3.3 Option: Extreme environments

Name: _____ Class: _____ Date: _____ **Total: 30 marks**

KEY WORDS extreme environment • moraine • permafrost • active layer • opportunity • challenge

Objective

Build the skills to answer Paper 1 questions on the **extreme environments** option: cold (mountains, polar, glacial) and dry (hot desert) places, glacial and desert landforms, **permafrost** , the opportunities and challenges these places offer, and how climate change is changing them.

You must be able to:

- describe where extreme environments are and why they are extreme
- explain glacial landforms (U-shaped valleys, moraines) and desert landforms (dunes, wadis)
- explain the challenges of building on permafrost and how engineers respond
- explain the opportunities extreme environments offer, with examples
- explain the effects of climate change on glaciers, permafrost and people

1 Key knowledge and worked examples

Cold and dry places

- **Cold**: high mountains, polar and glacial areas. Ice erodes valleys into a **U shape** and leaves piles of rock called **moraines** .
- **Dry**: hot deserts (under about 250 mm of rain a year). Clear skies give a large daily temperature range. Wind builds dunes; rare **flash floods** cut steep valleys (wadis).
- **Permafrost**: ground frozen for at least two years in a row. The top layer that thaws each summer is the **active layer** .

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Opportunities and challenges

opportunities	challenges
minerals, oil and gas	cold or heat, little water
tourism, adventure sport	poor access, high building costs
solar and wind energy	a fragile environment that recovers slowly
scientific research	small, often Indigenous, populations whose culture is under pressure

Case study: the Qinghai–Tibet Railway (opened 2006). Much of the line crosses permafrost. Heat from the track could thaw it and make the track sink, so engineers built bridges, embankments of crushed rock (cold air sinks between the stones) and heat pipes (thermosiphons) that carry heat out of the ground. It brings tourists and trade to Tibet; it also brings pressure on a fragile environment and on local culture.

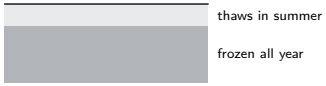
Climate change

Mountain glaciers are shrinking, which first adds meltwater and later reduces the water that rivers carry in the dry season. Lakes held by moraines can burst (**glacial lake outburst floods**). Thawing permafrost damages roads and buildings and releases methane.

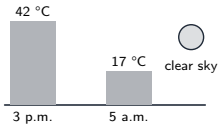
Worked example. A glacier was 6.0 km long in 1985 and 4.8 km long in 2025. Retreat = 1.2 km in 40 years = 1,200 ÷ 40 = 30 m a year.

2 Practice

2.1 Define **permafrost** and the **active layer**. [2]



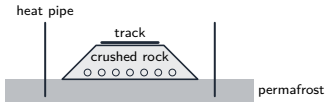
2.2 In a hot desert town, the temperature is 42 °C at 3 p.m. and 17 °C at 5 a.m. Calculate the daily range, and explain why it is so large. [3]



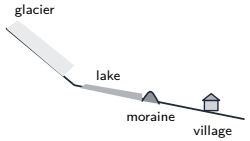
2.3 State **two** opportunities that extreme environments offer to people. [2]



2.4 Explain how engineers protected the Qinghai–Tibet Railway from thawing permafrost. [3]



2.5 Explain **two** ways in which shrinking mountain glaciers affect people living downstream. [4]



3 Exam-style questions

3.1 *(Paper 1 style.)* The table shows the length of a mountain glacier (illustrative data).

(a) Calculate the average rate of retreat, in metres per year, from 1985 to 2025. [2]

year	1985	1995	2005	2015	2025
length (km)	6.0	5.8	5.5	5.2	4.8

(b) Describe **two** landforms the glacier left behind as it retreated, and how each formed. [4]

3.2 "The opportunities of extreme environments are greater than the challenges." Discuss this statement. [10]

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