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GCSE · Physical geography

GEO.PH9 Tropical Storms: Formation, Structure and Distribution

AQA 8035 · Calculators not allowed · about 50 minutes

Total Marks

Name: ________________________________ Date: ____ / ____ / ______

Answer ALL questions. Show all your working.

1 State the minimum sea surface temperature (in degrees C) typically needed for tropical storm formation.

(Total for Question 1 is 1 mark)

2 Give one reason why the Coriolis effect is necessary for tropical storm formation, in the context of rotating storms over the ocean.

(Total for Question 2 is 1 mark)

3 Name TWO atmospheric conditions, other than warm sea surface temperature, that favour tropical storm formation.

(Total for Question 3 is 2 marks)

4 State the typical latitude band (in degrees north and south) where tropical storms most commonly form globally.

(Total for Question 4 is 1 mark)

5 Give one structural feature of a mature tropical storm and briefly state its function, using the storm structure context.

(Total for Question 5 is 2 marks)

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6 Explain why low vertical wind shear helps a tropical storm to intensify, in the oceanic formation context.

(Total for Question 6 is 3 marks)

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7 State approximately how deep the warm ocean layer typically needs to be (in metres) to support tropical storm formation, as used in GCSE specification context.

(Total for Question 7 is 2 marks)

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8 Figure 1 shows a simplified global map of tropical storm tracks over a recent 10 year period. The data are: Atlantic basin: 120 storms between 10 and 30 degrees north, mostly curving north-eastward after westward motion; North Pacific: 160 storms between 5 and 25 degrees north, tracking west then recurving poleward; South Pacific/Indian Ocean: 90 storms between 5 and 25 degrees south, moving westwards. Describe the global distribution of tropical storms shown in Figure 1.

(Total for Question 8 is 4 marks)

9 Label the main structural features on the annotated cross section of a mature tropical storm in Figure 2 and explain the role of the eyewall. Figure 2: a vertical cross section through the storm centre showing a central eye, a surrounding ring labelled 'eyewall', and outer spiralling rain bands.

(Total for Question 9 is 4 marks)

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10 Give TWO reasons why tropical storms tend not to form within about 5 degrees of the equator.

(Total for Question 10 is 2 marks)

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11 A tropical basin recorded 80 tropical storms in a 10 year period. If the North Pacific recorded 160 in the same period, what fraction of these two basins combined did the North Pacific represent? Give your answer as a fraction in simplest form.

(Total for Question 11 is 3 marks)

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12 Explain how climate warming might change the intensity and distribution of tropical storms in future, using physical processes taught in the tropical storms topic.

(Total for Question 12 is 4 marks)

13 Give THREE measurable hazards associated with a landfalling tropical storm that emergency planners would monitor, naming the hazard and its measurement method.

(Total for Question 13 is 3 marks)

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14 Explain how tropical storms form, starting from a warm ocean surface and including the roles of sea surface temperature, low pressure, rising air, the Coriolis effect and wind shear. Use named processes and sequence your explanation clearly for the tropical storm formation context.

(Total for Question 14 is 6 marks)

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15 Suggest two practical actions coastal communities can take to reduce the risk from tropical storm impacts, and give a brief reason for each action in the tropical storm preparedness context.

(Total for Question 15 is 4 marks)

Mark scheme · GEO.PH9 Tropical Storms: Formation, Structure and Distribution

Question 1

- **B1** 27 degrees C
- **Answer: 27 degrees C**

Question 2

- **B1** it causes the developing air to rotate, allowing a organised cyclonic circulation to form, oe
- **Answer: The Coriolis effect causes the air to rotate, allowing a organised cyclonic circulation to develop.**

Question 3

- **B1** low vertical wind shear, oe
- **B1** low surface pressure / an area of low pressure, oe
- **Answer: Low vertical wind shear and low surface pressure.**

Question 4

- **B1** about 5 to 30 degrees north and south of the equator, oe
- **Answer: About 5 to 30 degrees north and south of the equator.**

Question 5

- **B1** feature named, e.g. the eye, oe
- **B1** function, e.g. calm, low wind and low cloud area at the centre of the storm, oe
- **Answer: The eye, the calm central area with relatively low winds and reduced cloud.**

Question 6

- **B1** low wind shear allows the storm to remain vertically aligned, oe
- **B1** linked detail, e.g. vertical alignment keeps the rising warm, moist air above the surface heat source, allowing strong convection, oe
- **B1** linked consequence, e.g. this strengthens the central low pressure and increases wind speeds, so the storm intensifies, oe
- **Answer: Low wind shear allows the storm to stay vertically aligned so rising warm moist air remains above the ocean heat source, sustaining strong convection; this strengthens the central low pressure and increases wind speeds, causing intensification.**

Question 7

- **B1** about 60 metres, oe
- **B1** accept 60 to 70 metres, oe
- **Answer: About 60 to 70 metres (typically cited as about 60 metres).**

Question 8

- **B1** storms are concentrated between about 5 and 30 degrees north and south of the equator, oe
- **B1** most tracks begin moving westward then often curve poleward or northeast/east as they move, oe
- **B1** higher numbers in the North Pacific and Atlantic north of the equator compared with the southern hemisphere data given, oe
- **B1** some basins show recurving tracks when storms move away from the equator, oe
- **Answer: Tropical storms are concentrated in bands roughly 5 to 30 degrees north and south of the equator. In the Atlantic and North Pacific they commonly move westward then curve poleward or northeast as they recurve; the North Pacific shows the highest total in the data given, while the South Pacific and Indian Ocean tracks are mainly in the southern band and move westward.**

Question 9

- **B1** label eye, oe
- **B1** label eyewall, oe
- **B1** label spiral rainbands or outer rainbands, oe
- **B1** explain role of eyewall, e.g. location of the strongest winds and heaviest convection/rainfall that drives the storm, oe
- **Answer: Labels: eye; eyewall; spiral rainbands. The eyewall is the ring of strongest winds and most intense convection and heavy rain surrounding the eye; it is the main engine of the storm and produces the highest wind speeds and most destructive conditions.**

Question 10

- **B1** the Coriolis effect is too weak near the equator to cause sufficient spin, oe
- **B1** rising air near the equator tends to move vertically without producing the rotation needed, or other phrasing about lack of Coriolis force, oe
- **Answer: Because the Coriolis effect is too weak near the equator to provide the spin needed for cyclone rotation, and rising air there does not acquire sufficient rotation to form organised cyclonic circulation.**

Question 11

- **M1** 160 / (160 + 80) or 160 / 240 seen, oe
- **A1** 2/3 cao
- **B1** fraction simplified to 2/3 stated, oe
- **Answer: 2/3**

Question 12

- **B1** warmer sea surface temperatures can provide more heat energy and moisture, allowing storms to become more intense, oe
- **B1** linked detail, e.g. higher ocean heat content can increase the potential for higher wind speeds and heavier rainfall in storms, oe
- **B1** distribution change, e.g. storms may form or move into higher latitudes as warmer waters extend poleward, oe
- **B1** linked consequence, e.g. regions not previously exposed to frequent intense storms may face increased risk, oe
- **Answer: Climate warming raises sea surface temperatures and ocean heat content, giving storms more heat energy and moisture so they can become more intense with stronger winds and heavier rainfall. Warmer waters may extend poleward, allowing storms to form or track into higher latitudes and exposing new regions to risk.**

Question 13

- **B1** wind speed measured with anemometers or satellite estimates, oe
- **B1** rainfall amount measured in mm using rain gauges or radar estimates, oe
- **B1** storm surge or sea level rise measured in metres relative to normal tide levels or by tide gauges, oe
- **Answer: Wind speed measured by anemometers or satellite estimates; rainfall measured in mm by rain gauges or radar; storm surge measured in metres above normal tide level using tide gauges.**

Question 14

- **Level 3** (5-6): A clear, well-sequenced explanation that links warm sea surface temperatures and deep warm water to strong evaporation and rising moist air, describes development of a central low pressure and organised convection, explains how the Coriolis effect induces rotation, and shows why low wind shear is necessary for vertical alignment. The answer shows cause and effect throughout and reaches a coherent description of cyclone formation.
- **Level 2** (3-4): A reasonable explanation that covers most key processes, such as warm water causing evaporation and rising air, and mentions rotation by the Coriolis effect and low wind shear, but with less sequencing or weaker links between processes.
- **Level 1** (1-2): Limited factual points, for example naming one or two relevant factors (warm water, Coriolis) with little or no explanation of how they interact to form a tropical storm.
- **Level 0** (0): No relevant content.
- **Indicative content:**
  - Warm sea surface temperatures of about 27 degrees C or warmer, to a depth of around 60 to 70 metres, provide heat energy and moisture by evaporation.
  - Warm, moist air rises from the ocean surface, creating an area of low surface pressure beneath.
  - Rising air cools and condenses to form deep convection and thunderstorm clouds, releasing latent heat which warms the column of air and lowers pressure further, intensifying upward motion.
  - The Coriolis effect causes the rising air to turn, producing organised rotation around the low pressure centre and preventing air flowing directly into the centre; this rotation is essential for cyclone development but is too weak very close to the equator.
  - Low vertical wind shear allows the developing system to remain vertically aligned so the heat engine is maintained; strong shear would disrupt the structure and prevent intensification.
  - Over time, the organised convection and rotation produce a warm-core, tightly organised system with spiral rainbands, an eyewall of strongest winds, and a relatively calm eye at the centre.

Question 15

- **B1** action 1 named, e.g. building sea walls or flood defences, oe
- **B1** reason for action 1, e.g. reduces damage from storm surge and coastal flooding, oe
- **B1** action 2 named, e.g. early warning systems and evacuation planning, oe
- **B1** reason for action 2, e.g. allows people to move to safety and reduces casualties, oe
- **Answer: Build sea walls or flood defences to reduce damage from storm surge and coastal flooding; implement robust early warning systems and evacuation plans so people can move to safety and casualties are minimised.**