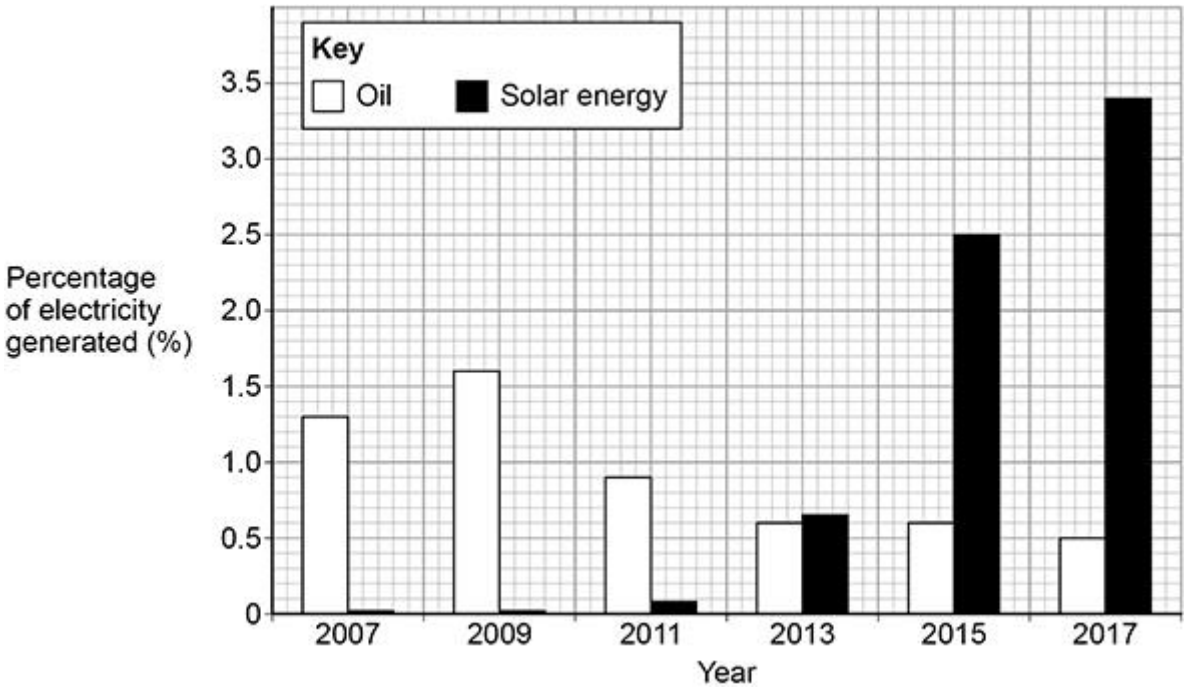
Questions are for both separate science and combined science students unless indicated in the question

Q1.

This question is about fuels and energy.

The graph below shows the percentage of electricity generated in the UK between 2007 and 2017 using:

- oil
- solar energy.



(a) Describe the changes in the percentage of electricity generated in the UK between 2007 and 2017 using:

- oil
- solar energy.

Use data from the graph above in your answer.

(3)

(b) Oil contains carbon and some sulfur.

When oil is burned, the products of combustion may be released into the atmosphere.

Explain the environmental effects of releasing these products of combustion into the atmosphere.

(6)

(c) Suggest **one** reason why using solar energy is a more sustainable way of generating electricity than burning oil.

(1)

(d) Solar energy may **not** be able to replace the generation of electricity from fossil fuels completely.

Suggest **two** reasons why.

1

2

(2)

(Total 12 marks)

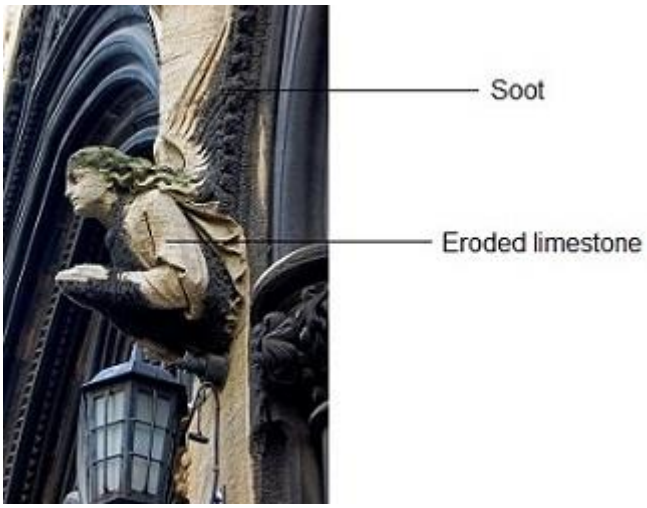
Q2.

This question is about atmospheric pollution.

The image below shows a limestone carving which has been damaged by atmospheric pollution.

The carving has been:

- blackened by soot
- eroded where the limestone has reacted with atmospheric pollutants.



(a) What reacted with the limestone to cause the erosion?

Tick (✓) **one** box.

Acid rain	☐
Ammonia	☐
Carbon monoxide	☐
Oxygen	☐

(1)

(b) Soot is produced by the incomplete combustion of diesel oil.

Complete the sentences.

Choose answers from the box.

ammonia	**carbon**	**methane**
nitrogen	**oxygen**	

Incomplete combustion happens when there is not enough _____.

Incomplete combustion produces particles of _____.

(2)

(c) Complete the sentence.

Particles of soot in the atmosphere cause global _____.

(1)

(d) Carbon monoxide is produced by the incomplete combustion of methane.

Balance the equation for the reaction.

$$2\ CH_4 + 3\ O_2 \rightarrow \_\_\_\_\ CO + 4\ H_2O$$

(1)

(e) Car engines work at high temperatures.

Complete the sentences.

Choose answers from the box.

air	**methane**	**oxides of nitrogen**
oxygen	**petrol**	**sulfur dioxide**

In car engines, nitrogen is present.

The nitrogen in car engines comes from _____.

At high temperatures, the nitrogen reacts with _____.

This reaction produces _____.

(3)

(Total 8 marks)

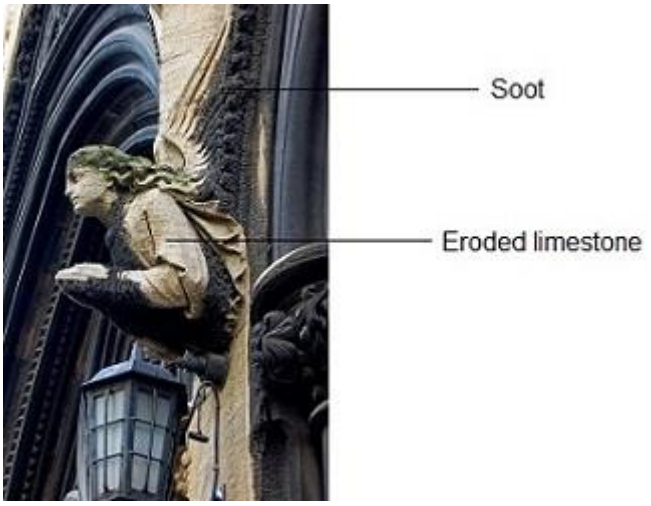
Q3.

This question is about atmospheric pollution.

The image below shows a limestone carving which has been damaged by atmospheric pollution.

The carving has been:

- blackened by soot
- eroded where the limestone has reacted with atmospheric pollutants.



(a) Explain why soot is formed when some fossil fuels are burned.

_____

_____

_____

_____

(2)

(b) Fossil fuels are burned in car engines.

Explain how reducing the amount of sulfur in fossil fuels reduces the erosion of limestone.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(c) Oxides of nitrogen are atmospheric pollutants which are formed in car engines.

Explain why oxides of nitrogen are formed in car engines.

_____

_____

_____

_____

(2)

(Total 8 marks)

Q4.

Some central heating boilers use methane as a fuel.

Carbon monoxide detectors are placed near central heating boilers.

(a) Which **three** properties of carbon monoxide make it necessary to use carbon monoxide detectors?

Choose answers from the box.

acidic	**alkaline**	**colourless**	**corrosive**
	insoluble	**odourless**	**toxic**

1 _____

2 _____

3 _____

(3)

(b) Complete the sentence.

Methane produces carbon monoxide when burning in a limited supply of

_____.

(1)

(c) 8 g of methane has a volume of 12 dm^3 at room temperature and pressure.

Calculate the mass of 36 dm^3 of methane. **(separate only)**

_____

_____

_____

_____

Mass = _____ g

(2)

(d) Most methane is obtained from natural gas, which is a fossil fuel.

Methane can also be produced renewably.

Which **two** are renewable sources of methane?

Tick (✓) **two** boxes.

Animal waste	☐
Food in landfill	☐
Nitrogen in the air	☐
Non-biodegradable plastics	☐
Scrap iron	☐

(2)

(Total 8 marks)

Q5.

This question is about combustion of fuels.

(a) Some central heating boilers use wood as a fuel.

Suggest **two** reasons why wood is more sustainable than natural gas as a fuel for central heating boilers.

1 _____

_____

2 _____

_____

(2)

Natural gas is mainly methane.

When methane burns it can produce both carbon monoxide and carbon dioxide.

(b) Explain the process by which carbon monoxide can be produced when methane is burned.

_____

_____

_____

_____

(2)

(c) Balance the equation for the combustion of methane to produce carbon monoxide.

_____$CH_4(g)$ + _____ $O_2(g)$ → _____ $CO(g)$ + _____ $H_2O(l)$

(1)

(d) Propane burns to form carbon dioxide and water.

The equation for the reaction is:

$$C_3H_8(g) + 5\ O_2(g) \rightarrow 3\ CO_2(g) + 4\ H_2O(l)$$

3.60 dm^3 carbon dioxide is produced when a sample of propane is burned in 7.25 dm^3 oxygen.

Calculate the volume of unreacted oxygen. **(separate only)**

Give your answer in cm^3

_____

_____

_____

_____

_____

_____

_____

_____

Volume of unreacted oxygen = _____ cm^3

(4)

(Total 9 marks)

Q6.

This question is about fuels.

Octane (C_8H_{18}) is a hydrocarbon in petrol.

(a) Cracking breaks down large hydrocarbon molecules into smaller hydrocarbon molecules.

Which hydrocarbon molecule can be cracked to produce octane, C_8H_{18}?

Tick **one** box.

C_4H_8 ☐

C_4H_{10} ☐

C_8H_{16} ☐

$C_{12}H_{26}$ ☐

(1)

(b) What type of carbon compound is octane, C_8H_{18}?

Tick **one** box.

Alcohol ☐

Alkane ☐

Carboxylic acid ☐

Ester ☐

(1)

(c) Oxygen is needed to burn fuels.

Name the source of the oxygen needed to burn fuels.

_____

_____

(1)

(d) Particulates and sulfur dioxide are pollutants produced when some fuels burn.

Draw **one** line from each pollutant to the polluting effect.

Pollutant	**Polluting effect**
	Acid rain

Particulates	Global dimming
	Global warming
Sulfur dioxide	Landfill
	Sewage sludge

(2)

(e) Which **two** gases are produced when fuels burn in car engines?

Tick **two** boxes.

- Ammonia ☐
- Carbon dioxide ☐
- Carbon monoxide ☐
- Nitrogen ☐
- Oxygen ☐

(2)

(f) Vehicles produce most of the atmospheric pollution in cities.

How could the atmospheric pollution in cities be reduced?

Tick **two** boxes.

- Build more roads in cities ☐
- Build new car factories ☐
- Develop fuel efficient engines ☐
- Make car tax cheaper ☐

Use electric cars ☐

(2)

(Total 9 marks)

Q7.

Older cars are tested each year to measure the amount of pollutants contained in exhaust fumes.

The table below shows the maximum allowed percentages of exhaust pollutants for petrol cars.

Age of car in years	Maximum allowed percentage (%) of exhaust pollutant	
	Carbon monoxide	Unburned hydrocarbons
16−24	0.30	0.02
3−16	0.20	0.02

(a) Explain how carbon monoxide is produced when petrol is burned in car engines.

_____

_____

_____

_____

(2)

(b) Suggest **two** reasons why the maximum allowed percentage of carbon monoxide has been decreased for newer cars.

1. _____

_____

2. _____

_____

(2)

(c) Give **one** reason for having a maximum allowed percentage of unburned hydrocarbons in exhaust fumes.

_____

_____

(1)

Oxides of nitrogen are also pollutants contained in exhaust fumes.

(d) Describe how oxides of nitrogen are produced when petrol is burned in car engines.

_____

_____

_____

_____

(2)

Catalytic converters are fitted to car exhausts to reduce the amount of pollutants released into the atmosphere.

(e) Nitrogen dioxide is an oxide of nitrogen.

Nitrogen dioxide reacts to produce nitrogen and oxygen in catalytic converters.

Complete the equation for this reaction.

The equation should be balanced.

$$\_\_\_ NO_2 (g) \longrightarrow \_\_\_\_\_ + \_\_\_ O_2 (g)$$

(2)

(f) Give **two** effects of atmospheric pollution which are reduced by using catalytic converters.

1. _____

_____

2. _____

_____

(2)

(g) The catalyst in catalytic converters is a mixture of three elements.

Where in the periodic table are these elements most likely to be found?

Tick **one** box. **(separate only)**

Alkali metals ☐

Halogens ☐

Noble gases ☐

Transition metals ☐

(1)

(Total 12 marks)

Q8.

Coal is used as a fuel in power stations.

The table shows the percentage of carbon and sulfur in four different coal samples.

Sample	Percentage (%) by mass in coal	
	Carbon	**Sulfur**
A	22.1	0.4
B	46.8	0.6
C	66.3	0.9
D	92.0	0.7

(a) Sulfur produces a gas that causes acid rain.

Name the gas.

_____

(1)

(b) Give **one** environmental effect caused by acid rain.

_____

(1)

(c) Which coal sample produces the most acid rain from 1 kg of coal?

Use the table above.

Give a reason for your answer.

Sample _____

Reason _____

_____

(2)

(d) Calculate the mass of coal sample **A** that would produce the same amount of carbon dioxide as 1 kg of coal sample **C**.

_____

_____

Mass of coal sample **A** = _____ kg

(2)

(e) Incomplete combustion of coal can produce carbon monoxide.

Carbon monoxide is a toxic gas.

Give **two** reasons why people may be unaware of the presence of carbon monoxide.

1. _____

_____

2. _____

_____

(2)

(Total 8 marks)

Q9.

This question is about hydrocarbons.

(a) The names and formulae of three hydrocarbons in the same homologous series are:

Ethane	C_2H_6
Propane	C_3H_8
Butane	C_4H_{10}

The next member in the series is pentane.

What is the formula of pentane?

_____

(1)

(b) Which homologous series contains ethane, propane and butane?

Tick **one** box.

Alcohols ☐

Alkanes ☐

Alkenes ☐

Carboxylic acids ☐

(1)

(c) Propane (C_3H_8) is used as a fuel.

Complete the equation for the complete combustion of propane.

$C_3H_8 + 5O_2 \rightarrow 3$ _____ + 4 _____

(2)

(d) Octane (C_8H_{18}) is a hydrocarbon found in petrol.

Explain why octane is a hydrocarbon.

_____

_____

(2)

(e) The table below gives information about the pollutants produced by cars using diesel or petrol as a fuel.

Fuel	**Relative amounts of pollutants**		
	Oxides of Nitrogen	**Particulate matter**	**Carbon dioxide**
Diesel	31	100	85
Petrol	23	0	100

Compare the pollutants from cars using diesel with those from cars using petrol.

_____

_____

_____

_____

_____

_____

(3)

(f) Pollutants cause environmental impacts.

Draw **one** line from each pollutant to the environmental impact caused by the pollutant.

Pollutant	Environmental impact caused by the pollutant
	Acid rain
Oxides of nitrogen	Flooding
	Global dimming
Particulate matter	Global warming
	Photosynthesis

(2)

(Total 11 marks)