Past-paper walk-through

Alkanes ▪ 14.1

eXercise

Questions in this set

- 9701/11 N25 Q28 ▪ 1 mark
- 9701/11 N25 Q29 ▪ 1 mark
- 9701/14 N25 Q25 ▪ 1 mark
- 9701/22 N25 Q3 ▪ 14 marks

Reading the mark scheme

- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- // separates answers the examiner accepts equally.
- **ecf** = error carried forward: a later part is marked on your own earlier answer.
- **owtte** = "or words to that effect" – the wording need not match.

Question 28

9701/11 N25 ▪ Q28 ▪ 1 mark

28 Two hydrocarbons, R–CH_3 and R'–CH_3, react separately with bromine in the presence of ultraviolet light. One of these hydrocarbons is unsaturated.

In each case, free radical substitution reactions occur.

R is $CH_3CHC(CH_3)$.

R' is $CH_3CH(CH_3)CH_2$.

Which row is correct?

	a propagation stage for the saturated hydrocarbon	a termination stage for the unsaturated hydrocarbon
A	$R–CH_2• + Br• \rightarrow R–CH_2Br$	$R'–CH_2• + Br• \rightarrow R'–CH_2Br$
B	$R–CH_2• + Br_2 \rightarrow R–CH_2Br + Br•$	$R'–CH_2• + Br_2 \rightarrow R'–CH_2Br + Br•$
C		

Question 28

C	$R'–CH_3 + Br\bullet \rightarrow R'–CH_2\bullet + HBr$	$2R–CH_2\bullet \rightarrow R–CH_2CH_2–R$
D	$2R'–CH_2\bullet \rightarrow R'–CH_2CH_2–R'$	$R–CH_3 + Br\bullet \rightarrow R–CH_2\bullet + HBr$

Solution 28

Answer: **C**

Why

- The saturated hydrocarbon is the one with no C=C, so its radical comes from R′.
- Propagation keeps the radical count the same – a radical goes in and a radical comes out.
- Termination destroys radicals: two combine to give a molecule and no new radical.

Question 29

9701/11 N25 ▪ Q29 ▪ 1 mark

29 The fumes from the exhausts of petrol-burning cars contain the following pollutants.

1 unburnt hydrocarbons

2 nitrogen dioxide

3 carbon monoxide

Which pollutants are removed by oxidation in a catalytic converter?

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

Solution 29

Answer: **C**

Why

- A catalytic converter *oxidises* the unburnt hydrocarbons and carbon monoxide to CO_2 and water.
- Nitrogen dioxide is *reduced* to nitrogen, not oxidised.
- So the pollutants removed by oxidation are 1 and 3.

Question 25

9701/14 N25 ▪ Q25 ▪ 1 mark

25 Two hydrocarbons, $CH_3CHC(CH_3)CH_3$ and $CH_3CH(CH_3)CH_2CH_3$, react separately with chlorine in the presence of ultraviolet light.

In each reaction, free-radical substitution occurs.

Which row is correct?

	identity of the hydrocarbon that can also undergo electrophilic addition	a termination stage of the free-radical substitution of the saturated hydrocarbon
A	$CH_3CHC(CH_3)CH_3$	$CH_3CH(CH_3)CH_2CH_2\bullet + Cl\bullet \rightarrow CH_3CH(CH_3)CH_2CH_2Cl$
B	$CH_3CHC(CH_3)CH_3$	$CH_3CHC(CH_3)CH_2\bullet + Cl\bullet \rightarrow CH_3CHC(CH_3)CH_2Cl$
C	$CH_3CH(CH_3)CH_2CH_3$	$CH_3CH(CH_3)CH_2CH_2\bullet + Cl\bullet \rightarrow CH_3CH(CH_3)CH_2CH_2Cl$
D	$CH_3CH(CH_3)CH_2CH_3$	$CH_3CHC(CH_3)CH_2\bullet + Cl\bullet \rightarrow CH_2CHC(CH_3)CH_2Cl$

Question 25

Solution 25

Answer: **A**

Why

- Electrophilic addition needs a C=C, so only the *unsaturated* hydrocarbon can do it.
- The saturated one can react only by free-radical substitution.
- A termination step must remove two radicals and produce no new one.

Question 3

9701/22 N25 ▪ Q3 ▪ 14 marks

3 The alkanes are a homologous series of organic molecules. Alkanes are generally unreactive and are commonly used as fuels.

(a) Define homologous series.

Question 3

(b) Give two reasons to explain the general unreactivity of alkanes.

Question 3

Question 3

[2]

(c) Alkanes with low relative molecular mass, M_r, are more useful than those found in heavier crude oil fractions.

Name the process that is used to obtain alkanes with low M_r from heavier crude oil fractions.

Question 3

(d) Hexane, C_6H_{14}, has four structural isomers.

Fig. 3.1 shows hexane and two of its structural isomers.

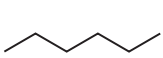
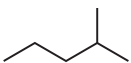
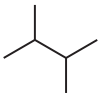
hexane	A	B	C	D
				

Fig. 3.1

(i) Complete Fig. 3.1 by drawing structures for **C** and **D**, the other two structural isomers of hexane. [2]

(ii) **A**, **B** and hexane have different boiling points.

Question 3

Question 3

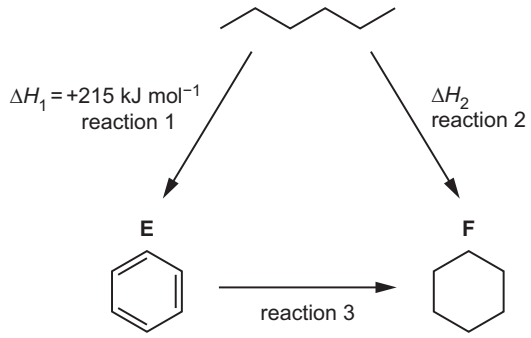
Arrange **A**, **B** and hexane in order of increasing boiling point.

Explain your answer.

Question 3

[3]

(e) Hexane can be converted into compounds **E** and **F** at high temperature and pressure. Fig. 3.2 shows the reaction scheme involving hexane, **E** and **F**.



Question 3

Fig. 3.2

Question 3

(i) Identify a suitable reagent for reaction 3.

Question 3

(ii) Use the data in Fig. 3.2 and in Table 3.1 to calculate the enthalpy change of reaction 2, ΔH_2.

Table 3.1

compound	enthalpy change of formation, ΔH_f / kJ mol^{-1}
	−156
	+48

Question 3

Question 3

Question 3

(iii) Write an equation for the complete combustion of hexane.

Question 3

[Total: 14]

Solution 3

(a)

Mark scheme

- M1 (family of molecules / compounds / series with) same general formula
- OR (family of molecules where) molecular formula differs (only) by (units of) CH2(n). **M2**
- similar chemical properties / reactions
- 2

Solution 3

(b)

Mark scheme

- M1 strong C—H (bonds) M2
- non-polar (C—H / molecule / bonds)
- 2

Solution 3

(c)

Mark scheme

- cracking
- 1

Solution 3

(d)(i)

Mark scheme

- 2

(d)(ii)

Mark scheme

- M1 B $<$ A $<$ hexane. **M2**
- hexane / unbranched has stronger / more IMFs **M3**
- hexane / unbranched requires most / more energy
- 3

Solution 3

(e)(i)

Mark scheme

- H2 ((g)) OR hydrogen (gas)
- 1

Solution 3

(e)(ii)

Mark scheme

- M1 $+215 + (-156) - (+48) =$ M2
- $+11$ kJ mol–1
- 2

Solution 3

(e)(iii)

Mark scheme

- C6H14 + 9½O2 → 6CO2 + 7H2O
- 1