Climate & the Environment

Figures current as of October 2026

What is happening to the planet and why: the chemistry and physics of a warming atmosphere, the record and the models, the impacts, the other environmental problems, where the emissions come from, the solutions sector by sector, carbon removal and geoengineering, the politics and the money, adaptation, and what to watch, with the arithmetic worked at each step.

MODULE 1 — The Chemistry and Physics

Goal: Understand why the gases trap heat and where the carbon goes.

How carbon dioxide, methane, and nitrous oxide absorb infrared and how much each, the carbon cycle and the ocean's chemistry, why methane is the fast lever, and one tonne of carbon dioxide followed from the tailpipe to the temperature.

MODULE 2 — The Record and the Models

Goal: Read how warming is measured and projected, and weigh whether it is speeding up.

Thermometers, the ocean, satellites, and ice cores; the models and their track record; the attribution science that ties a heatwave to a cause; and the argument over whether warming has accelerated.

MODULE 3 — The Impacts

Goal: Read what is here and what is coming, and who is hit first.

Heat, sea level, water, fire, storms, crops, the ocean, and ecosystems in a table, the events of 2025 and 2026, and the distribution of the damage.

MODULE 4 — The Other Environmental Concerns

Goal: Separate the problems that are climate from the ones that are not.

Air pollution, plastics, forever chemicals, biodiversity, the nitrogen cycle, forests, and water, each with its scale, its trend, and its tie to climate.

MODULE 5 — Where the Emissions Come From

Goal: Read the sources by sector and country.

The sectors, the countries in 2025, the three ways of counting responsibility, and an American household's tonnes worked.

MODULE 6 — Solutions: Energy and Transport

Goal: Understand the parts that are working, and the American reversal.

Solar, wind, batteries, nuclear, electric cars, and heat pumps in 2025 and 2026, what they avoided, and what Washington undid in 2025-26.

MODULE 7 — Solutions: The Hard Sectors

Goal: Understand the parts electricity does not reach.

Steel, cement, chemicals, aviation, shipping, and farming, the chemistry of each problem, the fixes and their prices, and the hydrogen question.

MODULE 8 — Carbon Removal and Geoengineering

Goal: Weigh taking carbon back and blocking the sun.

Removal method by method, what a billion tonnes a year would take, worked, solar geoengineering's physics and first experiments, and the argument over researching it.

MODULE 9 — The Politics and the Economics

Goal: Understand the agreements, the money, and the arguments.

Paris and its ratchet from Belém to Antalya, the pledges and the American exit, carbon prices and the border tax, the finance, the courts, and the argument over pace and cost.

MODULE 10 — Adaptation

Goal: Understand living with what is locked in.

What the next twenty years hold whatever is done, the defenses and their limits, who pays, and the argument over adaptation against cutting emissions.

MODULE 11 — Where Things Stand, and What to Watch

Goal: Close with the argument, the contradictions, and the dates.

The course in one argument, five contradictions, the settled and the unsettled, a dated watch list from October 2026 on, and a last word.

A note on the ground. Climate has a settled core and a contested edge, and the two are often confused. The greenhouse effect, the measured warming, and its human cause are settled to the standard of any science, while the sensitivity's exact value, the pace of the impacts, the cost of the fixes, and what to do are contested, honestly so. The science here is that of the Intergovernmental Panel on Climate Change (IPCC), the World Meteorological Organization (WMO), the US National Oceanic and Atmospheric Administration (NOAA), the Global Carbon Project, and the peer-reviewed literature. Energy figures come from the International Energy Agency (IEA) and Ember, and the pledge arithmetic from the UN Environment Programme (UNEP) and Climate Action Tracker, each named with its date in the table before Module 1. Where the field argues, over whether warming is speeding up, geoengineering, the pace and cost of the transition, and adaptation against cutting emissions, each side's case is put as its advocates make it, followed by the evidence and the course's reading. Figures are dated to October 2026.

Key Numbers, as of October 2026

The measurements and records the course relies on

Measure	Figure	Period	Source and release
Carbon dioxide	Global average 425.7 parts per million (ppm), 52% above the pre-industrial 280 (about 427 ppm at Mauna Loa, Hawaii); Mauna Loa's seasonal peak 432.3 ppm on NOAA's measure (432.0 on Scripps's), 1.8 ppm above a year earlier	2025; May 2026	Global Carbon Project, *Global Carbon Budget 2025* (November 13, 2025); NOAA and the Scripps Institution of Oceanography (June 2026)
Methane and nitrous oxide	Methane 1,942 parts per billion, about 2.7 times pre-industrial; nitrous oxide 338.0 parts per billion, about a quarter above	2024	WMO, *State of the Global Climate 2025* (March 23, 2026)
Global temperature	1.43°C (2.57°F) above 1850-1900, plus or minus 0.13, the second- or third-warmest year; 2024 the warmest, at about 1.55°C; 2015-2025 the eleven warmest years on record	2025	WMO (March 23, 2026)
Human-caused warming	1.37°C, rising 0.27°C a decade over 2016-2025; the observed 2016-2025 average 1.26°C	2025	*Indicators of Global Climate Change 2025* (IGCC), Forster and others, *Earth System Science Data* (June 11, 2026)
2026 so far	August tied July 2023 as the hottest month on record in absolute terms, 1.65°C above the pre-industrial August average; January-September the second warmest on record, behind 2024; September's ocean surface the warmest departure from normal of any month	January-September 2026	Copernicus Climate Change Service (September 10, 2026); NOAA National Centers for Environmental Information (October 9, 2026)
El Niño	Tropical Pacific (Niño-3.4) 2.1°C above normal in September; a strong-to-very-strong event over 83% likely, an 83% chance of passing every El Niño since 1950 in October-December, lasting at least through January-March 2027	October 2026	NOAA Climate Prediction Center, El Niño advisory (October 8, 2026)
Emissions	Fossil carbon dioxide 38.1 billion tonnes, a record, up 1.1%, plus 4.1 billion from land use; all greenhouse gases 57.7 billion tonnes of CO_2-equivalent in 2024, up 2.3%	2025; 2024	*Global Carbon Budget 2025* (November 13, 2025); UNEP, *Emissions Gap Report 2025* (November 4, 2025)
Remaining carbon budget	For a 50% chance of holding 1.5°C: 130 billion tonnes of carbon dioxide, about three years at current emissions (170 billion, about four years, on the Global Carbon Project's estimate)	From January 2026	IGCC (June 11, 2026); *Global Carbon Budget 2025*
Warming per tonne	About 0.45°C per 1,000 billion tonnes of carbon dioxide emitted (likely 0.27-0.63°C), the near-linear rule the budgets rest on	Assessed 2021	IPCC, Sixth Assessment Report, Working Group I (August 2021)
Sea level and heat	Sea level rising 4.75 mm (0.19 inch) a year in 2012-2025, against 2.65 mm in 1993-2011, and about 23 cm (9 inches) above 1901; ocean heat at a record; the planet's energy imbalance more than double its 1976-1995 level	2025	WMO (March 23, 2026); IGCC (June 11, 2026)
Arctic sea ice	Summer minimum 4.6 million km² (1.78 million square miles) on September 12, tied for 10th lowest; the March winter peak tied the record low	2026	The US space agency (NASA) and the National Snow and Ice Data Center (September and March 2026)

Measure	Figure	Period	Source and release
Where pledges lead	2.3-2.5°C of warming by 2100 if the pledges are met and 2.8°C on current policies (UNEP); 2.6°C on current policies, down from 3.6°C in 2015 (Climate Action Tracker)	November 2025	UNEP (November 4, 2025); Climate Action Tracker (November 13, 2025)
Clean power	Solar added a record 664 gigawatts (GW) of capacity, 57% of it in China, passing 3,000 GW in early 2026; wind added 165 GW, to 1,299 GW; solar and wind met 99% of the growth in electricity demand, and fossil generation fell 0.2%	2025	SolarPower Europe (June 22, 2026); Global Wind Energy Council (April 20, 2026); Ember, *Global Electricity Review 2026* (April 21, 2026)
Money and carbon prices	Clean-energy investment expected at about $2.2 trillion in 2026, against $1.2 trillion for fossil fuels; 87 carbon prices cover just over 29% of emissions and raised $107 billion in 2025; European Union (EU) allowances €82.40 a tonne (Intercontinental Exchange December contract, October 5, 2026)	2025-26	IEA, *World Energy Investment 2026* (June 2026); World Bank, *State and Trends of Carbon Pricing 2026* (May 19, 2026); Intercontinental Exchange (October 5, 2026)
Carbon removal	About 2.2 billion tonnes a year, 99.9% of it by forests and soils; newer methods about 2 million tonnes	Latest estimate	*The State of Carbon Dioxide Removal* (June 2026)
Damage and adaptation	About 546,000 heat deaths a year in 2012-2021, up 63% since the 1990s; disaster losses $224 billion in 2025, $108 billion insured; developing countries' adaptation needs $310-365 billion a year by 2035, against $26 billion of international public finance in 2023	Various	Lancet Countdown (October 29, 2025); Munich Re (January 13, 2026); UNEP, *Adaptation Gap Report 2025* (October 29, 2025)

A tonne is 1.10 US short tons, and a billion tonnes is a gigatonne. A rise of 1°C is a rise of 1.8°F. Gases are measured by their share of dry air, in parts per million or per billion. A gigawatt is a measure of generating capacity; energy is counted in gigawatt-hours or terawatt-hours (a terawatt-hour is 1,000 gigawatt-hours). Dollars are US dollars.

Terms the Course Uses

Term	Meaning	Why it matters
Greenhouse gas	A gas that lets sunlight in and absorbs the infrared the surface radiates back: carbon dioxide, methane, nitrous oxide, water vapor, and the fluorinated gases	The mechanism of Module 1
Radiative forcing	The change in the planet's energy balance from a cause, in watts per square meter	All human causes, net of the cooling from pollution particles, about 3.1 watts per square meter in 2025 (IGCC)
Climate sensitivity	The eventual warming from a doubling of carbon dioxide	Likely 2.5-4°C, best estimate 3°C, the number the projections turn on
Feedback	A response that amplifies or damps warming, such as water vapor, melting ice, clouds, and thawing permafrost	Why about 1.2°C of direct warming per doubling becomes about 3°C
Carbon budget	The carbon dioxide that can still be emitted for a given temperature limit	About three to four years of current emissions for 1.5°C
Net zero	Emissions balanced by removals, so the stock in the air stops rising	The condition for warming to stop; not the same as zero emissions
CO_2-equivalent	Other gases expressed as the carbon dioxide that would cause the same warming over a set period	Methane is about 80 times as potent over 20 years and about 30 over 100, so the period chosen changes the policy
Energy imbalance	The gap between the sunlight the earth absorbs and the heat it sends back to space	The most direct measure of the greenhouse effect at work; over 90% of the excess goes into the ocean

Term	Meaning	Why it matters
El Niño and La Niña	The warm and cool phases of the tropical Pacific's natural swing	An El Niño adds roughly a tenth to two-tenths of a degree to world temperatures for a year or so
Tipping point	A threshold past which a change sustains itself, as with the ice sheets, the Amazon, the Atlantic circulation, and permafrost	The nonlinear risk, with uncertain timing
Mitigation and adaptation	Cutting emissions, and living with the warming that comes anyway	Modules 6-8 and Module 10
Attribution	The science of how much more likely or intense warming made an event	Module 2; a heatwave's cause put as a number
Conference of the Parties (COP)	The annual summit of the UN climate treaty's members	The 30th summit (COP30) met in Belém, Brazil, in 2025, and the 31st (COP31) meets in Antalya, Turkey, in November 2026
Nationally determined contribution (NDC)	Each country's self-set pledge under the Paris Agreement, renewed every five years	The 2035 round, submitted in 2025-26, is the pledge arithmetic of Module 9

Module 1 — The Chemistry and Physics

Why the Gases Trap Heat, and Where the Carbon Goes

Recommended Reading / Reference

Book: Spencer Weart, *The Discovery of Global Warming* (revised edition, 2008), the history of the science; David Archer, *The Long Thaw* (2009), the carbon cycle for the general reader

Reference: IPCC, Sixth Assessment Report, Working Group I (2021), chapters 5 (the carbon cycle) and 7 (the energy budget); Global Carbon Project, *Global Carbon Budget 2025* (November 2025), for the sinks

1a. The Greenhouse Effect

Sunlight arrives as visible light and near-infrared, which the atmosphere largely lets through. The warmed surface sends the energy back out as infrared, at wavelengths of about 4 to 50 micrometers, and certain molecules absorb infrared at particular wavelengths because their bonds bend and stretch at those frequencies.

Nitrogen and oxygen, 99% of the air, are symmetric two-atom molecules with no electrical asymmetry for infrared to act on, so they absorb almost nothing. Carbon dioxide's three atoms bend at 15 micrometers, in the middle of the surface's emission, and stretch at 4.3. Methane absorbs at 3.3 and 7.7 micrometers, nitrous oxide at 7.8 and 17, and water vapor across much of the spectrum.

A molecule that absorbs infrared re-emits it in all directions, half of it back toward the ground, so the surface receives energy from the air as well as from the sun and warms until what it radiates balances what it receives. Without greenhouse gases the earth's surface would average about −18°C (0°F), and with them it averages about 15°C (59°F).

The relationship is not proportional, because carbon dioxide's absorption at the center of its 15-micrometer band is already nearly saturated. Each doubling therefore adds about the same forcing, about 3.9 watts per square meter on the IPCC's 2021 assessment, rather than twice as much as the last. That is why the effect is logarithmic and why sensitivity is stated per doubling, and the rise from 280 parts per million to about 426 has already delivered about 60% of one doubling's forcing.

1b. The Gases

Gas	Concentration	Share of greenhouse forcing	Time in the air	Warming per tonne vs carbon dioxide (100 years)	Main human sources
Carbon dioxide	425.7 ppm (2025), from 280	About two-thirds	No single lifetime: about a quarter of a release remains after 1,000 years	1	Fossil fuels and cement about 90%; land clearing about 10%
Methane	1.94 ppm (2024), from 0.72	About a sixth directly; about 0.5°C of the warming to date with its indirect effects	About 12 years	About 30 (about 80 over 20 years)	Fossil-fuel leaks and venting about a third, livestock about 30%, rice, landfills; wetlands naturally

Gas	Concentration	Share of greenhouse forcing	Time in the air	Warming per tonne vs carbon dioxide (100 years)	Main human sources
Nitrous oxide	0.338 ppm (2024), from 0.27	About 6%	About 110 years	About 270	Fertilizer and manure about 70%; industry; combustion
Halogenated gases	Parts per trillion	About an eighth	Years to millennia	Hundreds to tens of thousands	Refrigerants, electronics, aluminum smelting; the Montreal Protocol's bans and the Kigali Amendment's phase-down
Water vapor	Varies with temperature	The largest natural greenhouse gas; a feedback, not a forcing	Days	—	Rises about 7% per degree of warming, roughly doubling carbon dioxide's direct effect
Pollution particles (aerosols)	Varies	Cooling: about −1 watt (−0.96 in 2025)	Days to weeks	—	Coal and shipping sulfur; cleaning them up removes cooling

IPCC Sixth Assessment Report (2021); WMO (March 2026); IGCC (June 2026). The warming comparisons are the IPCC's; choosing a 20- or 100-year period is a policy choice.

Methane's short life makes it the fast lever. A cut in methane emissions lowers its concentration within a decade or two, while the warming from carbon dioxide persists for centuries, which is why the Global Methane Pledge's goal of a 30% cut from 2020 levels by 2030 matters so much for the next two decades' temperature.

1c. The Carbon Cycle, and the Ocean's Chemistry

Carbon moves among four stores: the atmosphere, holding about 900 billion tonnes of carbon, the land's plants and soils with about 2,500 billion, the ocean with about 38,000 billion, and the rocks and fossil fuels with tens of millions of billions. Before industry the flows among them balanced, as plants and the ocean exchanged about 200 billion tonnes of carbon with the air each year in each direction.

Human emissions of about 11.5 billion tonnes of carbon a year, the 42 billion tonnes of carbon dioxide, are small against those flows and large against their balance. The sinks have responded: the ocean takes up about a quarter of each year's emissions because carbon dioxide dissolves in seawater, and the land about a quarter because plants grow faster in richer air and longer seasons.

Both sinks weaken as the ocean warms, since warm water holds less gas, and as the land dries and burns. The 2023-24 El Niño cut the land sink sharply before it recovered in 2025, and the Global Carbon Project now counts climate change's drag on the sinks as 8% of the rise in carbon dioxide since 1960.

The ocean's uptake has a cost that is pure chemistry. Dissolved carbon dioxide forms carbonic acid, which releases hydrogen ions and has lowered surface pH from about 8.2 to 8.1 since 1800, a 30% rise in acidity. It also consumes the carbonate ions that corals, shellfish, and the plankton at the base of the food web need to build shells, and it is an effect of carbon dioxide that blocking sunlight cannot touch.

1d. One Tonne of Carbon Dioxide

Worked example — One Tonne, From the Tailpipe to the Temperature

Take one tonne of carbon dioxide, what an average car emits in about 2,800 miles at 25 miles a gallon, or about four weeks of the average American's share. **The tailpipe:** it leaves as 273 kilograms of carbon bound to 727 of oxygen, mixes through its hemisphere in weeks and the globe in about a year, and joins the roughly 3,300 billion tonnes already in the air. **The first decade:** the ocean's surface takes up a share within a year or two and the land's plants a share over the following years, but on standard carbon-cycle models about two-thirds of the tonne is still airborne after ten years. **The centuries:** the deep ocean slowly carries dissolved carbon down and the land's uptake saturates, leaving about 400 kilograms after a hundred years and about 250 after a thousand. That last quarter waits for the weathering of rocks, over tens to hundreds of thousands of years. **Why the budget is cumulative:** carbon dioxide has no single lifetime, the warming it causes is effectively permanent on a human timescale, and the atmosphere adds up everything emitted since 1850. **The temperature:** the IPCC's rule of about 0.45°C per 1,000 billion tonnes makes one tonne worth about 0.00000000000045°C. The arithmetic scales: a year of world emissions, about 42 billion tonnes, adds about 0.02°C, which comes close to the human-caused 0.27°C a decade once the other gases and the fading cooling from pollution are added. **The lesson:** the tonne is fungible and cumulative, because the atmosphere counts it once wherever it was emitted and keeps much of it for centuries. That is why the carbon budget is the right frame, why net zero is the physical requirement for stopping the warming rather than a slogan, and why a tonne removed and kept out of the air for good (Module 8) is worth about a tonne not emitted, whatever it costs.

Module 1 Key Points

The Chemistry and Physics

• Greenhouse gases absorb the surface's infrared because their bonds bend and stretch at those wavelengths; nitrogen and oxygen cannot.

• Each doubling of carbon dioxide adds about 3.9 watts per square meter, and the rise to 426 ppm has delivered 60% of one.

• Methane lasts about 12 years and is about 80 times as potent over 20, which makes cutting it the fast lever.

• The ocean and land absorb about half of each year's carbon dioxide, and both sinks weaken as the ocean warms and land dries.

• A quarter of a tonne of carbon dioxide is still airborne after 1,000 years, so the budget is cumulative and net zero is physics.

Module 1 Quiz

Check Your Understanding

1. Why do nitrogen and oxygen barely trap heat while carbon dioxide does?

A) They are symmetric two-atom molecules that absorb almost no infrared
B) Their molecules are too small to absorb sunlight
C) They sit above the heat in the high atmosphere
D) They absorb only visible sunlight, not heat

2. Roughly what share of a doubling's forcing has the rise from 280 to about 426 ppm already delivered?

A) About a fifth, since the effect grows with the square of the rise
B) About 60%
C) All of it, since the main band is saturated
D) About half, in direct proportion to the rise

3. What makes methane the 'fast lever'?

A) It is the most abundant greenhouse gas
B) It can be pulled from the air cheaply
C) It is released only by cattle and rice, which are easy to regulate
D) It lasts about 12 years and is very potent while it lasts

4. What is ocean acidification, chemically?

A) Plastic debris breaking down into acids in the ocean gyres
B) Warm surface water losing dissolved oxygen as it heats
C) Dissolved carbon dioxide forming carbonic acid
D) Acid rain from coal plants

5. In the worked example, about how much of a tonne of carbon dioxide is still in the air after a thousand years?

A) A trace, since the ocean absorbs it within a century
B) About half, because the ocean stops absorbing it
C) About 90%, because the deep ocean is saturated
D) About a quarter

Module 2 — The Record and the Models

How Warming Is Measured and Projected, and Whether It Is Speeding Up

Recommended Reading / Reference

Book: Michael Mann, *The New Climate War* (2021), and Steven Koonin, *Unsettled* (2021), the argument over what the science can and cannot say, from both sides

Paper: Grant Foster and Stefan Rahmstorf, 'Global Warming Has Accelerated Significantly' (*Geophysical Research Letters*, 2026); Zeke Hausfather and colleagues on model skill (*Geophysical Research Letters*, 2020)

Reference: WMO, *State of the Global Climate 2025* (March 2026); IGCC (June 2026); World Weather Attribution's event studies

2a. The Record

• **The instrumental record:** thermometers on land since 1850 and on ships and buoys at sea are assembled by several groups, among them NASA, NOAA, the UK's Hadley Centre, Berkeley Earth, and the European Union's Copernicus service, which share much of the raw data but process it differently. Their results agree within about a tenth of a degree, and on the WMO's combination of six datasets 2025 was 1.43°C above 1850-1900, with 2015-2025 the eleven warmest years.

• **The ocean:** more than 90% of the added heat goes into the sea, measured since the mid-2000s by about 4,000 Argo floats. Ocean heat set another record in 2025, it is the measure least disturbed by weather's year-to-year noise, and its gain shows the planet's energy imbalance has more than doubled since 1976-1995.

• **Satellites:** they have measured the lower atmosphere's temperature and the ice since 1979, sea level since 1993, and the energy balance at the top of the atmosphere continuously since 2000. Sea level rose 4.75 mm a year in 2012-2025, against 2.65 mm in 1993-2011.

• **The ice cores:** Antarctic ice holds 800,000 years of carbon dioxide and temperature, with carbon dioxide between 180 and 300 ppm through eight ice ages and never above 300 until the twentieth century. Today's level is outside anything in the history of the human species.

• **The proxies:** tree rings, corals, sediments, and cave formations reach back 2,000 years and more. They show the twentieth century's warming as the fastest of that span and today's temperature as the highest, probably for 100,000 years.

2b. The Models

A climate model divides the atmosphere, ocean, land, and ice into cells, about 100 kilometers on a side in the global models and about 10-50 in the regional ones, and solves the equations of fluid motion, radiation, and heat in each, stepping forward in time. The current generation of about 100 models, from about 50 groups, is what the projections rest on.

Their record can be checked. Models published between 1970 and 2007, run with the emissions that actually happened, projected the warming that followed within their stated uncertainty in 14 of 17 cases, including James Hansen's of 1988. The patterns they predicted before anyone saw them have also appeared: nights warming faster than days, the upper atmosphere cooling as the surface warms, the Arctic warming fastest, and land faster than sea.

Their limits are known too. Clouds are the largest uncertainty and the reason sensitivity is a range of 2.5-4°C rather than a single number, regional rainfall projections diverge, and the ice sheets and the Atlantic circulation are modeled more crudely than the air. Several of the newest models run 'hot,' with sensitivities above 5°C, and the IPCC judged them inconsistent with the record and gave them less weight.

Sensitivity is the number the century turns on. On a middle emissions path the IPCC's very likely range for warming by 2081-2100 runs from about 2.1°C to 3.5°C, much of that spread is sensitivity, and the difference is between a hard century and a dangerous one.

2c. Attribution

Since a study of Europe's 2003 heatwave in 2004, and within days of an event since about 2015, the question of whether climate change caused a heatwave has had a numerical answer. Attribution studies run the models with and without human influence and compare how likely and how intense an event is in each, often within days. The results are strongest for heat: the 2021 Pacific Northwest heat dome was virtually impossible without warming and at least 150 times more likely with it.

For extreme rainfall the findings are robust, since warmer air holds about 7% more water per degree, so the heaviest downpours get heavier. For drought they are mixed, for hurricanes' intensity and rainfall clear, for their number unclear, and for tornadoes and hail not yet possible. Attribution turned the abstract into the specific, and it now underpins the lawsuits, the insurance pricing, and the loss-and-damage claims of Modules 9 and 10.

2d. Is Warming Speeding Up?

The case that it is: Grant Foster and Stefan Rahmstorf removed the effects of El Niño, volcanoes, and the solar cycle from five temperature records and found warming of about 0.35°C a decade over the past ten years, against just under 0.2°C in 1970-2015, an acceleration they put at over 98% certainty (*Geophysical Research Letters*, 2026). Hansen and colleagues argued in 2025 that sensitivity is nearer 4.5°C and that cleaner shipping fuel added about half a watt of heating, which would bring 2°C by about 2045. Ocean heat keeps setting records, and 2023-25 ran hotter than El Niño alone explains.

The case for caution: the raw record shows no statistically detectable acceleration, and the significance appears only after the adjustments, whose own uncertainty the tests leave out, as a review on the RealClimate site put it in March 2026. Ten years is a short window, and the 'hiatus' of the 2000s was over-read the same way. The models already expected faster warming as pollution fell, about 0.24°C a decade on the IPCC's assessment and 0.29 across the full ensemble for 2015-2050, and the IGCC's human-caused rate of 0.27°C a decade sits inside that range.

The evidence between them: both sides accept that the rate has risen from about 0.2°C a decade to above 0.25, and that falling sulfate pollution is a large part of the reason. They differ over whether the last decade's 0.35 is the new trend or a noisy stretch, and over sensitivity. The doubling of the energy imbalance, measured in the ocean's heat gain and since 2000 by satellites, independently of the surface record, is the strongest evidence that something has changed, and Foster himself puts the plausible future rate at 0.24-0.30°C a decade.

The course's reading, stated once: warming has sped up, from about 0.2°C to about 0.27°C a decade in its human-caused trend, in large part because cleaner air is unmasking greenhouse warming, as the models anticipated. The faster rates measured since 2015 probably overstate the pace ahead, but the practical consequence is the same either way: at the current rate human-caused warming reaches 1.5°C around 2030, and the El Niño forecast to peak in the winter of 2026-27 could well make 2027 a record year, without settling the argument.

Module 2 Key Points

The Record and the Models

• The main temperature records agree within a tenth of a degree: 2025 was 1.43°C above pre-industrial, and 2015-2025 the eleven warmest.

• Sea level rose 4.75 mm a year in 2012-2025, nearly double the earlier pace, and the energy imbalance has more than doubled.

• Models published since 1970 projected the warming that happened in 14 of 17 cases; clouds remain the largest uncertainty.

• Attribution puts a number on an event: the 2021 Pacific Northwest heat dome was at least 150 times more likely with warming.

• Human-caused warming runs about 0.27°C a decade, up from 0.2; whether the faster post-2015 rate is the new trend is argued.

Module 2 Quiz

Check Your Understanding

1. How closely do the main global temperature records agree?

A) Within a full degree
B) Within about half a degree
C) Within about a tenth of a degree, despite different methods
D) Exactly, since they share one dataset

2. How fast did sea level rise in 2012-2025, on the WMO's figures?

A) About 4.75 mm a year, against 2.65 mm before 2012
B) About 1 mm a year, unchanged since 1900
C) About 1 centimeter a year since 2012, from Greenland's melt
D) About 3 mm a year

3. What is the largest uncertainty in the climate models?

A) The strength of the sun's eleven-year cycle and its effect on temperature
B) Clouds and how they respond
C) Volcanic eruptions and their timing in the future
D) The ocean's heat uptake

4. How much more likely did warming make the 2021 Pacific Northwest heat dome?

A) About twice as likely, within natural variability
B) No more likely, because heat domes are pure weather
C) At least 150 times more likely
D) Ten times

5. What does the course conclude about whether warming has accelerated?

A) It has slowed since 2015
B) It has not changed since 1970
C) It has tripled, to 0.6°C a decade
D) It has sped up to about 0.27°C a decade, largely as cleaner air unmasks greenhouse warming

Module 3 — The Impacts

What Is Here and What Is Coming

Recommended Reading / Reference

Reference: IPCC, Sixth Assessment Report, Working Group II (2022), on impacts and vulnerability; the Lancet Countdown on health and climate change (October 2025); Munich Re's natural-catastrophe reviews (January and July 2026); NOAA's Coral Reef Watch; two studies of the Atlantic circulation in *Science Advances* (April 2026)

3a. The Impacts, by System

System	Already observed	Projected at 2-3°C	Note
Heat	Heatwaves often made 1-3°C hotter and far more frequent; about 546,000 heat deaths a year in 2012-2021, up 63% since the 1990s	Parts of South Asia, the Gulf, and the Sahel near the limits of human tolerance for days a year; outdoor work hours lost	The first-order impact, falling hardest on the poor, the old, and outdoor workers
Sea level	About 23 cm (9 inches) since 1901, rising 4.75 mm a year and accelerating; coastal flooding more frequent	About 0.4-0.8 meter by 2100 at 2-3°C, more if the ice sheets destabilize; meters more committed over centuries	Greenland and West Antarctica the tipping elements; hundreds of millions of people on low coasts
Water	Longer, deeper droughts in the Mediterranean, the American West, and southern Africa; heavier downpours in most regions	Snowpack shrinking in most mountain ranges; many glacier-fed rivers past peak flow; wet regions generally wetter and many dry ones drier	The Rhine at Kaub fell to 4 cm on September 24, 2026, its lowest reading since 1880
Fire	Longer fire seasons; one estimate finds climate change doubled the forest area burned in the American West since 1984; Canada's record 2023 season	Many more fire-weather days in fire-prone regions	Insurers withdrawing from fire zones
Storms	Hurricanes wetter and more intense, with more rapid intensification and no clear change in their number	A rising share of Category 4-5 storms; surges on higher seas	Strong El Niños tend to quiet Atlantic hurricanes and stir Pacific typhoons
Agriculture	Wheat, maize, and rice yields held below trend by heat and drought; coffee, cocoa, and wine moving	Tropical yields down 10-25% at 3°C without adaptation; more volatile harvests	Food prices the first widely felt cost
The ocean	Record surface temperatures in 2023-26; the fourth global coral bleaching event, 2023-25, exposed 84% of the world's reefs in at least 83 countries and territories; fish moving toward the poles	Most warm-water coral lost at 2°C; acidification; a slowing Atlantic circulation	Every strong El Niño since 1998 has brought a global bleaching event
Ecosystems and health	Species moving poleward and uphill; parts of the southeastern Amazon releasing more carbon than they absorb; dengue and malaria spreading; longer pollen seasons	Extinction risk rising with each degree; disease carriers expanding	The Amazon as a tipping element

IPCC (2022); Lancet Countdown (October 2025); WMO (March 2026); NOAA Coral Reef Watch (June 2026); Munich Re (January 2026); German Federal Institute of Hydrology for the Rhine. Ranges as the sources give them.

Heat kills the most people, and the 35°C 'wet-bulb' limit of human survival, combining heat and humidity, is a theoretical ceiling, since laboratory studies put the practical limit for healthy young adults lower, near 31°C,

and lower still for the old and sick. Sea level is the slowest impact and the most certain, because the ice sheets respond over centuries to warming already delivered.

The ocean's circulation is the largest risk the numbers cannot yet price: two studies published in *Science Advances* in April 2026 found the Atlantic overturning circulation weakening at four latitudes since moorings began recording in 2004, and projected a slowdown of more than half by 2100, faster than most models show. A collapse would cool northwest Europe sharply, shift tropical rains, and raise sea level along the American east coast.

3b. 2025 and 2026 in the Record

The last two years showed what a warmer baseline does to ordinary weather: in 2025 the Los Angeles fires of January became the costliest disaster of the year, Hurricane Melissa made landfall in Jamaica in October at Category 5, and natural disasters cost $224 billion, $108 billion of it insured, by Munich Re's count. Insured losses from floods, fires, and severe storms reached $98 billion, against a ten-year average of about $60 billion.

In 2026 August tied July 2023 as the warmest month on record, at 1.65°C above pre-industrial, and in September the ocean's surface set the warmest departure of any month in NOAA's record. Europe's summer drought ran from the Rhine to the Danube, cutting harvests and shipping, while in the Pacific the building El Niño pushed sea temperatures to records.

Losses are not a clean climate signal, though, since the first half of 2026 was below average for insured losses, $44 billion against a ten-year average of $50 billion, and its costliest event, a double earthquake in Venezuela, had nothing to do with climate. Rising damage also reflects more people and property in harm's way, so the trend in the physical hazards is the better measure.

3c. The Distribution

The impacts fall first on those who contributed least, and that arithmetic is the subject's moral core. Sub-Saharan Africa and the small island states emit a few percent of the world's carbon dioxide, and South Asia, home to a quarter of humanity, about a tenth, yet they face the largest share of the heat, drought, flood, and sea-level damage with the least capacity to adapt. Within every country the poor live in the hotter neighborhoods, the floodplains, and the homes without cooling, and they work outdoors.

The rich countries' exposure is real and different, showing up as insurers leaving Florida and California, water fights in the American West, and summer heat that killed tens of thousands of Europeans a year in 2022-24, but wealth, cooling, and health care turn more of it into cost and less into death than in poor countries. Time is the other axis: the emissions of the last century were mostly the rich world's, while a child born in 2020 faces two to seven times as many extreme events as one born in 1960, by one widely cited estimate. That distribution is what the loss-and-damage fund of Module 10 exists to address, and it is why the politics of the subject are the politics of who pays.

Module 3 Key Points

The Impacts

• Heat is the first-order impact: about 546,000 heat deaths a year in 2012-2021, up 63% since the 1990s.

• Sea level is about 23 cm above 1901 and rising 4.75 mm a year; meters more are committed over centuries.

• The 2023-25 bleaching event exposed 84% of the world's reefs, and every strong El Niño since 1998 has brought one.

• Disasters cost $224 billion in 2025, $108 billion insured, but losses mix weather with exposure and earthquakes.

• The impacts fall first on those who emitted least: a death toll in poor countries, mostly a cost in rich ones.

Module 3 Quiz

Check Your Understanding

1. What does the module call the first-order impact of warming?

A) Sea-level rise on the world's low coasts
B) Heat
C) Wildfire in the forests of the north
D) Stronger hurricanes and typhoons

2. About how many heat-related deaths a year did the Lancet Countdown count for 2012-2021?

A) About 546,000, up 63% since the 1990s
B) About 5,000
C) About 5.4 million, a tenth of all deaths worldwide each year
D) About 50,000, mostly in Europe

3. What share of the world's coral reefs did the 2023-25 bleaching event expose to bleaching-level heat?

A) About 10%
B) About 84%, in at least 83 countries and territories
C) Only the Great Barrier Reef
D) About a third, all in the Caribbean

4. What did natural disasters cost in 2025, by Munich Re's count?

A) About $2 trillion, almost all insured
B) About $22 billion
C) About $900 billion, led by Asian floods
D) $224 billion, $108 billion insured

5. How does the module describe the distribution of climate damage?

A) Evenly spread across countries
B) Mostly on rich countries, which emit most
C) A death toll in poor countries that emitted least, mostly a cost in rich ones
D) Concentrated in the countries with the highest emissions per person, which suffer most

Module 4 — The Other Environmental Concerns

Separating the Problems That Are Climate From the Ones That Are Not

Recommended Reading / Reference

Book: Elizabeth Kolbert, *The Sixth Extinction* (2014); Hannah Ritchie, *Not the End of the World* (2024), two readings of the same data

Reference: Health Effects Institute, *State of Global Air 2025* (October 2025); the UN Food and Agriculture Organization (FAO), *Global Forest Resources Assessment 2025* (October 2025); the *Living Planet Report 2026* (October 2026); the Stockholm Resilience Centre's planetary-boundaries updates

4a. The Map

Climate change is the largest environmental problem and not the only one, and the others are often confused with it in both directions, with air pollution blamed on warming and warming blamed on plastic. An honest map has seven other problems, each with its own chemistry and trajectory and a tie to climate that is sometimes tight, sometimes loose, and sometimes opposite.

Some share a cause: burning fossil fuels produces both carbon dioxide and the fine particles that kill millions, so cutting one cuts the other. Some share a victim, as the ocean is warmed and acidified by carbon dioxide and also overfished and polluted. Some are improving while climate worsens, such as the ozone hole, acid rain, lead, and most rich-country air, and one, the sulfur pollution from coal and ships, has been masking warming, so cleaning the air has warmed the planet.

Problem	Scale	Trend	Connection to climate
Air pollution	About 7.9 million deaths in 2023, 86% of them from heart, lung, and other chronic diseases; the leading environmental risk factor for death	Improving in rich countries and China; worsening in much of South Asia and Africa	Tight: the same combustion. But cleaning up sulfur also removes cooling, and the 2020 shipping-fuel rule added measurable warming
Plastics	About 460 million tonnes a year, under a tenth recycled; microplastics found in blood and placentas	Rising; treaty talks collapsed in Geneva in August 2025 and resumed in 2026 under a new chair, Chile's Julio Cordano	Loose: plastics are a few percent of emissions, and climate policy does little for the waste
Forever chemicals	Per- and polyfluoroalkyl substances (PFAS), in nearly everyone's blood; linked to cancers and immune and thyroid effects	US limits of 4 parts per trillion stand for two of them, and the Environmental Protection Agency (EPA) proposed on May 18, 2026 to rescind limits for four others; the EU's limit for 20 applies from January 2026	Slight: some refrigerants adopted to replace climate-warming ones are themselves forever chemicals, but this is a persistence problem, not a carbon one
Biodiversity	Monitored wildlife populations down 73% on average from 1970 to 2022, freshwater species 85%; about a million species at higher risk of extinction	Worsening; the goal of protecting 30% of land and sea by 2030 underfunded; the UN biodiversity summit meets in Yerevan, Armenia, on October 19-30, 2026	Mixed: land use and overexploitation are the largest causes and climate the fastest rising; some climate fixes, from biofuels to badly sited mines, cost habitat

Problem	Scale	Trend	Connection to climate
Nitrogen and phosphorus	Synthetic fertilizer has doubled the reactive nitrogen in circulation; dead zones in the Gulf of Mexico and the Baltic; phosphorus a mined, finite resource	Among the most transgressed of the 'planetary boundaries' in the Stockholm assessments	Partial: nitrous oxide is about 6% of greenhouse forcing, and precise fertilizer use serves both
Forests and land	Deforestation about 10.9 million hectares a year in 2015-2025, down from 17.6 in the 1990s; tropical primary forest loss 4.3 million hectares in 2025, down 36%	Improving in Brazil; the EU's deforestation rule applies to large companies from December 30, 2026	Tight both ways: land clearing is about a tenth of carbon dioxide emissions, and the land absorbs about a quarter of each year's emissions
Water and the ocean	A third of fish stocks overfished; about 4 billion people short of water at least a month a year; groundwater falling	Mixed	Tight for water and for ocean heat and acidity; loose for fishing, which is a matter of governance

Health Effects Institute (October 2025); FAO (October 2025); the World Resources Institute's Global Forest Watch (April 2026); *Living Planet Report 2026* (October 2026); the EPA and the EU's Drinking Water Directive. The connections are the course's reading of the literature.

4b. Where the Solutions Help, Hurt, and Do Nothing

Three findings follow from the map, and the first is that the move off fossil fuels is the largest public-health measure available to any country, whatever one thinks of the greenhouse effect, because fossil burning causes between about a quarter and three-fifths of outdoor air-pollution deaths on different estimates. That is why the case for clean power in Delhi or Lagos does not need climate science to be made, though China shows a second route: its air improved after 2013 mostly through scrubbers, emission standards, and cleaner household fuels, while its coal use kept rising.

Second, the transition has environmental costs of its own that the map must count: the mines for its minerals, the land for solar, wind, and biofuel crops, and the habitat under a new transmission line. They are real and smaller than the fossil system's, and they are where the biodiversity and climate agendas sometimes collide.

Third, several of the largest environmental problems are not climate problems and will not yield to climate policy, because plastics, forever chemicals, most of the nitrogen problem, and most of the extinction crisis have their own causes and fixes. A reader who treats 'the environment' as one problem will misjudge both the progress, with cleaner air, a healing ozone layer, and rich-world rivers clearer than in 1970, and the failures, in the oceans, the species, and the chemicals.

The subject's two honest readings, Kolbert's that a sixth extinction is under way and Ritchie's that most measures of the human environment are improving, are readings of different problems on the same map. The *Living Planet Report 2026* holds both: a 73% average decline since 1970, and half of the monitored populations stable or growing, with recoveries in green turtles, bluefin tuna, tigers, and southern Africa's elephants.

Module 4 Key Points

The Other Environmental Concerns

• Climate is the largest environmental problem but not the only one; others tie to it tightly, loosely, or not at all.

• Air pollution killed about 7.9 million in 2023; fossil burning causes a quarter to three-fifths of the outdoor deaths.

• Plastics, forever chemicals, and most of the extinction crisis have their own causes, which climate policy will not solve.

• Monitored wildlife populations fell 73% on average from 1970 to 2022, mostly from land use and overexploitation.

• Deforestation slowed to 10.9 million hectares a year in 2015-2025; land clearing is about a tenth of carbon dioxide emissions.

Module 4 Quiz

Check Your Understanding

1. What did the State of Global Air report put as air pollution's death toll in 2023?

A) About 7.9 million
B) About 79,000, mostly in American cities
C) About 790,000, almost all from wildfire smoke
D) Under a million, because air has improved everywhere

2. How does the module describe the link between plastics and climate?

A) Plastics are the largest single cause of warming, ahead of coal
B) Plastics absorb carbon dioxide as they break down at sea
C) Loose: a few percent of emissions
D) Unrelated

3. By how much did monitored wildlife populations fall on average from 1970 to 2022?

A) About 73%, with freshwater species worst hit
B) About 7%
C) They rose, thanks to protected areas
D) About 99%, with most species now extinct in the wild

4. Why did cleaning up shipping fuel in 2020 add warming?

A) It raised fuel use
B) It removed sulfate particles that had been reflecting sunlight and masking warming
C) Ships burned more fuel to go faster
D) It released methane from the fuel tanks

5. How fast was the world losing forest to deforestation in 2015-2025, by the FAO's count?

A) About 50 million hectares a year, double the 1990s rate
B) About 1 million hectares a year, a tenth of the 1990s rate
C) About 17.6 million hectares a year, unchanged since the 1990s
D) About 10.9 million hectares a year

Module 5 — Where the Emissions Come From

The Sources by Sector and Country

Recommended Reading / Reference

Reference: Global Carbon Project, *Global Carbon Budget 2025* (November 2025); IEA, *Global Energy Review 2026* (March 2026); Rhodium Group's preliminary estimate of US emissions for 2025 (January 2026); the Centre for Research on Energy and Clean Air (CREA) quarterly analyses of China for Carbon Brief; Our World in Data's emissions pages

5a. By Sector

Sector	Share of greenhouse gases	What it is	The 2025-26 trend
Electricity and heat	About a quarter	Coal, gas, and oil burned for power and heat	The sector that turned in 2025, when solar and wind met nearly all the growth in demand (Module 6)
Industry	About a quarter, led by steel, cement, and chemicals	Process heat and the chemistry itself, such as cement's limestone and steel's coke	Roughly flat; the hard sectors of Module 7
Agriculture, forestry, and land	About a fifth: livestock methane, fertilizer, rice, and land clearing	Cattle, fertilizer, soils, and cleared forest	Counting the whole chain from farm to plate, food systems emitted 16.5 billion tonnes in 2023, 32% of the human total on the FAO's count
Transport	About 15%: road about 12%, aviation and shipping about 2% each	Oil in engines	Road emissions still rising worldwide but falling where electric cars are a large share; China's transport oil use fell 16% in the second quarter of 2026
Buildings	About 6% directly	Furnaces, boilers, and cooking	Heat pumps gaining (Module 6); building stocks turn over in decades
Fossil-fuel operations	About 6%	Methane leaks, venting, flaring, and mining	The cheapest cuts available; satellites now find the large leaks
Waste	About 4%	Landfill methane	Capturable

Shares of all greenhouse gases, rounded, on the IPCC's sector breakdown; the categories overlap. Ember (April 2026); FAO (October 2025); CREA for Carbon Brief (September 2026).

5b. By Country

Country or region	Share of carbon dioxide	Per person (tonnes)	Share of emissions since 1850	2025-26
China	About 31%	About 8.5	About 15%	Flat: up 0.4% in 2025 on the Global Carbon Project's projection, down 0.5% on the IEA's count of energy emissions, and still below its March 2024 peak in mid-2026 (CREA)
United States	About 13%	About 14	About a quarter, the largest	Up 1.9% in 2025 on the Global Carbon Project's projection, on a cold winter, coal, and data centers (Module 6)

Country or region	Share of carbon dioxide	Per person (tonnes)	Share of emissions since 1850	2025-26
India	About 8%	About 2	About 3%	Up 1.4% on the projection, though weather cut energy emissions slightly on the IEA's count
European Union	About 6%	About 5.5	About 16%	Up 0.4% on the projection, on a cold winter; its carbon border charge in force from January 2026
Russia	About 5%	About 12	About 7%	Europe's largest single emitter
Japan, Iran, Saudi Arabia, Indonesia, South Korea	About 2-3% each	2-20		Japan down 2.2% in 2025
Africa, the whole continent	About 4%	About 1	About 3%	The lowest per person; the fastest population growth
International aviation and shipping	About 3%			Outside any country's count; shipping's proposed carbon price is in Module 7

Global Carbon Project (November 2025, projections for 2025); IEA (March 2026); Rhodium Group (January 2026); Our World in Data; rounded. Counting emissions where goods are consumed rather than made shifts a few points from China to its customers.

5c. The Three Accountings

Who is responsible depends on the ruler, and the politics of Module 9 are an argument over which ruler to use. By current emissions China is first at about 31%, and that is the case the rich countries make. By emissions per person the United States, Canada, and Australia are at about 14-15 tonnes and the Gulf states at roughly 15-35, Europe and China at 5-9, India at about 2, and Africa at about 1, so the average American emits about seven times as much as the average Indian.

By cumulative emissions since 1850, the measure the physics of Module 1 says matters because the atmosphere adds up the whole record, the United States is first at about a quarter, the EU second at about 16%, and China third at about 15% with three to four times the population of either. That is the case the developing world makes at every summit: the warming already here was caused by countries that grew rich doing it, and the budget that remains is being asked of countries that did not. All three rulers are accurate, and no agreement has ever settled which one governs.

5d. An American Household's Tonnes

Worked example — An American Household's Tonnes, by Source

Take a typical American household of two adults and two children in a suburban house with two cars, and count its greenhouse gases for a year from the averages that the Environmental Protection Agency and the academic footprint calculators use. **Driving:** two cars at 12,000 miles each and 25 miles a gallon burn 960 gallons of gasoline at 8.9 kilograms of carbon dioxide a gallon: 8.5 tonnes, the largest single activity. **The house:** electricity of 11,000 kilowatt-hours at the American grid's average of about 0.37 kilograms per kilowatt-hour is 4.1 tonnes, nearer 7 in a coal-heavy state and 1 in a hydro or nuclear one. Gas for heat and hot water, 60,000 cubic feet, adds 3.3 tonnes. **Food:** the American diet's footprint is about 2.5 tonnes a person, half of it beef and dairy, so 10 tonnes for four, of which a beef-free diet would remove about 4. **Flights:** two round trips across the country for the family add about 4 tonnes. **Goods and services:** the clothes, electronics, furniture, health care, and the government's share embed about 3 tonnes a person, or 12. **Total:** about 42 tonnes, or 10.5 a person. **The levers, in order of size:** two electric cars on the average grid cut driving from 8.5 tonnes to about 3, a saving of 5.5, and solar panels on the roof save about 3 of the electricity's 4.1. A heat pump cuts the gas's 3.3 tonnes to about 1.2, halving the beef saves 2, and skipping one of the two trips saves 2. All five together bring the household to about 27 tonnes, a third below where it started. **The lessons:** the cars and the house are the household's own levers, and the cheap clean power of Module 6 is what makes them affordable. Food is the lever people underrate and the one that needs no technology. And what remains, the 12 tonnes in goods and services, the rest of the food, and the grid's residue, depends on how the economy around the household makes things, which is why individual action is real, bounded, and no substitute for changing the system.

Module 5 Key Points

Where the Emissions Come From

• Power and heat are about a quarter of emissions, and in 2025 solar and wind met 99% of the growth in electricity demand.

• Industry is about a quarter, agriculture and land about a fifth, transport about 15%, and buildings about 6% directly.

• China emits about 31% of carbon dioxide now; the United States has emitted the most since 1850, about a quarter.

• China's emissions were flat in 2025 and below their 2024 peak in mid-2026; America's rose about 2% in 2025.

• A typical American household emits about 42 tonnes; its own levers cut a third, and the rest depends on the wider economy.

Module 5 Quiz

Check Your Understanding

1. What share of the world's greenhouse gases comes from electricity and heat?

A) About two-thirds, more than all other sectors combined
B) About 5%, less than aviation
C) About half, with transport the rest
D) About a quarter

2. Which accounting puts the United States first?

A) Current annual emissions, where it is about 13%
B) Cumulative emissions since 1850
C) Emissions per dollar of output across the large economies
D) Per head, worldwide

3. What happened to China's carbon dioxide emissions in 2025 and the first half of 2026?

A) They rose 10% on new coal plants
B) They halved
C) Roughly flat, staying below the March 2024 peak
D) They fell by a fifth as electric cars took over the roads

4. In the worked household, why do the five levers stop at about 27 tonnes?

A) What remains is embedded in the goods, food, and power grid around the household
B) Because the cars cannot be electrified
C) Because heat pumps raise the power bill
D) Because flights are counted twice

5. Of these, which emits the most in the worked household?

A) Driving
B) The electricity for the house
C) Two cross-country flights for the family
D) Natural gas for heat and hot water

Module 6 — Solutions: Energy and Transport

The Parts That Are Working, and the American Reversal

Recommended Reading / Reference

Reference: Ember, *Global Electricity Review 2026* (April 2026); IEA, *Global Energy Review 2026* (March 2026) and *Global EV Outlook 2026*; SolarPower Europe, *Global Market Outlook 2026-2030* (June 2026); the Global Wind Energy Council's *Global Wind Report 2026* (April 2026); BloombergNEF's battery price survey (December 2025); Rhodium Group (January 2026)

6a. The Turning Point

The fixes that work at scale replace combustion with electricity and make the electricity clean, and in 2025 they crossed a line. World electricity demand grew by 849 terawatt-hours, and solar and wind met 99% of the increase, solar alone three-quarters of it, so fossil generation fell 0.2%, its first year without growth since 2020 (Ember).

Renewables, at 33.8% of the world's electricity, overtook coal at 33.0%, solar passed wind for the first time, China's fossil generation fell for the first time since 2015, and India's fell 3.3%. The IEA counted about 3 billion tonnes of carbon dioxide avoided in 2025 by the clean technologies installed since 2019, about 8% of energy emissions, as the table breaks down.

The reason is cost: solar modules sell for under 10 cents a watt after a fall of about 90% in a decade, battery prices fell another 8% in 2025, and new solar or wind is the cheapest new electricity in most of the world. China installs most of the world's new solar and makes most of its panels and batteries.

The transition is real and uneven: fast in China, Europe, and the American states that allow it, slow in India's coal fleet and Africa's grids, and reversed in American federal policy. It is not smooth from year to year either, since SolarPower Europe expects world solar additions to fall about 8% in 2026, the first contraction in over 20 years, as China's installations drop by about a quarter.

Technology	State in 2025-26	Cost	Avoided in 2025	Note
Solar	A record 664 GW added in 2025, 57% in China; over 3,000 GW installed by early 2026; about 9% of world electricity	Modules under 10 cents a watt; the cheapest new power in sunny places	1.5 billion tonnes	The grid, not the panel, is the limit
Wind	A record 165 GW added in 2025, 73% in China, to 1,299 GW	Onshore competitive with gas; offshore costs up with interest rates	1.1 billion tonnes	American offshore projects halted by federal orders in 2025
Batteries	112 GW and 307 GWh of grid storage added in 2025	Packs averaged $108 a kWh in 2025 (BloombergNEF); Chinese storage cells about $50 a kWh for export	Makes the first two firm	Two- to four-hour systems the norm; longer duration the frontier
Nuclear	About 9% of world electricity; American restarts and life extensions; China building the most	New Western plants expensive; existing plants among the cheapest firm power	About 0.2 billion tonnes	Firm, clean capacity, about a decade to build

Technology	State in 2025-26	Cost	Avoided in 2025	Note
Electric cars	More than 20 million sold in 2025, about a quarter of new cars and about half of China's; just under a tenth in the US, counting plug-in hybrids, where sales fell sharply after the tax credit ended	Cheaper to buy than gasoline cars in China; not yet in the US	About 0.1 billion tonnes	Fleets turn over in about 15 years, so the effect builds slowly
Heat pumps	Outsold gas furnaces in the US for a fourth straight year in 2025 and gas boilers in Germany for the first time; world sales down 2%	Dearer to install, cheaper to run	About 0.1 billion tonnes	Cheapest where power is cheap relative to gas
The grid	The constraint on all of it: connection queues, transmission lines, and firm power for the evening			Where the money and the delays are

Ember (April 2026); IEA, *Global Energy Review 2026* (March 2026) and *Global EV Outlook 2026* (May 2026); SolarPower Europe (June 2026); Global Wind Energy Council (April 2026); BloombergNEF (December 2025); InfoLink (July 2026). Capacity in gigawatts (GW); storage energy in gigawatt-hours (GWh).

6b. The American Reversal

The United States is the exception to the turn, since the July 2025 tax law ended the wind and solar credits for projects that had not started construction by July 4, 2026, unless they are in service by the end of 2027, and the electric-car credit ended on September 30, 2025. In 2025 federal orders halted offshore wind leasing and paused projects already under construction, and emergency orders kept coal plants running past their planned retirements.

Washington also left the Paris Agreement in January 2026 (Module 9), and Congress blocked the methane fee in 2025. On February 12, 2026 the Environmental Protection Agency rescinded the 2009 finding that greenhouse gases endanger health and welfare, the legal basis for federal climate rules, and with it every greenhouse standard for cars and trucks.

On September 17, 2026 the agency partly repealed the 2024 power-plant carbon standards, removing the carbon-capture requirements for coal plants and new baseload gas turbines, and the same day it proposed that the Clean Air Act allows no regulation of power-plant greenhouse gases at all, with comments due on November 2. Health and environmental groups and coalitions of states sued over the endangerment repeal in February and over the power-plant repeal in September and October, in the federal appeals court in Washington.

The 2025 data mostly reflect weather and fuel prices rather than the new policies: American greenhouse emissions rose an estimated 2.4%, ending two years of decline, as a cold winter raised heating demand and power-sector emissions rose 3.8% when gas prices up 58% pushed coal generation up 13% (Rhodium Group). Solar generation grew 34%, and the policies show up in the outlook instead, as Rhodium's projection for 2035 fell to 26-35% below 2005 levels, from 38-56% a year earlier.

The reversal's scale is the arithmetic of Module 5: the United States is about 13% of current emissions and about a quarter of the cumulative total, so a decade of its policy moves the world's total by a few percent. That is enough to matter for the budget and not enough to change the direction, which China and the cost curve now set.

Module 6 Key Points

Solutions: Energy and Transport

• Solar and wind met 99% of 2025's growth in electricity demand, fossil generation fell 0.2%, and renewables overtook coal.

• Clean technologies installed since 2019 avoided about 3 billion tonnes of carbon dioxide in 2025, about 8% of energy emissions.

• Solar added a record 664 gigawatts in 2025, 57% of it in China, though additions are expected to dip in 2026.

• Electric cars were about a quarter of world car sales in 2025 but just under a tenth in the United States.

• Washington ended credits, left Paris, and rescinded the endangerment finding; American emissions rose about 2.4% in 2025.

Module 6 Quiz

Check Your Understanding

1. What happened to world fossil-fuel electricity generation in 2025, on Ember's count?

A) It rose 5%, led by coal
B) It was flat
C) It grew faster than solar and wind combined, as coal surged in India and China
D) It fell 0.2%, its first year without growth since 2020

2. How much carbon dioxide did clean technologies installed since 2019 avoid in 2025, by the IEA's estimate?

A) About 30 million tonnes
B) About 3 billion tonnes, roughly 8% of energy emissions
C) About 30 billion tonnes, most of it
D) Too little to measure

3. What share of world car sales were electric in 2025?

A) About 2%, mostly in Norway
B) About 60%, led by Europe and the United States
C) About a quarter
D) Half

4. What did the Environmental Protection Agency do on February 12, 2026?

A) Raised fuel-economy rules
B) Approved California's car rules
C) Rescinded the 2009 endangerment finding, ending vehicle greenhouse standards
D) Proposed a national carbon tax on power plants, refineries, and steel mills, starting in 2028

5. What happened to American greenhouse gas emissions in 2025, on Rhodium Group's estimate?

A) They rose about 2.4%, with power-sector emissions up 3.8% as coal generation climbed
B) They fell 5% as solar grew
C) They were unchanged
D) They fell for a third straight year

Module 7 — Solutions: The Hard Sectors

The Parts Electricity Does Not Reach

Recommended Reading / Reference

Book: Vaclav Smil, *How the World Really Works* (2022), on steel, cement, ammonia, and plastics and why they are hard

Reference: IEA, *Global Hydrogen Review 2025*; the International Air Transport Association (IATA) on aviation fuel (December 2025); Carbon Brief's account of the shipping talks (April 2026); the Mission Possible Partnership's sector roadmaps

7a. Why They Are Hard

About a third of emissions come from processes electricity does not easily replace: the chemistry of making steel, cement, and fertilizer, the energy density that aircraft and ships need, and the biology of cattle and rice. Steel is made by stripping oxygen from iron ore with carbon, as coke in a blast furnace, so the carbon is part of the reaction and not just the heat, and each tonne of steel emits about 1.9 tonnes of carbon dioxide on average, more from blast furnaces.

Cement is made by heating limestone, which gives off carbon dioxide as calcium carbonate becomes calcium oxide, a reaction behind about 60% of cement's emissions, with the kiln's fuel the other 40%, and the world makes about 4 billion tonnes of cement a year. Ammonia for fertilizer is made from hydrogen that today comes from natural gas and, in China, from coal.

A long-haul aircraft needs fuel with about fifty times the energy per kilogram of a battery, and a container ship crossing the Pacific needs fuel it can carry for weeks. A cow produces methane in its stomach whatever it eats, and flooded rice paddies produce it in their mud. For each problem a fix exists in a laboratory or a pilot plant, and not yet at a price the market pays, as the table shows.

Sector	Share of emissions	The chemistry of the problem	The fixes and their state in 2026	The cost
Steel	About 7% of carbon dioxide	Coke strips oxygen from ore, emitting about 2 tonnes of carbon dioxide per tonne of blast-furnace steel	Hydrogen in place of coke: Stegra's 5-million-tonne plant at Boden, Sweden, kept going by a €1.4 billion financing round closed in June 2026, its start date under review; electric furnaces melting scrap, about 30% of steel	Green steel 20-40% dearer; needs clean hydrogen near $2 a kilogram
Cement	About 7% of carbon dioxide	Heating limestone releases carbon dioxide, 60% of the emissions, whatever the fuel	Capture at the kiln: Heidelberg Materials' Brevik plant in Norway, built to capture about 400,000 tonnes a year, operating since mid-2025; clay-based and electrochemical cements in pilots; less cement per building	Capture roughly doubles cement's cost; new chemistries unproven at scale
Chemicals and fertilizer	About 5% of carbon dioxide	Hydrogen made from gas; process heat	Hydrogen from water and clean power, and ammonia made from it; low-emission hydrogen under 1% of the world's nearly 100 million tonnes	Green ammonia 50-100% dearer
Aviation	About 2.5% of carbon dioxide, more counting contrails	Energy density: no battery flies a wide-body jet	Sustainable aviation fuel (SAF) from waste oils and crops, 1.9 million tonnes in 2025, 0.6% of jet fuel, forecast 0.8% in 2026; synthetic fuels in pilots; routes that avoid contrails	SAF about twice the price of jet fuel and up to five times where mandated

Sector	Share of emissions	The chemistry of the problem	The fixes and their state in 2026	The cost
Shipping	About 2-3% of carbon dioxide	Fuel for weeks at sea	Engines for methanol and ammonia; the International Maritime Organization's (IMO) net-zero framework, approved in draft in April 2025 but not adopted, stalled that October, revived in April 2026, now goes to a vote on December 4, 2026	If adopted, ships over the targets pay $100 or $380 a tonne of excess emissions, from 2028
Agriculture	About 12% of greenhouse gases, livestock about 6% directly	Methane from cattle's stomachs and rice paddies; nitrous oxide from fertilizer	Feed additives such as Bovaer, approved in the EU in 2022 and the US in 2024, cut a cow's methane about 30%; better water management for rice; precise fertilizer use; less beef; Denmark taxes livestock emissions from 2030	Diet the cheapest lever; additives cost cents a day

IEA (2025); IATA (December 2025); Carbon Brief (April 2026); company reports. Shares are of carbon dioxide for the first five rows and of all greenhouse gases for agriculture, rounded.

7b. The Hydrogen Question

Four of the table's six rows run through one molecule, since hydrogen made by splitting water with clean electricity can strip the oxygen from iron ore, feed ammonia and synthetic fuels, and power ships, and the chemistry is a century old. The problem is price: the 2021-23 enthusiasm announced hundreds of projects, and most have slipped or been cancelled as electrolysers stayed expensive and buyers stayed away.

The IEA's 2025 review put world hydrogen use at almost 100 million tonnes in 2024, less than 1% of it low-emission, with about 1 million tonnes expected in 2025. Projects already built or financed would bring that to about 4.2 million tonnes by 2030, and the total announced for 2030 fell for the first time, from 49 million tonnes to 37 million. Electrolysers cost $2,000-2,600 a kilowatt installed outside China and $600-1,200 inside it, and China holds about 65% of the world's capacity.

What decides it is the price of electricity: at about 2 cents a kilowatt-hour, which solar reaches in the deserts, hydrogen from water approaches $2 a kilogram on most estimates and the hard sectors' economics change, while at 6 cents they do not. The honest reading in 2026 is that the hard sectors will be the last to decarbonize, through the 2030s and 2040s, and that fixes exist for all of them at a premium the world has not yet agreed to pay, which is why carbon pricing (Module 9) matters most exactly here.

Module 7 Key Points

Solutions: The Hard Sectors

• About a third of emissions come from chemistry, energy density, and biology that electricity cannot easily replace.

• Cement's limestone releases carbon dioxide whatever the fuel; Norway's Brevik plant has captured it at the kiln since 2025.

• Green steel needs hydrogen near $2 a kilogram; Sweden's Stegra needed a 2026 rescue round to keep building.

• Sustainable aviation fuel was 0.6% of jet fuel in 2025, at about twice the price of the fossil kind.

• Shipping's carbon price, stalled in 2025 and revived in April 2026, goes to a vote on December 4, 2026.

Module 7 Quiz

Check Your Understanding

1. Why is cement hard to decarbonize?

A) Its kilns cannot run on electricity at any temperature
B) Limestone releases CO_2 whatever the fuel
C) Because it is made abroad, beyond any carbon rules
D) Its makers lack capital

2. What share of jet fuel was sustainable aviation fuel in 2025?

A) About 10%, after the European mandates took effect
B) About a third, mostly from used cooking oil
C) About 5%, double the 2024 share
D) About 0.6%

3. What is the state of shipping's net-zero framework as of October 2026?

A) In force since January 2026, with a levy of $10 a tonne
B) A vote is due on December 4, 2026
C) Abandoned after the United States left the shipping body
D) Adopted in 2025

4. What share of the world's hydrogen was low-emission in 2024, per the IEA?

A) Under 1%
B) About a quarter, mostly in China
C) About half, after a decade of subsidies
D) About 10%, from new electrolysers

5. What happened to Stegra's green-steel plant in Sweden?

A) It opened on schedule in 2025
B) It was cancelled outright
C) It needed a €1.4 billion rescue round in 2026, and its start date is under review
D) It was sold to a Chinese steelmaker

Module 8 — Carbon Removal and Geoengineering

Taking Carbon Back, and Blocking the Sun

Recommended Reading / Reference

Book: David Keith, *A Case for Climate Engineering* (2013), and Elizabeth Kolbert, *Under a White Sky* (2021), the case for research and the case for unease

Reference: *The State of Carbon Dioxide Removal* (June 2026); the US National Academies' 2021 report on solar geoengineering research; the UK Advanced Research and Invention Agency (ARIA) on its Exploring Climate Cooling programme (April 2026)

8a. Why Removal Is in Every Pathway

Every IPCC pathway that holds warming to 1.5 or 2°C removes carbon dioxide from the air as well as cutting emissions, billions of tonnes a year by mid-century, for two reasons the earlier modules gave. The hard sectors of Module 7 will still be emitting in 2050, and net zero means their residue must be balanced by removals. And the 1.5°C budget is nearly spent, so returning to 1.5°C after overshooting it means taking back what was put in.

Removal today is about 2.2 billion tonnes a year, 99.9% of it by forests and soils, and newer methods remove about 2 million tonnes, almost all of it by biochar and bioenergy with capture, growing about 40% a year. Buyers signed contracts for about 40 million tonnes of future removals in 2025, with Microsoft alone making about 82% of the purchases of the newer kinds. The State of Carbon Dioxide Removal finds countries' plans short of the pathways by about 0.3 billion tonnes a year in 2030 and 5.2 billion in 2050.

The methods differ in how long they store carbon, what they cost, and how much land they use. A tree holds its carbon until it burns or rots, while carbon turned into rock stays for millennia, and that difference is what a tonne of removal is worth.

Method	How it works	Scale today	Cost per tonne	Permanence and limits
Forests	Photosynthesis: planting and restoring forests	With soils, about 2.2 billion tonnes a year, nearly all removal today	$10-50	Decades to a century; reversed by fire, drought, and logging; competes with farmland
Soils and biochar	Farming practices that hold carbon in soil; charcoal from crop waste buried in fields	With bioenergy with capture, almost all of the newer methods' 2 million tonnes (June 2026)	$50-150	Decades for soils, longer for biochar; hard to measure
Bioenergy with capture (BECCS)	Grow biomass, burn it for power or ferment it, capture the carbon dioxide, and bury it	Mainly at ethanol plants; with biochar, almost all newer removals	$100-200	Permanent if stored; land is the limit, since a billion tonnes needs about Iraq's area in crops
Enhanced weathering	Crushed basalt spread on fields reacts with carbon dioxide over years	Large field trials	$80-200	Permanent; measurement is the argument; good for soils

Method	How it works	Scale today	Cost per tonne	Permanence and limits
Direct air capture (DAC)	Fans pull air across a material that binds carbon dioxide, which heat then releases for burial	Small plants in Iceland and elsewhere; Occidental's Stratos in Texas, built for up to 500,000 tonnes a year, due to start at the end of 2026, two years late	$400-1,000 now; $100-300 the target	Permanent when injected into basalt or deep saline rock; needs about 1.5-2 megawatt-hours of energy per tonne
Ocean alkalinity	Adding lime or crushed rock to seawater so it absorbs more carbon dioxide and resists acidification	Pilots	$50-150 projected	Permanent; the ecology and the measurement unknown; field tests contested
Mineralization	Reacting carbon dioxide with industrial waste or mine tailings	Small	$50-200	Permanent; limited by the volume of waste

The State of Carbon Dioxide Removal (June 2026), whose cost estimates run from under $10 to over $1,000 a tonne, most with upper estimates above $200; company reports; Occidental on Stratos (August 2026).

8b. A Billion Tonnes a Year

Worked example — What Removing a Billion Tonnes a Year Would Take

Take a billion tonnes of carbon dioxide a year, about a fortieth of current emissions and well under the pathways' mid-century needs, and build it with each method. **Forests:** a hectare of new temperate forest absorbs about 5 tonnes a year for fifty years, so a billion tonnes needs 200 million hectares, the area of Mexico, planted and then protected from fire and drought for a century on land that is now farmed or grazed. That is why the tree pledges of the 2020s have delivered a fraction of their promises. **Bioenergy with capture:** a tonne of dry biomass yields about 1.5 tonnes of carbon dioxide when burned and captured, and a hectare of energy crops yields about 15 tonnes of biomass, so a billion tonnes needs about 45 million hectares, an Iraq, of cropland, plus the plants and pipelines, and gives up the food that land would have grown. **Direct air capture:** a Stratos-sized plant takes 500,000 tonnes a year, so a billion tonnes needs about 2,000 of them. At 1.5-2 megawatt-hours a tonne they would use 1,500-2,000 terawatt-hours of clean energy a year, a third to nearly half of American electricity generation, and at first-of-a-kind costs of over $1 billion a plant they would need more than $2 trillion of capital up front. All costs included, the removal would cost $400 billion a year at $400 a tonne and $100 billion at the $100 target. **Enhanced weathering:** a tonne of crushed basalt captures about 0.3 tonnes of carbon dioxide over a decade, so a billion tonnes a year needs about 3 billion tonnes of rock a year spread on 100 million hectares, mining and grinding about a third of the world's coal tonnage, with the removal verified by soil chemistry still being standardized. **The comparison:** newer methods removed about 2 million tonnes a year in the June 2026 count, and the assessed scenarios need them above 3.5 billion by 2050. A portfolio of methods could plausibly reach a billion tonnes at $100-300 billion a year, against the $2.2 trillion the world now invests in clean energy annually, while ten billion would strain land, energy, and rock at once. **The lessons:** removal is real, necessary, and small, and scaling it is one of the largest new industries the pathways assume. A tonne removed and stored for good is worth about a tonne not emitted, but durable removal costs many times what the cheapest cuts do, which is why cutting comes first. Its honest role is the residue, the cement, the aircraft, and the cattle, plus the overshoot, not a reason to slow the cuts.

8c. Solar Geoengineering

The other intervention reflects sunlight instead of removing carbon. Stratospheric aerosol injection would have aircraft spray sulfate or chalk-like particles high into the stratosphere to mimic a volcano, as Pinatubo's 1991 eruption cooled the planet about 0.5°C for a year. Marine cloud brightening would spray sea salt to whiten low clouds, and smaller ideas include thinning high cirrus clouds and brightening surfaces.

The physics is not in doubt: a few million tonnes of sulfate a year, delivered by a few hundred flights a day at a cost estimated at $10-20 billion a year, could offset a degree of warming within a year or two. Everything else is in doubt, from shifts in the monsoons the models show and the ozone damage to the 'termination shock' of a decade's warming in a few years if spraying stopped. It would do nothing for ocean acidification, one country or one billionaire could deploy it, and it offers a cheap substitute for cutting emissions.

The 2026 state is research and its first fights. ARIA's £56.8 million programme funds 22 projects, with outdoor experiments limited in size and approved stage by stage, including fieldwork in northern Canada on thickening Arctic sea ice and cloud-brightening trials over the Great Barrier Reef. Stardust, an Israeli-American startup, raised $60 million in October 2025 for a proprietary reflective particle and said it planned contained stratospheric tests from April 2026, drawing calls for regulation.

Against them, Harvard cancelled its stratospheric experiment in 2024, Mexico said in 2023 it would bar such experiments, Tennessee (2024) and Florida (2025) have banned solar geoengineering, and bills have been introduced in many other states since 2024. A startup sells 'cooling credits' from balloons of sulfur dioxide it releases, with no oversight beyond its own.

8d. The Cases on Geoengineering, Made as Their Advocates Make Them

For research and readiness: the warming is here, the 1.5°C budget is nearly spent, emissions are at a record, and the tipping points do not wait for the transition. A tool that could hold temperatures down cheaply and quickly for the decades the transition needs is one the world should understand before a desperate government deploys it badly. The risks are real and researchable, ignorance is the only alternative to research, and the governance question is best answered by knowing what the technology does.

Against: it treats the symptom and not the cause, and it would have to run for a century to avoid a termination shock worse than the warming it masks. It would redistribute rainfall by decisions no one has the standing to make, leave the oceans acidifying, and hand the largest lever on the planet to whoever can afford a few hundred aircraft. Research, on this view, legitimizes deployment, weakens the will to cut emissions, and starts down a path that the institutions that failed to stop the emissions could not stop either.

The evidence between them: the physics of cooling is well understood from volcanoes, and the side effects are modeled but untested at scale. No body has the legitimacy to decide for the world, and the early field work is small, local, and reversible by design.

The course's reading, stated once: removal is necessary, and its honest scale is the residue. Solar geoengineering is a real option with real physics whose use would be the largest single act of planetary management ever undertaken. Its research is more defensible than its prohibition, but its governance, the question of who decides, has no answer, which is why it belongs on the watch list rather than in the plan.

Module 8 Key Points

Carbon Removal and Geoengineering

• Every 1.5 or 2°C pathway removes billions of tonnes a year by mid-century, for the residual emissions and the overshoot.

• Removal runs about 2.2 billion tonnes a year, nearly all forests and soils; newer methods about 2 million.

• A billion tonnes a year needs a Mexico of new forest, an Iraq of energy crops, or 2,000 large air-capture plants.

• A tonne removed and stored for good is worth about a tonne not emitted, but it costs far more, so cutting comes first.

• Solar geoengineering's physics is settled and cheap; its rainfall effects, termination risk, and governance are not.

Module 8 Quiz

Check Your Understanding

1. Why is carbon removal in every 1.5 or 2°C pathway?

A) Because it is cheaper than cutting emissions
B) Because the sinks will stop working
C) Because the pathways assume emissions keep rising past 2050 and removal offsets all of them
D) To balance residual emissions and reverse the overshoot

2. How much do the newer, engineered methods remove each year, by The State of Carbon Dioxide Removal?

A) About 2 billion tonnes
B) About 200 million tonnes
C) About 2 million tonnes, mostly biochar and bioenergy with capture
D) About 20 billion tonnes

3. In the worked example, what would a billion tonnes a year of direct air capture require?

A) A dozen plants
B) No new electricity, because the fans run on waste heat from industry
C) Land the size of Mexico for the fans and sorbent beds, plus the pipelines
D) About 2,000 Stratos-sized plants

4. What did Pinatubo's 1991 eruption show?

A) That stratospheric sulfate can cool the planet, about 0.5°C for a year
B) That volcanoes warm the planet
C) That sulfate has no climate effect
D) That one eruption can permanently reverse warming, which is why geoengineering would need to run only once

5. What is the course's reading on solar geoengineering?

A) Deploy it now, since the 1.5°C budget is spent and the physics is settled
B) Research it; deployment has no governance
C) Ban all research permanently under a global treaty
D) It cannot cool the planet at any affordable cost

Module 9 — The Politics and the Economics

The Agreements, the Money, and the Arguments

Recommended Reading / Reference

Book: William Nordhaus, *The Climate Casino* (2013), and Nicholas Stern, *Why Are We Waiting?* (2015), the economics from the two ends of the discount-rate argument

Reference: The UN Framework Convention on Climate Change (UNFCCC) decisions from Belém (November 2025); UNEP, *Emissions Gap Report 2025*; Climate Action Tracker's global update (November 2025); World Bank, *State and Trends of Carbon Pricing 2026*; IEA, *World Energy Investment 2026*

9a. Paris and Its Ratchet

The 2015 Paris Agreement replaced the Kyoto model, binding targets for rich countries and none for the rest, with a universal one. Every country sets its own pledge, reports on it, and is expected to strengthen it every five years, with no penalty for failing, toward a shared goal of holding warming 'well below 2°C' and pursuing 1.5°C.

The ratchet has worked partly. Climate Action Tracker's estimate of warming by 2100 under the policies actually in place fell from 3.6°C in 2015 to 2.6°C in November 2025, and full delivery of every pledge and net-zero target would bring it to about 1.9-2.2°C. UNEP's 2025 report puts the pledges at 2.3-2.5°C and current policies at 2.8°C, and both groups found that the new pledges for 2035 barely moved the outlook, leaving a real bend in the curve and still a gap of about a degree.

The 2035 round of pledges came late and uneven. China pledged, for the first time, an absolute cut, net greenhouse emissions 7-10% below their peak by 2035, submitted on November 3, 2025. The EU agreed in December 2025 a binding 90% net cut by 2040 from 1990 levels, approved by the European Parliament in February 2026, with up to 5 points from international credits from 2036, and delayed its second carbon market, for buildings and road fuel, to 2028. India's cabinet approved on March 25, 2026 a 47% cut in emissions per unit of output from 2005 levels by 2035 and 60% of power capacity from non-fossil sources.

The United States left the Paris Agreement on January 27, 2026, its second exit, and abandoned the 2035 target the previous administration had submitted in December 2024. A January 2026 memorandum also ordered it out of the UN climate treaty, the IPCC, and the Green Climate Fund, though leaving the treaty takes effect only a year after formal notice.

The 30th summit, in Belém, Brazil, closed on November 22, 2025 with a package called the 'global mutirão,' or collective effort. It called for tripling adaptation finance by 2035, set a two-year process to define adaptation indicators, launched the Tropical Forest Forever Facility to pay countries for standing forest, and carried forward the 2024 goal of $300 billion a year for developing countries by 2035, with rich countries taking the lead, within $1.3 trillion a year from all sources.

It produced no roadmap for moving away from fossil fuels in its decisions, because producer countries blocked one, and the Brazilian presidency promised roadmaps of its own on fossil fuels and deforestation instead. The 31st summit meets in Antalya, Turkey, on November 9-20, 2026, with leaders on November 11-12, under Turkey's environment minister Murat Kurum as president and Australia's climate minister Chris Bowen as 'President of Negotiations,' after a pre-summit in Fiji and Tuvalu on October 5-8. The 2027 summit goes to Addis Ababa.

9b. The Instruments

Instrument	Where	How it works	State in 2026
Carbon pricing	87 carbon taxes and trading systems covering just over 29% of world emissions, raising $107 billion in 2025 at an average near $21 a tonne; EU allowances €82.40 a tonne (October 5, 2026); China's national market extended to steel, cement, and aluminum in 2025; Canada's consumer carbon charge ended in April 2025	A tax or a capped market puts a price on each tonne, so the hard sectors' premium becomes the cost of not switching	The EU's market review is due by early 2027; Italy and Czechia want to suspend the reserve that withholds surplus allowances; the EU's second market starts in 2028
Carbon border charge	The EU's, in its definitive phase from January 2026, on steel, cement, aluminum, fertilizer, electricity, and hydrogen; Britain's from 2027	Importers pay the EU carbon price on the emissions embedded in what they bring in	Importers under 50 tonnes a year exempt; certificates for 2026 imports bought in 2027; India and China object
Subsidies and credits	The American 2022 law's wind, solar, and electric-car credits, cut back or ended by the July 2025 law, while storage, nuclear, geothermal, carbon-capture, and manufacturing credits largely survive; industrial programs in the EU, China, India, and Japan	Paying for the clean option rather than taxing the dirty one, the politically easier form	The American reversal; the rest of the world continuing
Regulation	Vehicle and appliance standards, power-plant and methane rules, building codes	Mandates that remove the dirty option	US: endangerment finding rescinded (February 2026), power-plant standards partly repealed (September 2026); EU: the Commission proposed in December 2025 to replace the 2035 zero-emission car rule with a 90% cut
Finance	$300 billion a year, with rich countries taking the lead, and $1.3 trillion from all sources, for developing countries by 2035; development banks; the loss-and-damage fund	Moving capital to where emissions are growing	Clean-energy investment expected to reach about $2.2 trillion in 2026, nearly double the $1.2 trillion for fossil fuels (IEA)
Litigation	The International Court of Justice's advisory opinion of July 23, 2025 that states have legal duties to prevent climate harm, and the Inter-American Court of Human Rights' opinion of July 2025; national cases in Germany, the Netherlands, and Montana; suits against companies	Courts as the enforcement Paris lacks	The opinions' first uses in national courts; mixed results in American courts, advancing ones in Europe

World Bank (May 2026); Intercontinental Exchange (October 2026); the European Commission; IEA (June 2026); UNFCCC. 'Definitive phase' means importers now owe the charge, not just report.

9c. The Cases, Made as Their Advocates Make Them

The transition is affordable and under way: clean electricity is the cheapest new power on earth, electric cars are cheaper than gasoline ones in the largest market, and investment in clean energy now far exceeds investment in fossil fuels. The cost of the transition is a fraction of a percent of world output a year, against damage that already costs hundreds of billions, so the obstacle is politics, not economics.

The transition is a cost the world is being asked to bear on a schedule it never agreed: the pathways require the largest industrial rebuilding in history within twenty-five years, on a budget already nearly spent. The costs fall on households through energy prices and on industries through carbon prices their competitors do not pay, and the developing world will not give up the growth the rich world enjoyed. On this view the honest path is a slower transition, more adaptation, and the removal technologies of Module 8, rather than targets every country has missed.

Degrowth against technology: one school holds that no transition at 3% growth stays inside the budget, so consumption must fall in the rich world. The other holds that clean technology is outgrowing the fossil system and that growth is what pays for it, and both cite 2025, the degrowth side for its record emissions and the technology side for its fall in fossil power.

The discount rate: beneath the economics sits one number: how much a dollar of damage in 2100 is worth today. At Stern's 1.4% the case for acting now is overwhelming, while at Nordhaus's 4% the economically optimal path warms to about 3°C, and because the choice is ethical rather than empirical, economists have argued over it for twenty years.

What the evidence says: clean technology's costs have fallen faster than almost every projection, and the costs of damage have kept rising. Policies have bent the curve by about a degree since 2015, but the bending stalled in 2021-25 as emissions held at a record. The arguments that remain are over pace, distribution, and the discount rate, which are arguments about values resting on an empirical floor this course has laid out.

Module 9 Key Points

The Politics and the Economics

• Policies under Paris, helped by falling clean-energy costs, bent projected warming from 3.6°C in 2015 to about 2.6°C.

• The Belém summit tripled the adaptation-finance goal for 2035 but left any fossil-fuel roadmap out of its decisions.

• The United States left Paris on January 27, 2026; China pledged its first absolute cut, 7-10% below peak by 2035.

• Carbon prices cover just over 29% of emissions, and the EU's border charge entered its definitive phase in January 2026.

• The arguments left are over pace, distribution, and the discount rate: values, resting on an empirical floor.

Module 9 Quiz

Check Your Understanding

1. How did the Paris Agreement change the Kyoto model?

A) It made targets binding on all
B) Universal self-set pledges, strengthened every five years
C) It ended all targets
D) It set binding targets only for China and India, with penalties enforced by trade sanctions

2. What did the Belém summit leave out of its decisions?

A) A finance goal
B) A call to triple adaptation finance by 2035
C) Any mention of forests, the summit's own theme, in the final text
D) A fossil-fuel roadmap

3. When did the United States' second exit from the Paris Agreement take effect?

A) November 4, 2025, a year after notice was given
B) It never took effect, because the Senate blocked it in 2025
C) January 27, 2026
D) January 20, 2025, the day the order was signed

4. What is China's 2035 pledge?

A) Net greenhouse gas emissions 7-10% below their peak by 2035, its first absolute cut
B) Net zero by 2035
C) A 65% cut in carbon intensity
D) No new pledge was made

5. What does the EU's carbon border charge do?

A) Charges importers the EU carbon price on embedded emissions
B) Sets quotas on imported steel
C) Pays EU producers a subsidy for each tonne they cut
D) Places a flat 25% tariff on all imports from countries without a carbon price, from 2026

Module 10 — Adaptation

Living With What Is Locked In

Recommended Reading / Reference

Reference: UNEP, *Adaptation Gap Report 2025: Running on Empty* (October 2025); IPCC, Sixth Assessment Report, Working Group II (2022), the adaptation chapters; the board papers of the Fund for responding to Loss and Damage (April 2026); Munich Re's catastrophe reviews (2026); the World Bank's *Groundswell* reports on climate migration

10a. What Is Locked In

Much of the warming of the next twenty years is already set, because emissions cannot fall to zero overnight and each year's emissions add to the total, while cleaning up the cooling pollution unmasks warming it had hidden. At the current rate human-caused warming reaches about 1.5°C around 2030, and cuts made now would show clearly in the temperature only after about twenty years, by the IPCC's assessment. Sea-level rise to mid-century is also largely committed, because the ice sheets and the deep ocean respond over centuries to warming already delivered, and the heat, flood, and fire of Module 3 will run above 2025's levels for at least a decade.

Adaptation is the response, and its first honest feature is that it is local: a seawall protects one city, a heat plan one region, a drought-tolerant seed one crop. Its second is that it has limits: no seawall saves a poor, sinking delta like Bangladesh's from a meter of sea level, no cooling protects a laborer in extreme humid heat, and no irrigation restores a glacier-fed river that has passed its peak.

UNEP's 2025 report puts developing countries' adaptation needs at $310-365 billion a year by 2035, against $26 billion of international public adaptation finance in 2023, down from $28 billion in 2022, so the need is 12-14 times the flow. The Glasgow goal of doubling that finance by 2025 has almost certainly been missed, and the Belém summit's call to triple it by 2035 is the next target. The largest adaptation under way is unplanned: people moving away from places becoming unlivable, which the World Bank projects could reach more than 200 million people within their own countries by 2050.

Threat	The adaptation	Examples	The limit and the cost
Sea level and storm surge	Seawalls, surge barriers, raised infrastructure, managed retreat, mangrove restoration	The Netherlands' Delta Works and its plan to 2100; Venice's flood gates; Miami's pumps; Indonesia's planned move of its capital away from sinking Jakarta; Bangladesh's cyclone shelters, which helped cut cyclone deaths from hundreds of thousands in 1970 to dozens in recent storms	A meter of rise defeats most walls; retreat is the honest plan for many coasts; costs in the trillions
Heat	Cooling centers, heat-action plans, white roofs, tree cover, work-hour rules, air conditioning	Ahmedabad's heat-action plan, credited with saving over a thousand lives a year; Europe's plans after 2003; Phoenix's heat office	Air conditioning for billions more people is a grid and emissions problem; extreme humid heat has no fix outdoors
Water	Storage, efficiency, desalination, recycling, and the rules for sharing	Israel's and Singapore's systems; Cape Town's 'Day Zero' averted in 2018; the Colorado River cuts imposed for 2027-28	Rivers past peak flow; desalination's energy and brine
Fire	Fuel management, building codes, evacuation, insurance	California's and Australia's building codes; insurers' retreat as the price signal	Building into the wildland edge keeps growing

Threat	The adaptation	Examples	The limit and the cost
Agriculture	Heat- and drought-tolerant seeds, irrigation, crop shifts, insurance	India's heat-tolerant wheat; drought-tolerant maize across Africa; vineyards and coffee moving uphill and poleward	Tropical yield losses at 3°C only partly adaptable; seed the fastest lever
Health	Disease surveillance, early warning, mosquito control	Dengue's spread into southern Europe and the American South; malaria climbing to higher altitudes	Surveillance is cheap; diseases move faster than health systems
Migration	Planned relocation, legal pathways for climate migrants, support for receiving cities	Tuvalu's 2023 treaty with Australia, offering 280 residence places a year; movement across the Sahel and Central America	No legal status for climate migrants in international law; receiving cities unprepared

10b. Who Pays, and the Argument

Adaptation's politics are Module 3's distribution in reverse: the countries that need it most can least afford it, and the finance is a fraction of the need. The Fund for responding to Loss and Damage, agreed in 2022 to pay for harm adaptation cannot prevent, held about $822 million in pledges by April 2026, of which about $422 million had arrived. It set aside $250 million for its first grants and had received ten requests worth about $166 million, against damage running to hundreds of billions a year.

In the rich countries the question runs through insurance: as insurers withdraw from Florida, California, and other fire and flood zones, state-backed insurers of last resort absorb the risk and premiums begin to price the climate, so retreat from the riskiest coasts and forests starts by price before any plan.

The case for putting adaptation first: the warming of the next two decades is largely set by emissions that cannot stop overnight, so money spent on walls, seeds, warnings, and cooling saves lives and property now and in the places where the damage will certainly fall. Emissions cuts by any one country barely move the global temperature, while its own adaptation protects its own people.

The case for putting cutting emissions first: every tonne not emitted reduces the adaptation needed forever, and adaptation has hard limits that cutting emissions does not, at the sea's meters and at the heat no body survives, and adaptation without mitigation, on this view, is an escalator with no top floor.

The course's reading, stated once: it is a false choice for the world and a real one for a budget, since a country with $10 billion must decide. The evidence says adaptation pays best where the impacts are certain and near, as with heat plans, early warning, and building codes, and cutting emissions where the impacts belong to the century, as with the sea, the ice, and the tipping points, which divides the money between them rather than choosing one.

Module 10 Key Points

Adaptation

• Human-caused warming reaches about 1.5°C around 2030 at the current rate, since emissions cannot stop overnight.

• Adaptation is local and has limits: a meter of sea level defeats most walls, and extreme humid heat has no fix outdoors.

• Developing countries need $310-365 billion a year for adaptation by 2035; international public finance gave $26 billion in 2023.

• The loss-and-damage fund held about $822 million in pledges, about half received, against damage in the hundreds of billions.

• Adaptation against cutting emissions is a false choice for the world, a real one for a budget; certainty and nearness divide the money.

Module 10 Quiz

Check Your Understanding

1. Why is the next twenty years' warming largely locked in?

A) Because the ocean will release its stored carbon
B) Because the sun is entering a stronger cycle
C) Because emissions cannot reach zero overnight, and cleaner air removes cooling
D) Because methane lasts for centuries

2. What has no adaptation outdoors, in the module's account?

A) Sea-level rise of a few centimeters on a protected coast
B) A drought on irrigated farmland with groundwater reserves
C) A heatwave in a city with cooling centers and warnings
D) Extreme humid heat

3. How large is the adaptation-finance gap, by UNEP's 2025 count?

A) Fully funded
B) $310-365 billion needed a year, $26 billion given
C) About $1 billion needed, all of it already delivered through the Green Climate Fund
D) About $26 trillion a year, a quarter of world output

4. What does the module call the adaptation that reaches rich countries first?

A) Seawalls around every major port city
B) Planned migration away from the coasts and fire zones
C) Insurers' retreat
D) Heat plans in the Sun Belt's cities

5. What is the course's reading of adaptation against cutting emissions?

A) Adaptation first, since warming is locked in
B) A false choice for the world, a real one for a budget, with money divided by how certain and near the impact is
C) Cutting emissions first, since adaptation has limits
D) Neither, since both cost too much

Module 11 — Where Things Stand, and What to Watch

The Argument, the Contradictions, and the Dates

Recommended Reading / Reference

Reference: The Global Carbon Budget each November; Copernicus's monthly bulletins and NOAA's El Niño updates; the IEA's annual reviews; Climate Action Tracker after each pledge round; the Antalya summit's decisions, due in November 2026

11a. The Argument

The physics is settled. Emissions of carbon dioxide and the other gases, grown to about 42 billion tonnes of carbon dioxide a year, have warmed the planet by 1.37°C from human causes as of 2025, and the warming is running about 0.27°C a decade, faster than before, in large part because cleaner air is unmasking it. The budget for 1.5°C is three to four years of current emissions, so the 1.5°C line will be crossed as a long-term average around 2030.

The energy system has begun to turn while emissions have not. In 2025 solar and wind met nearly all of the growth in electricity demand and fossil generation fell, yet total emissions reached another record, because fossil fuel use outside the power sector kept growing. China's emissions have been flat since early 2024, India's are rising more slowly, Europe's sit well below their 1990 level, and America's rose in 2025, on weather and gas prices, as its federal policy reversed.

The fixes divide in three. Some work and are winning on cost: solar and wind, made firm by batteries, along with electric cars and heat pumps, and together with nuclear they avoided about 3 billion tonnes of carbon dioxide in 2025. Some exist at a premium no one has agreed to pay: hydrogen for steel and fertilizer, capture for cement, and clean fuels for aircraft and ships. And some are necessary but tiny or ungoverned: engineered removal at about 2 million tonnes a year against billions needed, and solar geoengineering, with settled physics and no one entitled to decide on it.

The politics bent the projected warming by about a degree and then stalled, and the money now favors clean energy nearly two to one. The impacts are arriving largely as the models projected, and in places faster, falling first on those who emitted least. The course's answer to its own question, whether the problem can be solved, is that the means exist for most of it at a cost below the damage, and that whether the world ends nearer 2°C or 3°C is being decided by politics the physics does not wait for.

11b. Five Contradictions

A record year for emissions was also the year clean power met all new demand: the power sector turned in 2025 while the rest of the economy kept emissions at a record, which is why one statistic can be read as triumph and another as failure in the same week.

Cleaner air warms the planet: cutting sulfur pollution from ships and coal plants saves millions of lives over time, and it also removes the haze that was masking warming, much of why warming has sped up.

The country building the most clean power is also building coal: China installed 57% of the world's new solar in 2025, and in the first half of 2026 it also added 30 gigawatts of coal capacity, its most for any first half since 2016.

The largest cumulative emitter left the Paris Agreement while its clean power kept growing: Washington withdrew and rescinded the legal basis for federal climate rules, yet American solar generation grew 34% in 2025, because the economics no longer depend only on the policy.

Markets price the risk faster than governments plan for it: insurers retreating from fire and flood zones are the first real adaptation in rich countries, and the retreat falls hardest on the households least able to move.

11c. The Settled and the Unsettled

Settled	Unsettled
The greenhouse effect, the warming, and its human cause	The exact sensitivity, 2.5°C or 4°C per doubling, and so the temperature on any emissions path
The carbon budget's arithmetic and the 1.5°C line's approach around 2030	Whether the faster warming since 2015 is the new trend
That clean electricity is the cheapest new power and that the power sector has begun to turn	Whether the hard sectors decarbonize by 2050 or later, and at what price
That heat, heavy rainfall, sea level, and fire weather are worsening and attributable	Regional rainfall; the number of hurricanes; the tipping points' timing, from the ice sheets to the Atlantic circulation
That removal is needed at some scale	Whether removal reaches billions of tonnes, and whether geoengineering is ever governed
That the impacts fall first on those who emitted least	Who pays, how much, and when

11d. What to Watch

Date	What to watch	Why it matters
October 15-16, 2026	The European Council	Italy's and Czechia's proposal to suspend the reserve that withholds surplus carbon allowances
October 19-30, 2026	The UN biodiversity summit in Yerevan	Money for protecting 30% of land and sea by 2030, and how far nature and climate finance are linked
November 2, 2026	Comments close on the EPA's proposal to end federal regulation of power-plant greenhouse gases	Whether any federal climate rule for power plants survives
November 3, 2026	US midterm elections	The Congress that oversees the repeals, the remaining credits, and future budgets
November 9-20, 2026	The Antalya summit, with leaders on November 11-12	Whether Brazil's fossil-fuel and deforestation roadmaps enter the formal process; the adaptation indicators; the finance roadmap
November 2026	The Global Carbon Budget for 2026	Whether fossil emissions fall for the first time outside a recession
December 4, 2026	The shipping body's vote on the net-zero framework, after its committee meets on November 30-December 3	The first global carbon price on a sector, or its failure
December 30, 2026	The EU's deforestation rule applies to large companies	Proof that soy, cattle, palm oil, cocoa, coffee, rubber, and wood come from land not cleared after 2020

Date	What to watch	Why it matters
End of 2026	Stratos, the largest direct-air-capture plant, due to start	The first real operating costs for engineered removal at scale
Late 2026-early 2027	El Niño's peak	Whether 2027 sets a new temperature record, and renewed coral bleaching
January 2027	The 2026 annual temperature from Copernicus, NOAA, and the WMO	Likely the second-warmest year, after 2024
2027	The Addis Ababa summit; the EU carbon-market review	The ratchet's next turn, and Europe's resolve
2028	The EU's second carbon market begins; the second global stocktake; the shipping framework's earliest start	The ratchet's measuring point
Ongoing	The Atlantic circulation's moorings, the Amazon's southeast, and the ice sheets; geoengineering trials and state bans; China's quarterly emissions	The tipping elements, the governance question, and the plateau

11e. The Last Word

A molecule that bends at 15 micrometers, released at 42 billion tonnes a year alongside the other gases, has driven most of the world's warming of about a degree and a third, and will add more for as long as emissions continue. The chemistry is settled, the impacts are arriving much as projected, some of them faster, and the fixes exist for most of the problem at a cost now below the damage. What remains is the hard third of emissions, the billions of tonnes to take back, and the money and will to move the developing world's growth onto the clean path before it repeats the rich world's.

A reader who has followed the tonne from the tailpipe to the temperature, the household to the sector, and the solar panel to the steel mill can read the next emissions figure, the next temperature record, and the next summit's decision for what they are. Each is the arithmetic of a budget being spent, the record of a turn that has begun, or the politics of who pays for the difference, and the course's question applies to every claim: what is the chemistry, what is the number, and who measured it.

Module 11 Key Points

Where Things Stand, and What to Watch

• Human-caused warming is 1.37°C and rising about 0.27°C a decade; the 1.5°C budget lasts three or four more years.

• The power sector turned in 2025, but emissions hit a record as fossil fuel use outside power kept rising.

• Clean energy draws nearly two dollars for every fossil dollar, yet current policies still point to about 2.6°C.

• Watch the Antalya summit on November 9-20, the shipping vote on December 4, and El Niño's peak.

• Whether the world ends nearer 2°C or 3°C is being decided by politics the physics does not wait for.

Module 11 Quiz

Check Your Understanding

1. Why were 2025's emissions a record even though clean power met all of the growth in electricity demand?

A) Because coal use doubled
B) Because shipping and aviation tripled
C) Because the sinks stopped absorbing carbon dioxide altogether in 2025, leaving all emissions airborne
D) Because fossil fuel use outside power kept rising

2. How does cleaning up air pollution affect warming, in the course's second contradiction?

A) It unmasks warming
B) It has no effect on temperature, only on health
C) It cools the planet, because sulfur traps heat
D) Slows it

3. What happens on December 4, 2026?

A) The Antalya summit opens
B) The shipping body's members vote on adopting the net-zero framework and its carbon price
C) The EU's deforestation rules apply
D) The US midterm elections take place

4. Where and when does the 31st UN climate summit meet?

A) Belém, Brazil, in November 2025
B) Bonn, in June 2026
C) Antalya, Turkey, on November 9-20, 2026
D) Addis Ababa, Ethiopia, in 2027, after Turkey withdrew as host over the cost of the venue

5. What is the course's closing judgment?

A) The problem is solved by the cost curve, so policy no longer matters
B) The outcome is fixed at 3°C whatever is done
C) Removal will decide the outcome
D) Politics decides between 2 and 3°C

Answer Sheet

Answers to every module's Check Your Understanding quiz.

Module	Answers
Module 1 Quiz	1. A 2. B 3. D 4. C 5. D
Module 2 Quiz	1. C 2. A 3. B 4. C 5. D
Module 3 Quiz	1. B 2. A 3. B 4. D 5. C
Module 4 Quiz	1. A 2. C 3. A 4. B 5. D
Module 5 Quiz	1. D 2. B 3. C 4. A 5. A
Module 6 Quiz	1. D 2. B 3. C 4. C 5. A
Module 7 Quiz	1. B 2. D 3. B 4. A 5. C
Module 8 Quiz	1. D 2. C 3. D 4. A 5. B
Module 9 Quiz	1. B 2. D 3. C 4. A 5. A
Module 10 Quiz	1. C 2. D 3. B 4. C 5. B
Module 11 Quiz	1. D 2. A 3. B 4. C 5. D