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

Q1.

This question is about burning fuels in central heating boilers.

In the future, gas central heating boilers may burn hydrogen rather than natural gas.

The table below shows information about these fuels when 1 dm^3 of the fuel is burned in a central heating boiler.

	Fuel	
	Hydrogen	**Natural gas**
Energy released in kJ	11.9	37.1
Mass of carbon dioxide produced in grams	0.00	1.83
Mass of water vapour produced in grams	0.75	1.50
Mass of oxides of nitrogen produced in grams	6.6×10^{-4}	4.9×10^{-4}

(a) Explain how oxides of nitrogen are produced when burning fuels.

_____

_____

_____

_____

(2)

(b) Explain **one** positive impact on the environment of burning hydrogen rather than natural gas as a fuel.

Use the table above.

_____

_____

_____

_____

(2)

(c) Explain **one** negative impact on the environment of burning hydrogen rather than natural gas as a fuel.

Use the table above.

_____

_____

_____

_____

(2)

(d) Air is 20% oxygen.

Calculate the volume of air needed to provide enough oxygen to react with 3.50 dm^3 of hydrogen gas. **(chemistry only) (HT only)**

The equation for the reaction is

$$2\ H_2 + O_2 \rightarrow 2\ H_2O$$

_____

_____

_____

_____

_____

Volume of air = _____ dm^3

(3)

(e) Central heating boilers can also burn kerosene.

Kerosene is produced from crude oil in a fractionating column using fractional distillation.

In the first step, crude oil is heated and hydrocarbon vapours are formed.

Explain how kerosene is produced from these hydrocarbon vapours.

_____

_____

_____

_____

_____

(3)

(Total 12 marks)

Q2.

This question is about the fractions obtained from crude oil.

(a) Crude oil is separated into fractions by fractional distillation.

The fractions obtained from crude oil include:

- lubricating oil
- naphtha
- petroleum gases.

Table 1 shows the boiling point range of these fractions.

Table 1

Fraction	**Boiling point range in °C**
Lubricating oil	300–350
Naphtha	90–200
Petroleum gases	< 25

Explain how these fractions are obtained from crude oil by fractional distillation.

_____

_____

_____

_____

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_____

_____

_____

(4)

(b) Fractions from crude oil can be processed to produce feedstock for the petrochemical industry.

Which **two** are useful materials produced from this feedstock?

Tick (✓) **two** boxes.

Alloys	☐
Ceramics	☐
Detergents	☐
Fertilisers	☐
Solvents	☐

(2)

Another fraction obtained from crude oil is petrol.

(c) Petrol contains a hydrocarbon with the formula C_9H_{20}

Complete the equation for the complete combustion of C_9H_{20}

You should balance the equation.

C_9H_{20} + _____ → _____ + _____

(2)

(d) Petrol obtained from crude oil contains sulfur impurities.

Explain why sulfur impurities are removed before petrol is burned in car engines.

_____

_____

_____

_____

(2)

(e) **Table 2** shows information about two more fractions obtained from crude oil.

Table 2

Fraction	Range of number of carbon atoms in each molecule
Kerosene	11–15
Heavy fuel oil	20–40

A student predicted that heavy fuel oil is more viscous than kerosene.

The student's prediction was correct.

Justify the student's prediction.

_____

_____

_____

_____

(2)

The heavy fuel oil fraction can be processed to produce smaller hydrocarbon molecules.

(f) Name the process which produces smaller hydrocarbon molecules from heavy fuel oil.

Give the conditions used in this process.

Name of process _____

Conditions _____

_____

_____

(3)

(g) Hydrocarbon molecules containing seven and eight carbon atoms can be produced when heavy fuel oil is processed.

Which pair of hydrocarbon molecules would **both** turn bromine water colourless?

Tick (✓) **one** box.

C_7H_{14} and C_8H_{16} ☐

C_7H_{14} and C_8H_{18} ☐

C_7H_{16} and C_8H_{16} ☐

C_7H_{16} and C_8H_{18} ☐

(1)

(Total 16 marks)