kJ
14	**(a) Nitrification, the nitrogen cycle; (b) Nitrogen fixation, the nitrogen cycle**	—
15	**1116.9 kg; about 45 trees**	180 × 17 × 365 ÷ 1000 = 1116.9 kg; 1116.9 ÷ 25 ≈ 44.7, round up
16	**15 units; 34%**	100 − 34 − 51 = 15
17	**Plants take in carbon dioxide for photosynthesis and store carbon in food. Animals eat plants. Respiration of all living things, decay by decomposers and burning of fuels return carbon dioxide to the air. Some carbon is stored for long times in fossil fuels and in the oceans.**	—
18	**321,000 L; about 642 days**	20 × 20 = 400 m^2; × 1070 mm = 428,000 L; × 75% = 321,000 L; ÷ 500

Q	Answer	Working
19	**Water: 6 °C; sand: 30 °C. The land becomes hotter, so air over it rises and a sea breeze blows from the sea to the land.**	ΔT = Q ÷ (m × c): 100800 ÷ (4 × 4200) and 100800 ÷ (4 × 840)
20	**(a) Water has a high specific heat capacity, so the sea heats and cools slowly. (The sea warms slowly.) (b) Ice has a high albedo; the darker ocean absorbs more sunlight. (Dark sea water replaces white ice.)**	—