A Level Geography – Year 13				
Topic : Carbon Cycle				
Week	**Lesson**	**Lesson Title**	**Key concepts**	**Independent Learning** **Student to complete as advised by teacher**
Most global carbon is locked in terrestrial stores as part of the long-term geological cycle.	**1**	**Biochemical Carbon Cycle**	The biogeochemical carbon cycle consists of carbon stores of different sizes (terrestrial, oceans and atmosphere), with annual fluxes between stores of varying size (measured inPg/Gt), rates and on different timescales. (1)	
	2	**Geological carbon cycle**	Most of the earth's carbon is geological, resulting from the formation of sedimentary carbonate rocks (limestone) in the oceans and biologically derived carbon in shale, coal and other rocks.	
	3	**Chemical carbon cycle**	Chemical weathering removes carbon from silicate rocks. The carbon ends up in the ocean as carbonate rock. Carbon is released via outgassing at ocean ridges, hotspot volcanoes and subduction zones.	
2 Biological processes sequester carbon on land and in the oceans on shorter timescales.	**1**	**Carbon Sequesters**	Phytoplankton sequester atmospheric carbon during photosynthesis in surface ocean waters; carbonate shells/tests move into the deep ocean water through the carbonate pump and action of the thermohaline circulation	
	2	**Short term carbon cycle**	Terrestrial primary producers sequester carbon during photosynthesis; some of this carbon is returned to the atmosphere during respiration by consumer organisms.	
	3	**Biological carbon cycle**	Biological carbon can be stored as dead organic matter in soils, or returned to the atmosphere via biological decomposition over several years.	

3 A balanced carbon cycle is important in sustaining other earth systems but is increasingly altered by human activities.	**1**	**A balanced carbon cycle**	The concentration of atmospheric carbon (carbon dioxide and methane) strongly influences the natural greenhouse effect, which in turn determines the distribution of temperature and precipitation.	
	2		Ocean and terrestrial photosynthesis play an important role in regulating the composition of the atmosphere. Soil health is influenced by stored carbon, which is important for ecosystem productivity.	
	3	**Human disruption to the carbon cycle balance.**	The process of fossil fuel combustion has altered the balance of carbon pathways and stores with implications for climate ,ecosystems and the hydrological cycle	
4 Energy security is a key goal for countries, with most relying on fossil fuels.	**1**	**Energy consumption**	Consumption (per capita and in terms of units of GDP) and energy mix (domestic and foreign, primary and secondary energy, renewable versus non-renewable).	
	2	**Physical factors affecting the access to energy consumption**	Access to and consumption of energy resources depends on physical availability, cost, technology, public perception, level of economic development and environmental priorities, national comparisons: **USA versus France**	
	3	**Energy players and their role**	Energy players ***(P: role of TNCs, The Organisation of the Petroleum Exporting Countries (OPEC), consumers, governments)*** have different roles in securing pathways and energy supplies	
5 Reliance on fossil fuels to drive economic		**Mismatch of energy supply and demand**	There is a mismatch between locations of conventional fossil fuel supply (oil, gas, coal) and regions where demand is highest, resulting from physical geography.	
		Energy patheways	Energy pathways (pipelines, transmission lines, shipping routes, road and rail) are a key aspect of security but can be prone to disruption especially as conventional fossil fuel sources depleted. **Russian gas to Europe**	

development is still the global norm.		**Unconventional fossil fuels**	The development of unconventional fossil fuel energy resources (tar sands, oil shale, shale gas, deep water oil) has social costs and benefits, implications for the carbon cycle, and consequences for the resilience of fragile environments. **Canadian tar sands, USA fracking, Brazilian deep water** oil) ***(P: role of business in developing reserves, versus environmental groups and affected communities)***	
6 There are alternatives to fossil fuels but each has costs and benefits.	**1**	**Renewable and recyclable energy**	Renewable and recyclable energy (nuclear power, wind power and solar power) could help decouple fossil fuel from economic growth; these energy sources have costs and benefits economically, socially, and environmentally and in terms of their contribution they can make to energy security .**Changing UK energy mix case study**	
	2	**Bio fuels**	Biofuels are an alternative energy source that are increasing globally; growth in biofuels however has implications for food supply as well as uncertainty over how 'carbon neutral' they are. **Biofuels in Brazil case study**	
	3	**Carbon Capture and alternative energy**	Radical technologies, including carbon capture and storage and alternative energy sources (hydrogen fuel cells, electric vehicles) could reduce carbon emissions but uncertainty exists as to how far this is possible	
7 Biological carbon cycles and the water cycle are threatened by human activity.	**1**	**Human factors affecting carbon stores**	Growing demand for food, fuel and other resources globally has led to contrasting regional trends in land-use cover(deforestation, afforestation, conversion of grasslands to farming) affecting terrestrial carbon stores with wider implications for the water cycle and soil health.	
	2	**Ocean acidification**	Ocean acidification, as a result of its role as a carbon sink, is increasing due to fossil fuel combustion and risks crossing the critical threshold for the health of coral reefs and other marine ecosystems that provide vital ecosystem services	
	3	**Climate change and the carbon cycle**	Climate change, resulting from the enhanced greenhouse effect, may increase the frequency of drought due to shifting climate belts, which may impact on the health of forests as carbon stores. (🌍 Amazonian drought events)	
8	**1**	**Kuznets curve model**	Forest loss has implications for human wellbeing but there is evidence that forest stores are being protected and even expanded, especially in countries at higher levels of	

There are implications for human wellbeing from the degradation of the water and carbon cycles..			development (**environmental Kuznets' curve model**).	
	2	**Artic case study**	Increased temperatures affect evaporation rates and the quantity of water vapour in the atmosphere with implications for precipitation patterns, river regimes and water stores(cryosphere and drainage basin stores) Arctic case study	
	3	**Threats to ocean health**	Threats to ocean health pose threats to human wellbeing, especially in developing regions that depend on marine resources as a food source and for tourism and coastal protection.	
9 Further planetary warming risks large-scale release of stored carbon, requiring responses from different players at different scales.	**1**	**Tipping point**	Future emissions, atmospheric concentration levels and climate warming are uncertain owing to natural factors (the role of carbon sinks), human factors (economic growth, population, energy sources) and feedback mechanisms (carbon release from peatlands and permafrost, and tipping points, including forest die back and alterations to the thermohaline circulation	
	2	**Adaptation strategies**	Adaptation strategies for a changed climate (water conservation and management, resilient agricultural systems, land-use planning, flood-risk management, solar radiation management) have different costs and risks.	
	3	**Re-balancing the carbon cycle**	Re-balancing the carbon cycle could be achieved through mitigation (carbon taxation, renewable switching, energy efficiency, afforestation, carbon capture and storage) but this requires global scale agreement and national actions both of which have proved to be problematic. ***(A: attitudes of different countries, TNCs and people)***	
10	**1**	**Assessment**	Revision	
	2	**Assessment**	Revision	
	3	**Assessment**	Revision	

11	**1**	**Assessment**	Revision	
	2	**Assessment**	Exam	
	3	**Assessment**	Feedback and redraft	