OXFORD
INTERNATIONAL
AQA EXAMINATIONS

OXFORD AQA INTERNATIONAL A-LEVEL
CHEMISTRY
(9620)

PAPER 3

Specimen 2018 Morning Time allowed: 1 hour 30 minutes

Materials
For this paper you must have:
- a pencil
- a ruler
- a calculator
- a data booklet

Instructions
- use black ink or ball-point pen
- answer **all** questions
- show all your working.

Information
- The marks for questions are shown in brackets
- The maximum mark for this paper is 80 marks

Please write clearly, in block capitals, to allow character computer recognition.

Centre number ☐☐☐☐☐ Candidate number ☐☐☐☐

Surname

Forename(s)

Candidate signature _____

Answer **all** questions in the spaces provided.

0 1 This question is about bond enthalpy.

0 1 . 1 Define the term mean bond enthalpy.

[2 marks]

0 1 . 2 Ethyne contains a carbon-carbon triple bond.

Ethyne reacts with chlorine.

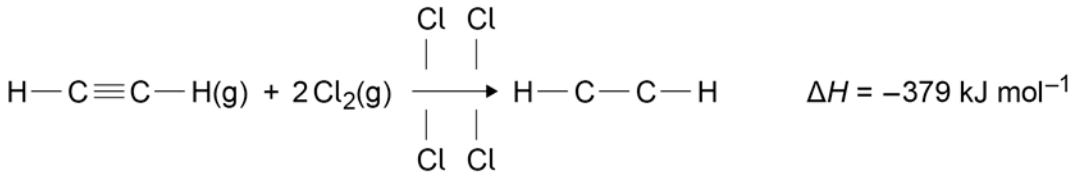


Table X shows some mean bond enthalpies.

Table X

Bond	C≡C	C-H	Cl-Cl	C-C
Mean bond enthalpy / kJ mol^{-1}	837	412	242	348

Use **Table X** to calculate a value for the C-Cl bond enthalpy.

[3 marks]

C-Cl bond enthalpy = _____ kJ mol^{-1}

0 2 . 1 Write an equation for the process that has an enthalpy change equal to the electron affinity of fluorine.

[1 mark]

0 2 . 2 In terms of electrostatic forces, suggest why the electron affinity of fluorine has a negative value.

[2 marks]

0 2 . 3 Complete the Born–Haber cycle for silver fluoride by adding the missing species on the dotted lines.

[3 marks]

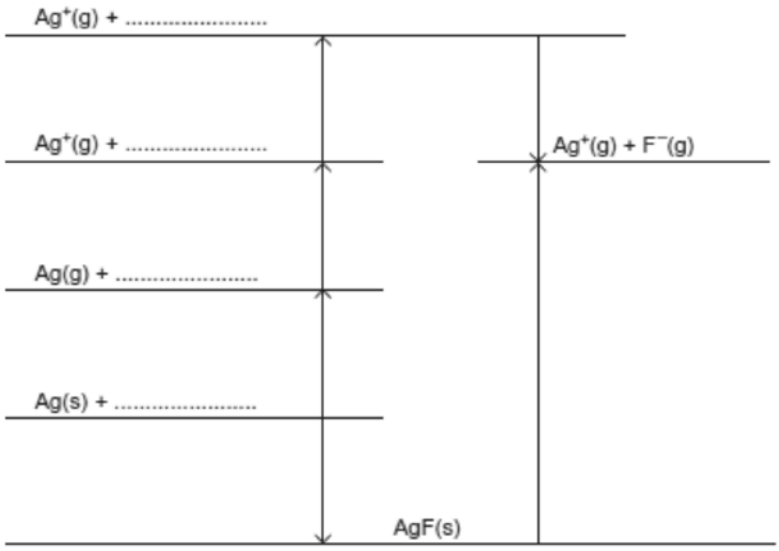


Table 1 shows some enthalpy data.

Table 1

Enthalpy change	**Value / kJ mol^{-1}**
Enthalpy of atomisation for silver	+ 289
First ionisation energy for silver	+ 732
Electron affinity for fluorine	– 348
Experimental enthalpy of lattice dissociation for silver fluoride	+ 955
Enthalpy of formation for silver fluoride	– 203
Enthalpy of hydration for Ag^+	– 464
Enthalpy of hydration for F^-	– 506
Enthalpy of hydration for Cl^-	– 364

0 2 . 4 Use the cycle in Question 02.3 and the data in Table 1 to calculate a value, in kJ mol–1, for the bond enthalpy of the fluorine-fluorine bond.

[2 marks]

Bond enthalpy = _____ kJ mol^{-1}

0 2 . 5 Use data from **Table 1** to calculate a value for the enthalpy of hydration of silver fluoride.

[2 marks]

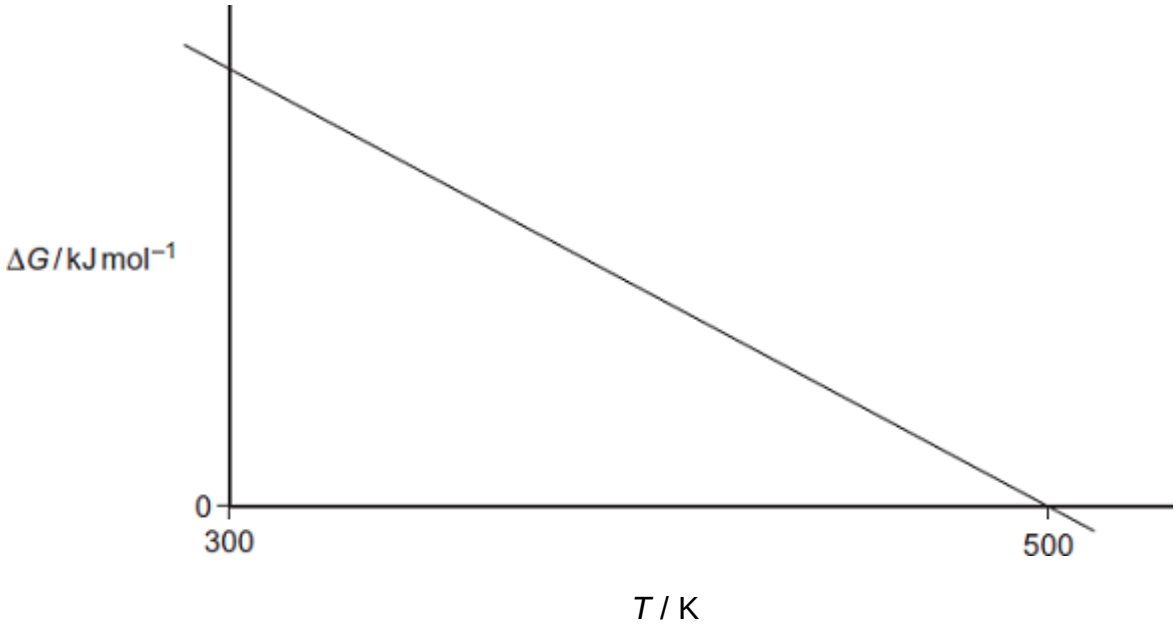
Enthalpy of hydration = _____ kJ mol^{-1}

0 2 . 6 Use data from **Table 1** to explain why the value for the enthalpy of hydration of the fluoride ion is more negative than that for the chloride ion.

[2 marks]

3 **Figure 1** shows how the free-energy change for a particular gas-phase reaction varies with temperature.

Figure 1



0 3 . 1 State what you can deduce about the feasibility of this reaction at temperatures lower than 500 K.

[1 mark]

0 3 . 2 Deduce the thermodynamic term value that can be found from the gradient of this graph using the mathematical equation for a straight line: y= mx + c

[1 mark]

0 3 . 3 Explain why the magnitude of ΔG decreases as T increases in this reaction.

[1 mark]

The following reaction becomes feasible at temperatures above 5440 K.

$$H_2O(g) \longrightarrow H_2(g) + \tfrac{1}{2}\, O_2(g)$$

The entropies of the species involved are shown in **Table 2.**

Table 2

	$H_2O(g)$	$H_2(g)$	$O_2(g)$
S / J K^{-1} mol^{-1}	189	131	205

0 3 . 4 Calculate the entropy change ΔS for this reaction.

[1 mark]

0 3 . 5 Calculate a value, with units, for the enthalpy change for this reaction at 5440 K.

(If you have been unable to answer part 3.3, you may assume that the value of the entropy change is +98 J K^{-1} mol^{-1}. This is not the correct value.)

[2 marks]

0 3 . 6 Which one of the following equations below represents a reaction that is feasible at all temperatures?

[1 mark]

Tick (✓) one box.

$P(s) \rightarrow Q(s) + R(g)$	endothermic	☐
$2L(g) + M(g) \rightarrow 2N(g)$	exothermic	☐
$S(g) \rightarrow 2T(g)$	exothermic	☐
$A(g) + B(g) \rightarrow C(g)$	endothermic	☐

0 4 . 1 A 25.0 cm^3 sample of 0.0850 mol dm^{-3} hydrochloric acid was placed in a beaker.
Distilled water was added until the pH of the solution was 1.25.

Calculate the total volume of the solution formed. State the units.

[3 marks]

[Extra Space]

At 298 K, the value of the acid dissociation constant (K_a) for the weak acid HX in aqueous solution is 3.01×10^{-5} mol dm^{-3}.

0 4 . 2 Write an expression for the acid dissociation constant (K_a) for the weak acid HX.

[1 mark]

0 4 . 3 Calculate the pH of a 0.174 mol dm^{-3} solution of HX at this temperature.
Give your answer to 2 decimal places.

[3 marks]

[Extra Space]

0 4 . 4 An acidic buffer solution is formed when 10.0 cm^3 of 0.125 mol dm^{-3} aqueous sodium hydroxide are added to 15.0 cm^3 of 0.174 mol dm^{-3} aqueous HX.
The value of K_a for the weak acid HX is 3.01×10^{-5} mol dm^{-3}.

Calculate the pH of this buffer solution at 298 K.
Give your answer to 2 decimal places.

[6 marks]

[Extra Space]

5 There is a link between the properties of the oxides of the Period 3 elements and their structure and bonding. **Table 3** shows the melting points of the oxides of some Period 3 elements.

Table 3

	Na_2O	SiO_2	P_4O_{10}
T_m/K	1548	1883	573

0 5 . 1 In terms of crystal structure and bonding, explain in each case why the melting points of sodium oxide and silicon dioxide are high, but the melting point of phosphorus(V) oxide is low.

[6 marks]

0 5 . 2 Write an equation for the reaction of phosphorus(V) oxide with water.

[1 mark]

6 **Table 4** shows observations of changes from some test-tube reactions of aqueous solutions of compounds Q, R and S with five different aqueous reagents.

The initial colours of the solutions are not given.

Table 4

	$BaCl_2$ + HCl	$AgNO_3$ + HNO_3	NaOH	Na_2CO_3	HCl (conc)
Q	No visible change	Yellow precipitate	Pale green precipitate that darkens on standing	Pale green precipitate	No visible change
R	White precipitate	No visible change	White precipitate that dissolves in excess sodium hydroxide	White precipitate and bubbles of gas	No visible change
S	No visible change	White precipitate	Brown precipitate	Brown precipitate and bubbles of gas	Yellow solution

0 6 . 1 Identify each of compounds Q, R and S. You are not required to explain your answers.

[6 marks]

Identity of Q _____

Identity of R _____

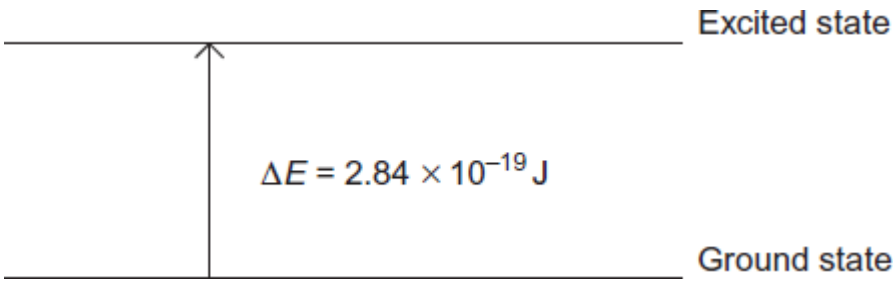
Identity of S _____

0 6 . 2 Write ionic equations for each of the positive observations with S.

[4 marks]

Turn over for next question

7 This diagram represents the energy change that occurs when a d electron in a transition metal ion is excited by visible light.



0 7 . 1 Give the equation that relates the energy change ΔE to the Planck constant h and the frequency of the visible light v.

Use this equation and the information in the diagram to calculate a value for the frequency of the visible light, and state the units.
The Planck constant h = 6.63×10^{-34} J s.

[2 marks]

Equation _____

Calculation _____

_____

_____

_____

_____

0 7 . 2 Explain why this electron transition causes a solution containing the transition metal ion to be coloured.

[2 marks]

_____

_____

_____

_____

_____

0 7 . 3 The energy change shown in the diagram represents the energy of red light and leads to a solution that appears blue.
Blue light has a higher frequency than red light.

Suggest whether the energy change *ΔE* will be bigger, smaller or the same for a transition metal ion that forms a red solution. Explain your answer.

[2 marks]

Energy of change _____

Explanation _____

_____

_____

0 7 . 4 State **three** different features of transition metal complexes that cause a change in the value of ΔE, the energy change between the ground state and the excited state of the d electrons.

[3 marks]

Feature 1 _____

Feature 2 _____

Feature 3 _____

Turn over for next question

8 This diagram represents the energy change that occurs when a d electron in a transit

Table 5 shows some standard electrode potential data.

Table 5

Electrode half-equation	$E^{\ominus}$ / V
$Au^{+}(aq) + e^{-} \longrightarrow Au(s)$	+1.68
$\frac{1}{2} O_2(g) + 2H^{+}(aq) + 2e^{-} \longrightarrow H_2O(l)$	+1.23
$Ag^{+}(aq) + e^{-} \longrightarrow Ag(s)$	+0.80
$Fe^{3+}(aq) + e^{-} \longrightarrow Fe^{2+}(aq)$	+0.77
$Cu^{2+}(aq) + 2e^{-} \longrightarrow Cu(s)$	+0.34
$Fe^{2+}(aq) + 2e^{-} \longrightarrow Fe(s)$	−0.44

0 8 . 1 Draw a labelled diagram of the apparatus that could be connected to a standard hydrogen electrode in order to measure the standard electrode potential of the Fe^{3+} / Fe^{2+} electrode.

In your diagram, show how this electrode is connected to the standard hydrogen electrode and to a voltmeter. Do **not** draw the standard hydrogen electrode.

State the conditions under which this cell should be operated in order to measure the standard electrode potential.

[5 marks]

Conditions _____

_____

_____

0 8 . 2 Use data from the table to deduce the equation for the overall cell reaction of a cell that has an e.m.f. of 0.78 V
Give the conventional cell representation for this cell.
Identify the positive electrode

[4 marks]

0 8 . 3 Use data from the table to explain why Au^+ ions are **not** normally found in aqueous solution
Write an equation to show how Au^+ ions would react with water.

[3 marks]

0 9 . 1 Explain how the electron pair repulsion theory can be used to deduce the shape of, and the bond angle in, PF_3

[5 marks]

END OF QUESTIONS