Cambridge International AS & A Level

Cambridge Assessment International Education
Cambridge International Advanced Subsidiary and Advanced Level

CHEMISTRY **9701/12**

Paper 1 Multiple Choice **October/November 2019**

1 hour

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)
Data Booklet

* 5 1 6 5 4 4 1 3 7 8 *

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.
DO **NOT** WRITE IN ANY BARCODES.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
Electronic calculators may be used.

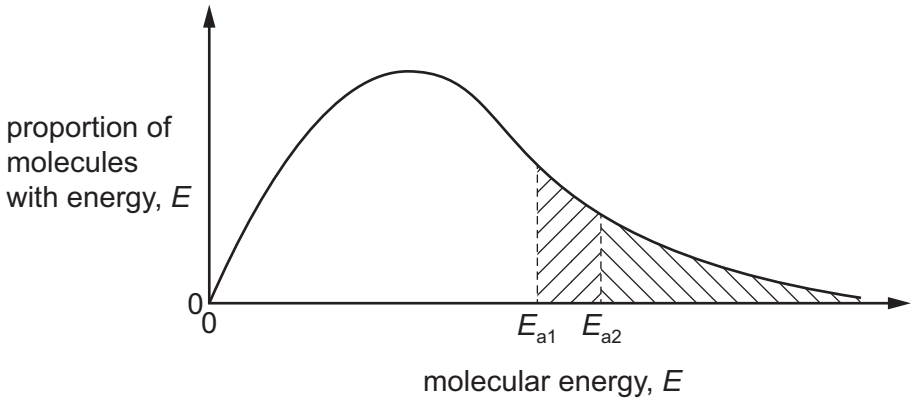
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Section A

For each question there are four possible answers, **A**, **B**, **C** and **D**. Choose the **one** you consider to be correct.

Use of the Data Booklet may be appropriate for some questions.

1 The diagram shows a Boltzmann distribution of the energies of gaseous molecules and the activation energies, E_a, of a reaction with and without a catalyst.



Which statement about this distribution curve is correct?

A If the temperature of the gas is increased, the maximum of the curve becomes higher.

B If the temperature of the gas is increased, the maximum of the curve moves to the left.

C The fraction of molecules that react in the presence of a catalyst is shown by ▨.

D The fraction of molecules that react in the absence of a catalyst is shown by ▨.

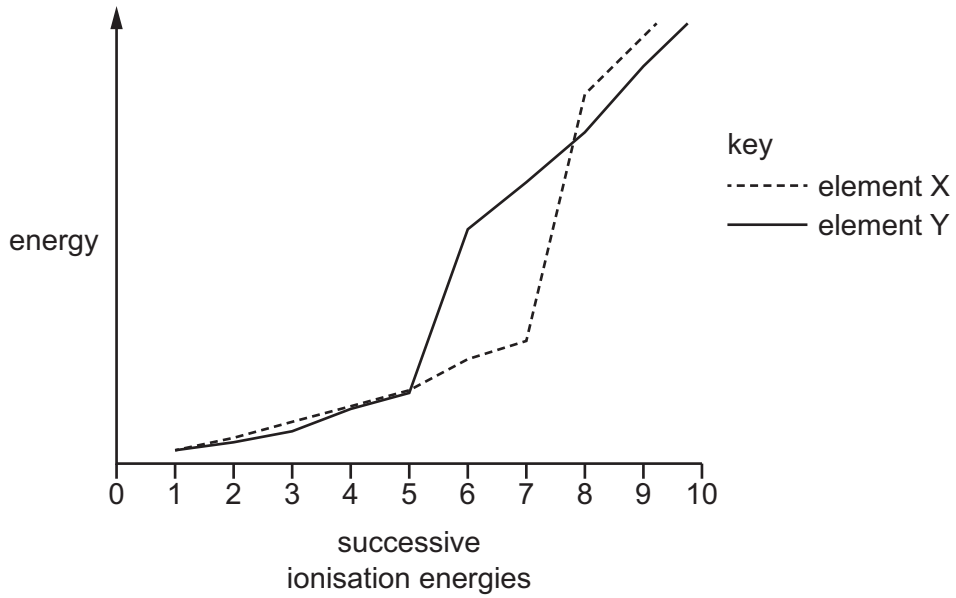
2 In this question it should be assumed that $(NH_4)_2CO_3.H_2O(s)$ dissolves in water without causing an increase in volume.

Which mass of $(NH_4)_2CO_3.H_2O(s)$ should be added to 800 cm^3 of water to form a 0.100 $mol\,dm^{-3}$ solution of NH_4^+ ions?

A 4.56 g **B** 7.13 g **C** 9.12 g **D** 14.3 g

3 The graph shows the successive ionisation energies of element X and element Y.

Both elements are in Period 3.



Which statement is correct?

A An atom of element X needs one extra electron for a full outer shell; an atom of element Y needs three extra electrons for a full outer shell.

B An atom of element Y has five electrons in the 3p subshell.

C Element X has an oxidation number of +7 in most of its compounds.

D When element X combines with element Y, the bonding is ionic.

4 Which statement about the electrons in a ground state carbon atom is correct?

A Electrons are present in four different energy levels.

B There are more electrons in p orbitals than there are in s orbitals.

C The occupied orbital of highest energy is spherical.

D The occupied orbital of lowest energy is spherical.

5 In this question you should assume the vapour behaves as an ideal gas.

0.175 g of a volatile liquid produces a vapour of volume $4.50 \times 10^{-5}\,m^3$ at 100 °C and pressure of 1.013×10^5 Pa.

What is the M_r of the liquid?

A 31.9 **B** 87.1 **C** 119 **D** 127

6 Which reaction is endothermic?

A $Ca(OH)_2(aq) + 2HCl(aq) \rightarrow CaCl_2(aq) + 2H_2O(l)$

B $2Cl(g) \rightarrow Cl_2(g)$

C $2Ca(s) + O_2(g) \rightarrow 2CaO(s)$

D $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$

7 Which equation correctly represents the standard enthalpy change of atomisation of the given element?

A $\frac{1}{2}I_2(g) \rightarrow I(g)$

B $Na(s) \rightarrow Na(g)$

C $Cl_2(g) \rightarrow 2Cl(g)$

D $Na(g) \rightarrow Na^+(g) + e^-$

8 $(NH_4)_2Cr_2O_7$ decomposes when heated.

$$(NH_4)_2Cr_2O_7 \rightarrow N_2 + 4H_2O + Cr_2O_3$$

Which element is oxidised and which element is reduced?

	oxidised	reduced
A	chromium	nitrogen
B	hydrogen	chromium
C	nitrogen	chromium
D	nitrogen	hydrogen

9 When lead(II) sulfide, PbS, is heated in air, sulfur dioxide and lead(II) oxide are formed.

What is the equation for the reaction between PbS and oxygen?

A $PbS + 2O_2 \rightarrow SO_2 + PbO_2$

B $PbS + 2\frac{1}{2}O_2 \rightarrow SO_3 + PbO_2$

C $PbS + 1\frac{1}{2}O_2 \rightarrow SO_2 + PbO$

D $PbS + 2O_2 \rightarrow SO_3 + PbO$

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10 The decomposition of $SO_3(g)$ is a dynamic equilibrium.

$$2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$$

What happens when the pressure of the system is increased?

A The rate of reaction will decrease and the position of the equilibrium will move to the left.

B The rate of reaction will decrease and the position of the equilibrium will move to the right.

C The rate of reaction will increase and the position of the equilibrium will move to the left.

D The rate of reaction will increase and the position of the equilibrium will move to the right.

11 Hydrated aluminium ions undergo the following reaction.

$$[Al(H_2O)_6]^{3+}(aq) + H_2O(l) \rightleftharpoons [Al(H_2O)_5OH]^{2+}(aq) + H_3O^+(aq)$$

Which statement about this reaction is correct?

A $H_2O(l)$ and $[Al(H_2O)_5OH]^{2+}(aq)$ are a conjugate acid-base pair.

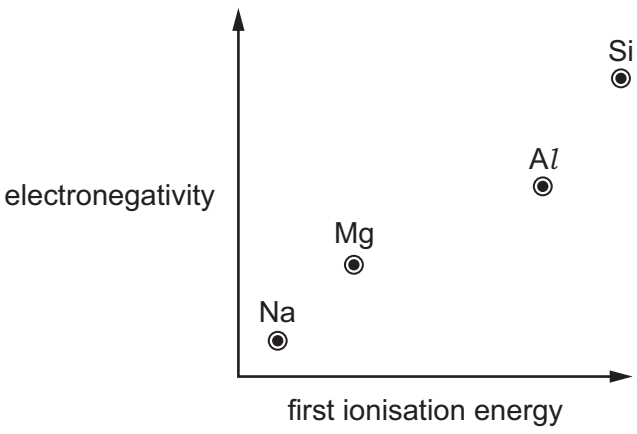
B $H_2O(l)$ is acting as an acid as it is donating H^+ ions.

C If $OH^-(aq)$ is added, the equilibrium will move to the right.

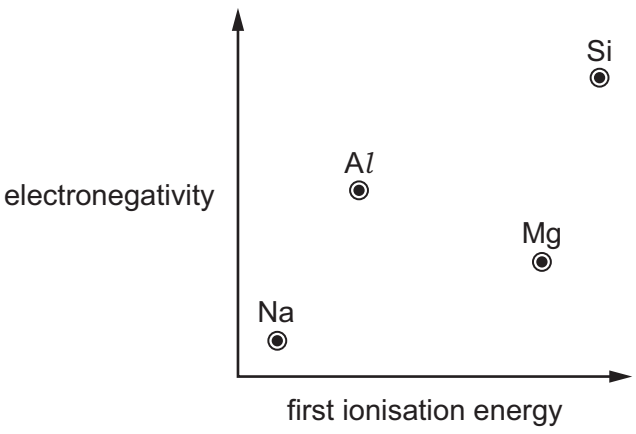
D K_c varies as the pH is varied.

12 Which diagram correctly shows the electronegativity of the elements Na, Mg, A*l* and Si plotted against their first ionisation energies?

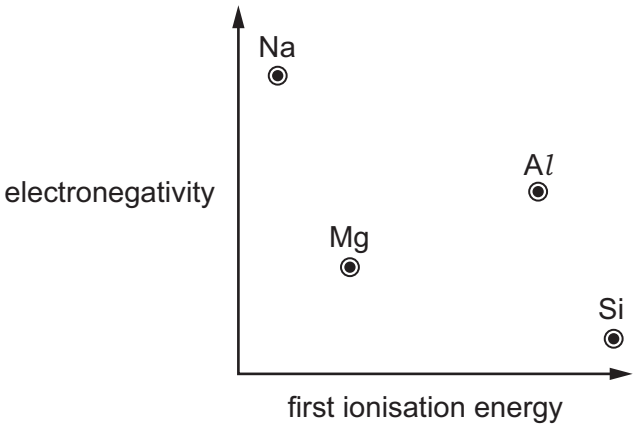
A



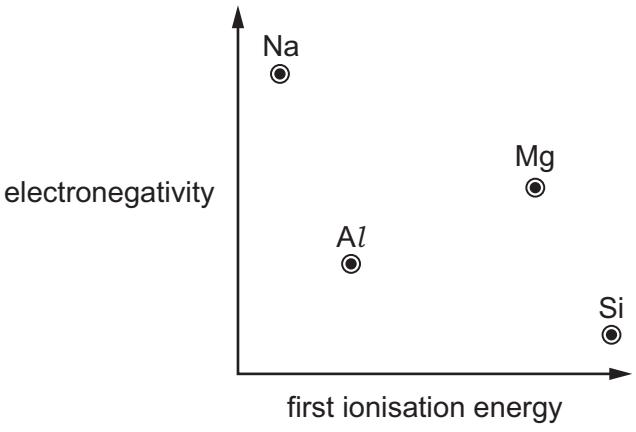
B



C



D



13 Which statement about the compounds of Group 2 elements magnesium to barium is correct?

A Carbonates of Group 2 elements produce bubbles when added to dilute nitric acid.

B Nitrates of Group 2 elements produce nitrogen and oxygen on heating.

C Oxides of Group 2 elements produce bubbles when added to dilute hydrochloric acid.

D The oxides of Group 2 elements are amphoteric.

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14 When equal volumes of saturated solutions of barium hydroxide and calcium hydroxide are mixed, a white precipitate, Y, forms. The mixture is filtered and carbon dioxide is bubbled through the filtrate, producing a second white precipitate, Z.

What are Y and Z?

	Y	Z
A	$Ba(OH)_2$	$Ca(OH)_2$
B	$Ba(OH)_2$	$CaCO_3$
C	$Ca(OH)_2$	$BaCO_3$
D	$Ca(OH)_2$	$Ba(OH)_2$

15 Chlorate(V) ions, ClO_3^-, are produced in the redox reaction between chlorine and hot aqueous sodium hydroxide. Oxidation numbers can be used to help balance the equation for this reaction.

$$vCl_2(g) + wOH^-(aq) \rightarrow xCl^-(aq) + yClO_3^-(aq) + zH_2O(l)$$

What are the values of v, x and y in the balanced equation?

	v	x	y
A	2	3	1
B	3	4	2
C	3	5	1
D	7	12	2

16 The properties of chlorine, bromine and their compounds are compared.

Which property is **smaller** for chlorine than for bromine?

A bond strength of the hydrogen-halide bond

B first ionisation energy

C solubility of the silver halide in $NH_3(aq)$

D strength of the van der Waals' forces between molecules of the element

17 Solid sodium iodide reacts with concentrated sulfuric acid to form more than one product that contains sulfur.

What is the lowest oxidation number of sulfur in these products?

A –2 **B** 0 **C** +4 **D** +6

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18 Which emission from an internal combustion engine contributes to the erosion of marble statues?

A carbon monoxide

B nitrogen

C nitrogen dioxide

D unburnt hydrocarbons

19 Ammonia, carbon dioxide and water react together to form ammonium carbonate.

Which statement about this reaction is correct?

A It is a redox reaction.

B It is an acid-base reaction.

C The H–N–H bond angle decreases as a consequence of this reaction.

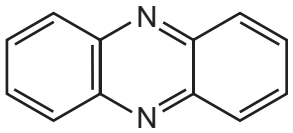
D The three substances react in a 1 : 1 : 1 ratio in this reaction.

20 Structural isomerism and stereoisomerism should be considered when answering this question.

How many isomers with the formula C_5H_{10} have structures that involve π bonding?

A 3 **B** 4 **C** 5 **D** 6

21 The diagram shows the skeletal formula of phenazine.



phenazine

What is the empirical formula of phenazine?

A C_6H_4N **B** C_6H_6N **C** $C_{12}H_8N_2$ **D** $C_{12}H_{12}N_2$

22 An organic compound X reacts with hot, concentrated acidified potassium manganate(VII) solution to give a single carbon-containing product.

What could be X?

A $CH_2C(CH_3)_2$

B $CH_3CHCHCH_3$

C $CH_2CHCH_2CH_3$

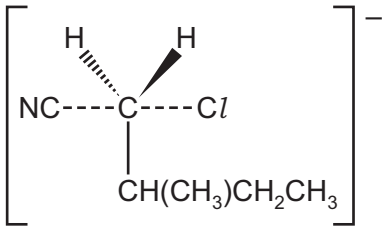
D $CH_3CH_2CH_2CH_3$

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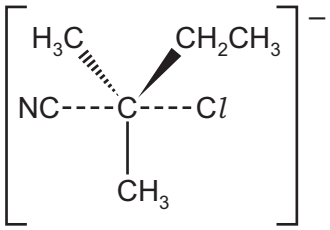
23 1-chloro-2-methylbutane reacts with sodium cyanide in ethanol in a nucleophilic substitution reaction.

What is the most likely intermediate or transition state in this reaction?

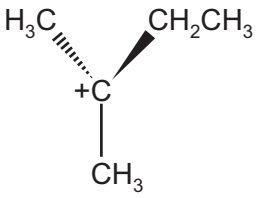
A



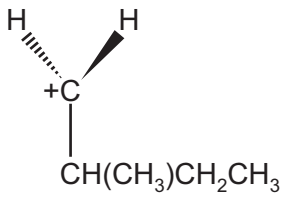
B



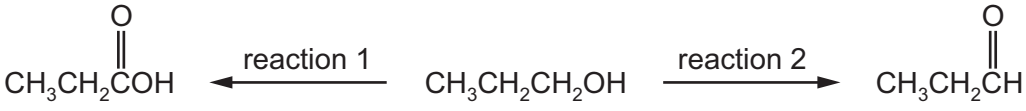
C



D



24 Propan-1-ol can be reacted with acidified potassium dichromate(VI) to form propanoic acid, reaction 1, or propanal, reaction 2.



propan-1-ol

How can the reaction be carried out to ensure that reaction 2 occurs rather than reaction 1?

A An excess of acidified potassium dichromate(VI) is used.

B An excess of concentrated sulfuric acid is added.

C The reaction mixture is distilled immediately after mixing.

D The reaction mixture is heated under reflux.

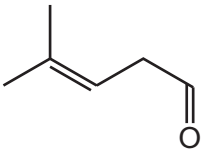
25 What is the smallest amount of oxygen molecules needed for the complete combustion of 40.0 g of methanol?

A 1.88 moles **B** 2.50 moles **C** 3.75 moles **D** 5.00 moles

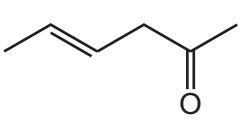
26 Compound X has stereoisomers and forms a precipitate when warmed with Fehling's reagent.

What could be the structure of compound X?

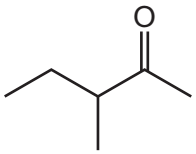
A



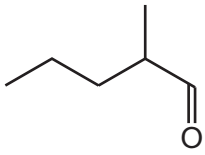
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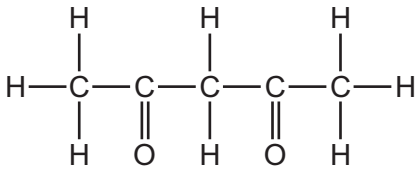
C



D



27 The diagram shows the structure of Y.



Two suggestions are made about Y.

1 Y can be oxidised by hot, acidified dichromate(VI) ions.

2 One mole of Y gives one mole of tri-iodomethane when it reacts with an excess of alkaline aqueous iodine.

Which suggestions are correct?

A both 1 and 2

B 1 only

C 2 only

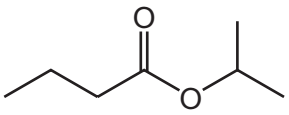
D neither 1 nor 2

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28 Esters can be prepared by the reaction of a carboxylic acid with an alcohol in the presence of concentrated sulfuric acid.

Which row gives the correct names of the reagents that would be suitable to prepare ester Z?

Z



	alcohol	carboxylic acid
A	butan-1-ol	methyl propanoic acid
B	propan-1-ol	butanoic acid
C	propan-2-ol	butanoic acid
D	propan-2-ol	propanoic acid

29 Compound Q can be hydrolysed by HCl(aq). The two products of this hydrolysis have the same empirical formula.

What could Q be?

A $CH_3CO_2CH_2CH_2OH$

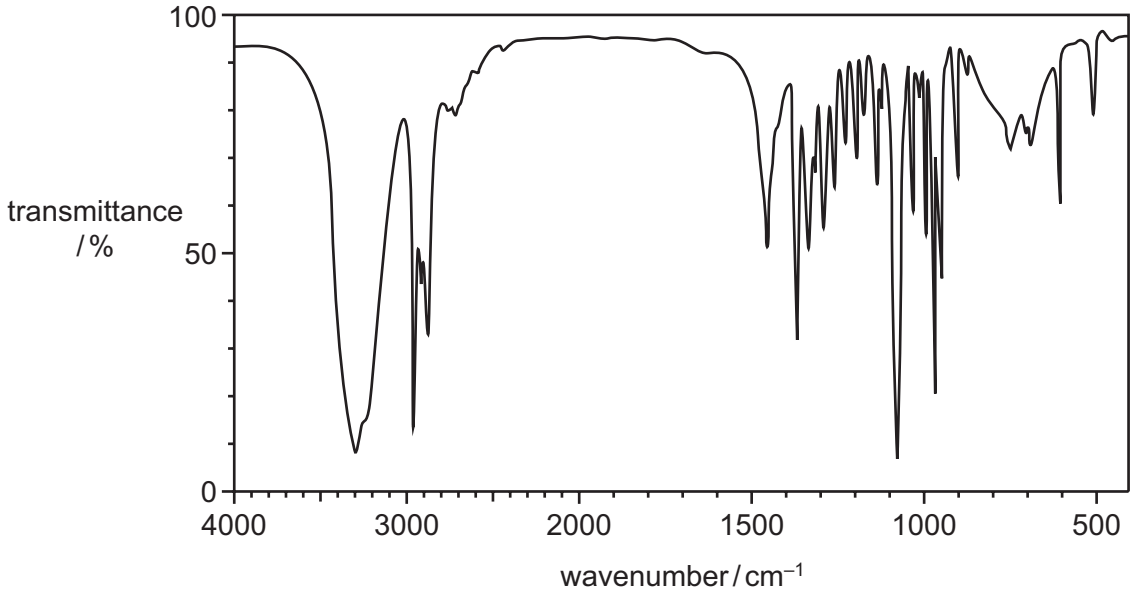
B $CH_3CO_2CH_2CH_2CO_2H$

C $CH_3CH_2CO_2CH_2CH_2CH_3$

D $CH_3CH_2CH(OH)CH(OH)CH_2CH_3$

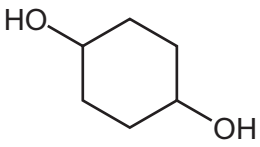
30 Substance T was analysed and found to contain 62.07% carbon, 10.34% hydrogen and 27.59% oxygen.

The infra-red spectrum of substance T is shown.

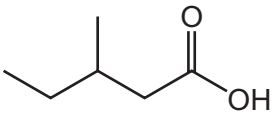


Which substance could be T?

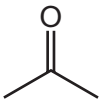
A



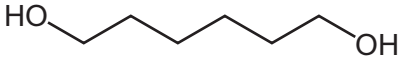
B



C



D



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Section B

For each of the questions in this section, one or more of the three numbered statements **1** to **3** may be correct.

Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements that you consider to be correct).

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, **2** and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

Use of the Data Booklet may be appropriate for some questions.

31 Which gaseous molecules are polar?

1 ammonia

2 hydrogen sulfide

3 boron trifluoride

32 A carbon monoxide molecule, CO, has three bonds between the carbon atom and the oxygen atom.

Which features are present in one CO molecule?

1 two lone pairs of electrons

2 a co-ordinate (dative covalent) bond from oxygen to carbon

3 two π bonds

33 Carbon can exist as allotropes which include graphite, diamond and a fullerene.

Which statements are correct?

1 All three allotropes contain covalent bonds.

2 All three allotropes are giant molecular.

3 All three allotropes have delocalised electrons.

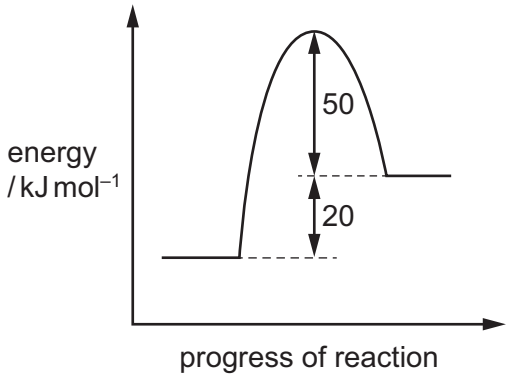
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The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, **2** and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

34 The reaction pathway diagram for a reversible reaction is shown.



Which statements are correct?

1 The enthalpy change for the backward reaction is –20 kJ mol^{-1}.

2 The forward reaction is endothermic.

3 The activation energy for the forward reaction is +70 kJ mol^{-1}.

35 Silicon forms a tetrachloride, $SiCl_4$.

Which statements are correct?

1 In $SiCl_4$, the Si is δ+ and each Cl is δ–.

2 $SiCl_4$ is a liquid at room temperature.

3 $SiCl_4$ reacts with water to give an acidic solution and a precipitate.

36 Which statements about ammonia are correct?

1 An ammonia molecule has three bond pairs and one lone pair of electrons.

2 When ammonia is bubbled into water the pH of the solution increases.

3 Ammonia gas can be made by warming ammonium sulfate with aqueous hydrochloric acid.

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37 Following fractional distillation of crude oil, which processes can be used to produce propene from larger hydrocarbon molecules?

1 cracking

2 reduction

3 polymerisation

38 Bromoethane undergoes nucleophilic substitution reactions.

Which statements are correct?

1 Bromoethane reacts with aqueous NaOH to make ethanol.

2 Bromoethane reacts with ethanolic NH_3 to make ethylamine.

3 Bromoethane reacts with ethanolic KCN to make ethanenitrile.

39 Which reagents, when used in excess, can convert Y into Z?

$$\underset{\text{Y}}{CH_3CH(OH)CO_2H} \rightarrow \underset{\text{Z}}{CH_3CH(OH)CO_2Na}$$

1 Na

2 Na_2CO_3

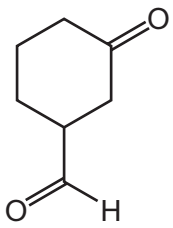
3 NaOH

40 Each of the compounds below is treated separately with an excess of $NaBH_4$.

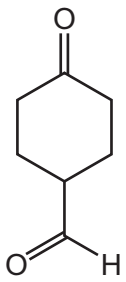
The product of each reaction is then heated with an excess of concentrated H_2SO_4.

Which compounds give **only one** final product with the molecular formula C_7H_{10}?

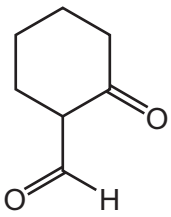
1



2



3



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