WELSH JOINT EDUCATION COMMITTEE
General Certificate of Education
Advanced Subsidiary/Advanced

WJEC
CBAC

CYD-BWYLLGOR ADDYSG CYMRU
Tystysgrif Addysg Gyffredinol
Uwch Gyfrannol/Uwch

CHEMISTRY

CH1

SPECIMEN PAPER

(1 hr 30 min)

ADDITIONAL MATERIALS

In addition to this examination paper, you will need a
- calculator
- copy of the Periodic Table supplied by WJEC

INSTRUCTIONS TO CANDIDATES

Answer all questions.
Write your name, centre number and candidate number in the spaces at the top of this page.
Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

You are reminded that assessment will take into account the quality of written communication used in your answers.

No certificate will be awarded to a candidate detected in any unfair practice during the examination.

SECTION A

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

1. Complete the following table

Particle	*Relative Charge*	*Relative Mass*
proton	+1	1
neutron	no charge	
electron		$\frac{1}{1840}$

[1]

2. Below are several nuclides of elements

$^{12}_{6}C$ $^{24}_{12}Mg$ $^{52}_{24}Cr$ $^{73}_{32}Ge$ $^{84}_{36}Kr$

(a) From the above choose

(i) **one** element whose atom contains 41 neutrons [1]

.....

(ii) **two** elements whose atoms each have the same number of electrons in the outer shell [1]

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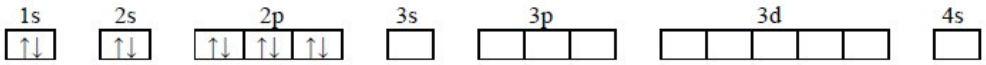
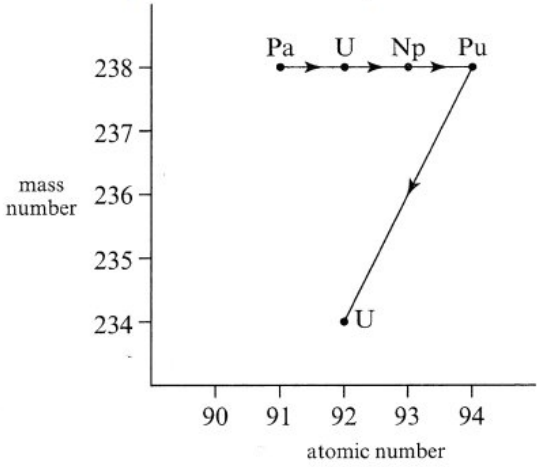
(b) Complete the boxes below, by inserting arrows to represent electrons, to show the electronic configuration of a chromium atom.



[1]

3. The diagram below shows part of a radioactive decay series.



State which **one** of the following best describes the emissions involved in the decay from ^{238}Pa to ^{234}U.

A 1 α-emission and 3 β-emissions
B 2 α-emissions and 2 β-emissions
C 3 α-emissions and 1 β-emission
D 4 α-emissions ..... [1]

4. Identify the letter, **A**, **B**, **C** or **D**, which correctly describes the behaviour of γ radiation.

	Behaviour in an electric field	*Relative penetrating power*
A	deflected towards the positive electrode	high
B	deflected towards the negative electrode	moderate
C	no deflection	low
D	no deflection	high

[1]

5. The half life of cobalt, ^{60}Co, used in radiotherapy, is 5.3 years.
Calculate how long it will take for the activity of the isotope to decay to $\frac{1}{8}$ of its original activity. [1]

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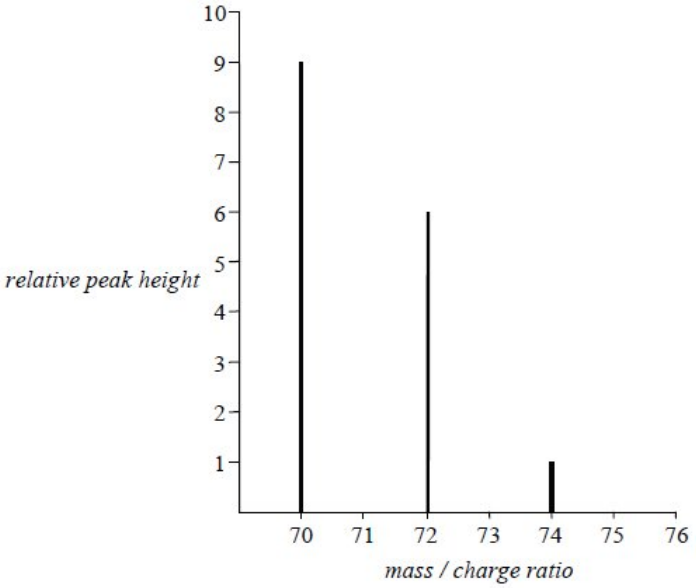
.....

6. State which one of the following gases contains the greatest number of molecules.

A 4 g of hydrogen
B 11 g of carbon dioxide
C 16 g of oxygen
D 28 g of nitrogen ..... [1]

7. Naturally occurring chlorine consists of two isotopes and gives a mass spectrum in the **molecular** ion region as shown



(i) State the mass numbers of the two isotopes. [1]

.....

(ii) Give the percentage abundance of each isotope. [1]

.....

Section A Total [10]

SECTION B

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

8. *(a)* Ethanol may be manufactured from ethene and steam by the reaction

$CH_2{=}CH_2(g) + H_2O(g) \rightleftharpoons CH_3CH_2OH(g) \qquad \Delta H^{\ominus} = -46 \text{ kJ mol}^{-1}$

The manufacturing process involves the use of a ***heterogeneous*** catalyst.

(i) Explain the meaning of the term ***heterogeneous***. [1]

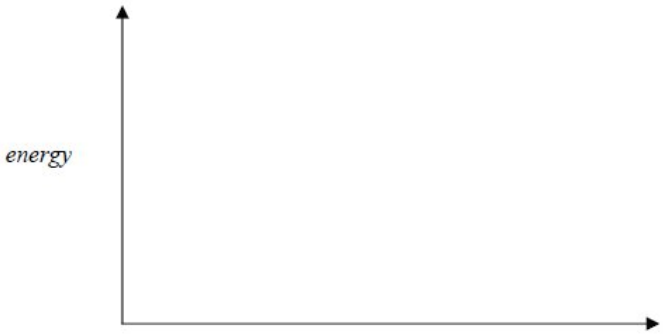
.....

.....

(ii) State the effect of the catalyst, if any, on the equilibrium yield of ethanol. [1]

.....

(iii) Draw energy profiles for the catalysed and uncatalysed reactions. [3]



(b) Explain, in terms of simple collision theory, why the rate of the reaction in (a) will increase with an increase in temperature. [4]
(QWC) [2]

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.....

(c) (i) Use the standard enthalpy change for the reaction in (a) and the standard enthalpy change of formation values, $\Delta H_f^{\ominus}$, given in the table below to calculate the enthalpy change of formation of gaseous ethanol. [3]

Compound	$\Delta H_f^{\ominus}$ / kJ mol^{-1}
CH_2=CH_2(g)	52.3
H_2O(g)	–242

.....

.....

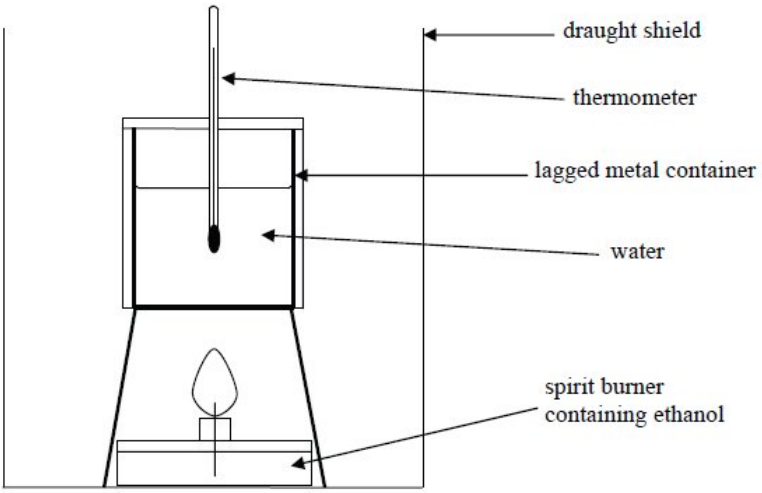
.....

(ii) Given that the standard enthalpy change of formation of liquid ethanol is –248kJmol^{-1} calculate the enthalpy change for the conversion of one mole of liquid ethanol to one mole of gaseous ethanol at 298 K. [1]

.....

Total [15]

9. *(a)* Andrew carries out an experiment, using the simple apparatus shown below, to find the enthalpy change of combustion (ΔH_c) of ethanol.



Here are his results

Mass of ethanol before experiment	15.8 g
Mass of ethanol after experiment	14.3 g
Mass of water	500 g
Temperature of water before experiment	20.5 °C
Temperature of water after experiment	40.0 °C

To find the enthalpy change of combustion he uses the equation

$$\Delta H = -\frac{mc\Delta T}{n}$$

where m is the mass of the water in the metal container, c is the specific heat capacity of the water, ΔT is the temperature rise and n is the number of moles of ethanol burned and he assumes that c = 4.18 J g^{-1} K^{-1} and M_r ethanol = 46.1

(i) State why the apparatus is shielded from draughts. [1]

.....

(ii) State why the mass of water must be known. [1]

.....

(iii) State why the metal container holding the water must be very thin and light. [1]

.....

(iv) State why the mass of the ethanol is measured both before and after the experiment. [1]

.....

(v) Calculate the number of moles of ethanol used in the experiment. [1]

.....

.....

(vi) Calculate the enthalpy change of combustion (ΔH_c) of ethanol, in kJ mol^{-1}. [2]

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.....

.....

(vii) Give **one** reason why the value obtained for the enthalpy change in this experiment is lower than the true value. [1]

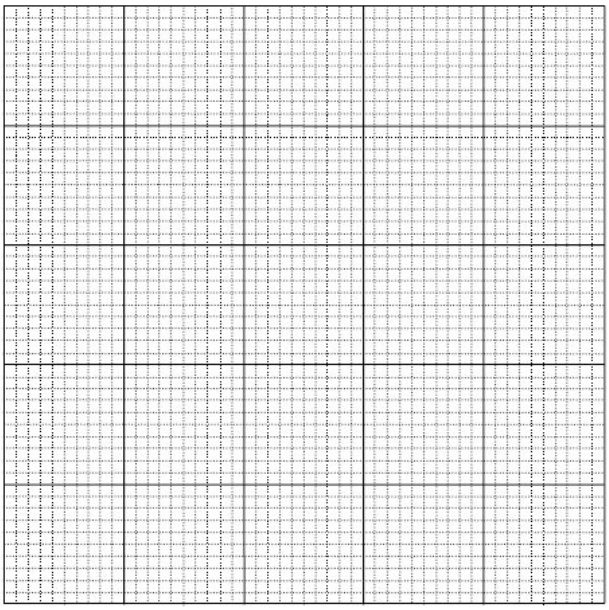
.....

(b) Alice obtained the following results when measuring the initial rate of decomposition of aqueous hydrogen peroxide, as in the following equation.

$$H_2O_2(aq) \longrightarrow H_2O(l) + {}^1/_2\,O_2(g)$$

concentration of peroxide / mol dm^{-3}	0.100	0.200	0.300	0.400	0.500
rate / mol dm^{-3} s^{-1}	0.050	0.100	0.148	0.220	0.250

(i) Label each axis and, choosing suitable scales for the axes, plot the results on the grid below and draw the line which best fits the points. [5]



(ii) State which main factor needs to remain constant in order to obtain good results in the experiment. [1]

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(iii) Suggest a method, other than measuring the concentration of hydrogen peroxide, that Alice could have used to follow this reaction. [1]

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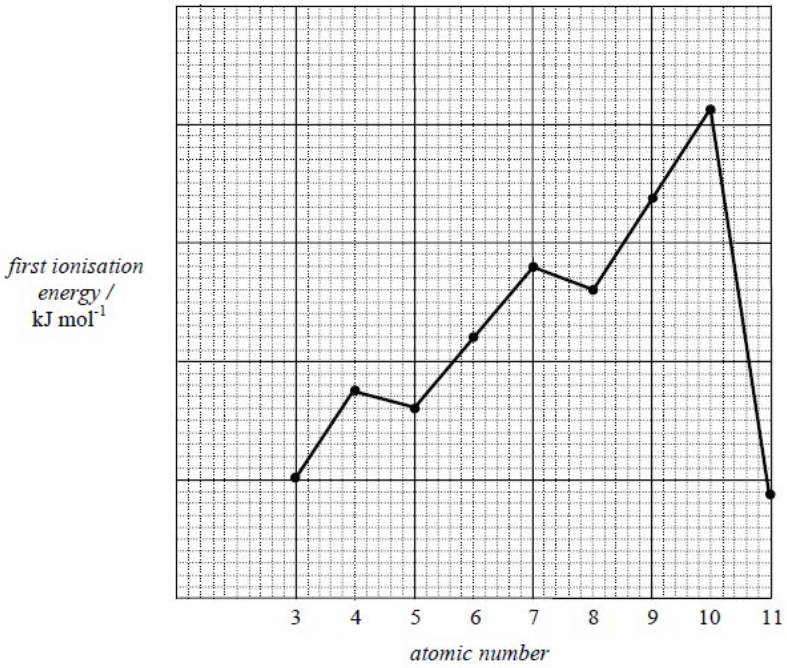
Total [15]

10. *(a)* The graph below shows variation of first molar ionisation energy with atomic number for the elements of atomic number 3 to 11.



(i) Explain why there is a general increase in first ionisation energy from lithium to neon. [2]

.....

.....

(ii) Explain why boron has a lower first ionisation energy than beryllium. [2]

.....

.....

(iii) Explain why sodium has a lower first ionisation energy than lithium. [2]

.....

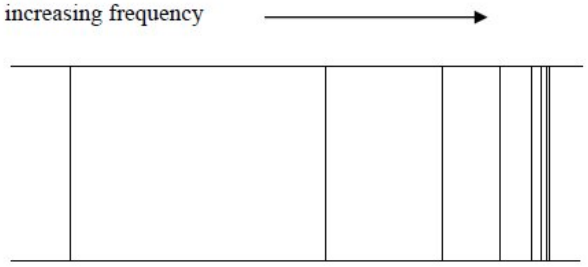
.....

(iv) Select the probable second ionisation energy of sodium from the values listed below. [1]

247; 700; 988; 4560 kJ mol^{-1}

.....

(b) The diagram below shows a part of the atomic emission spectrum of hydrogen.



Explain why it consists of a series of sharp lines and is not a continuous spectrum. [2]
(QWC) [1]

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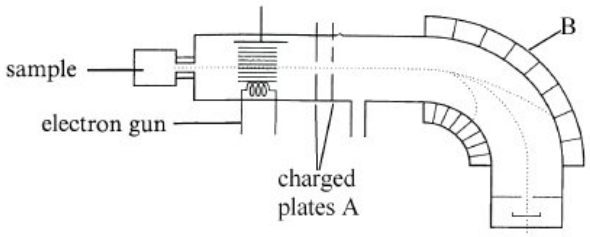
(c) Below is a simplified diagram of a mass spectrometer.



(i) State the sign of the charge on the plates, **A**, and explain their purpose. [2]

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.....

.....

(ii) State the function of part **B**. [1]

.....

.....

Total [13]

11. For an industrial process represented by the equilibrium

$$2A(g) + B(g) \rightleftharpoons 2C(g)$$

the following data were obtained

Temperature T / K	*Relative rate of the forward reaction* $\log k_{rel}$	*Fractional conversion to C at equilibrium* f	*Product of* $\log k_{rel} \times f$
600	10.16	0.997	10.13
650	10.90	0.988	10.77
700	11.59	0.967	
750	12.14	0.930	11.29
800	12.66	0.875	
850	13.11	0.798	10.46
900	13.50	0.708	9.56

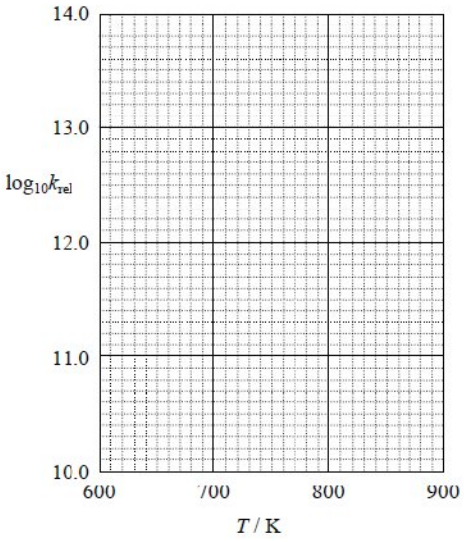
(a) (i) Complete the table by filling in the missing values [1]

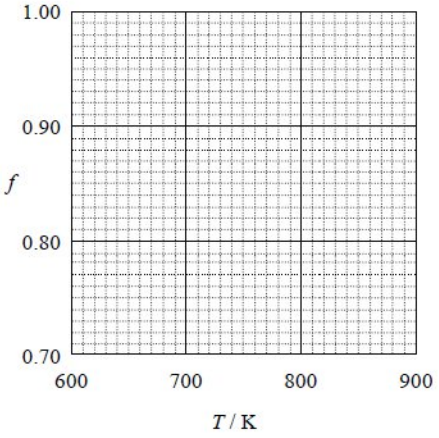
(ii) Use the graph grids below to plot the points and draw the curves for

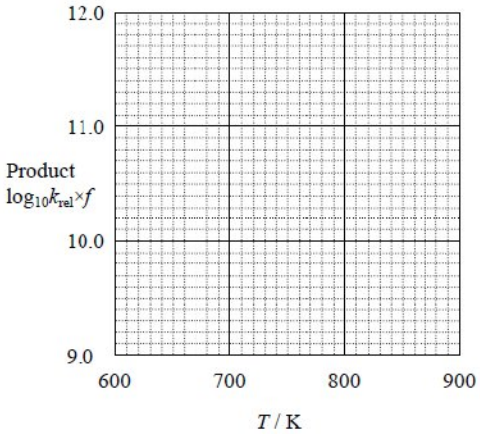
I the variation of $\log k_{rel}$ with T

II the variation of f with T

III the variation of $(\log k_{rel} \times f)$ with T [6]







(b) State and explain what conclusions may be drawn from the plots in (a) above concerning the optimal conditions for the production of C [?]

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.....

(c) State and explain the effect on the position of equilibrium (if any) of increasing the total pressure. [2]

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(d) State and explain what can be deduced about the enthalpy change (ΔH) for the equilibrium. [2]

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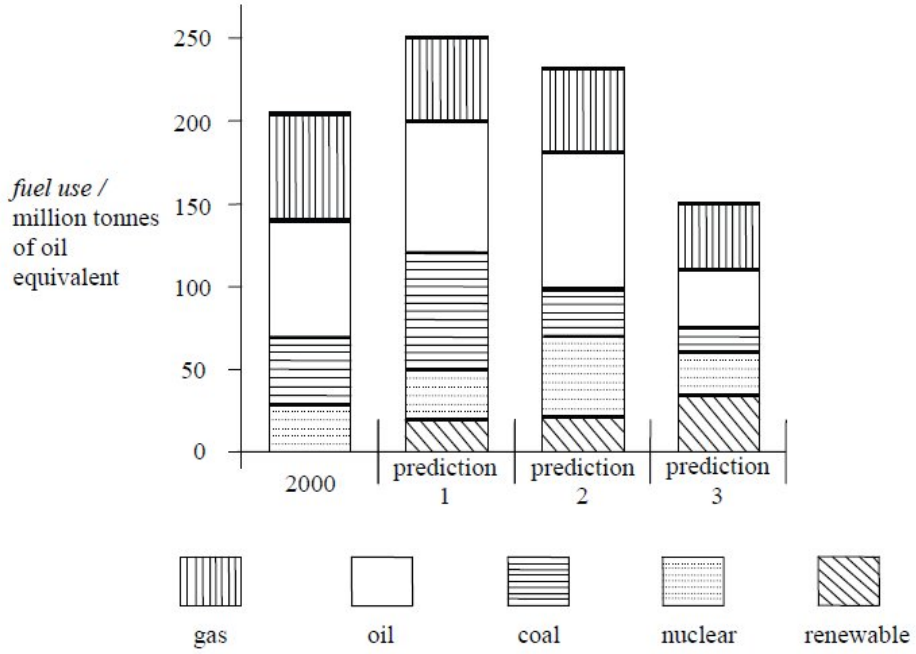
Total [13]

12. *(a)* Reliable resources of energy need to be available in the future. A UK report anticipates the differing quantities of fuels needed in 50 years time. In this report three predictions are made based on different assumptions about future energy supply and demand. Among the assumptions the following were included:

A Large new coal deposits can be accessed.
B The difficulties surrounding the safe disposal of nuclear waste are resolved.
C Many more wind farms are built both on land and off shore.
D International agreement on large reductions in carbon dioxide emissions is reached and is enforced.

The diagram below shows the use of the following energy sources; renewable, nuclear, coal, oil and gas in 2000 and three predictions for 2057 based on different possibilities.



For each of the three predictions select **one** assumption (from **A** – **D** above) that applies to that prediction and explain the reason for your choice.

(i) Prediction 1. [2]

Assumption .....

Reason .....

.....

(ii) Prediction 2. [2]

Assumption .....

Reason .....

.....

(iii) Prediction 3. [2]

Assumption .....

Reason .....

.....

(b) The use of hydrogen gas as a fuel to replace petrol is being actively researched by car manufacturers. Give **one** advantage and **one** disadvantage of hydrogen as a car fuel. [2]

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(c) A major environmental cause for concern in the 21st century is acid rain, which is rain that is artificially more acidic than normal. One of the main contributors to acid rain pollution is sulfur dioxide gas, SO_2.

(i) State the meaning of the term ***acid***. [1]

.....

.....

(i) Give **one** reason why the level of atmospheric SO_2 is greater in winter than in summer. [1]

.....

.....

(ii) State **one** problem which is caused by acid rain. [1]

.....

.....

(d) Sulfur dioxide can be oxidised to sulfur trioxide which dissolves in water to form sulfuric acid.
In a titration experiment, 21.0 cm^3 of sulfuric acid was exactly neutralised by 24.0 cm^3 of sodium hydroxide solution of concentration 0.0950 mol dm^{-3}.
The equation for the reaction between aqueous sulfuric acid and aqueous sodium hydroxide is

$$H_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2H_2O$$

To three significant figures, calculate

(i) the number of moles of sodium hydroxide used. [1]

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.....

(ii) the concentration of the sulfuric acid. [2]

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Total [14]

Section B Total [70]