Neap

Trial Examination 2022

Suggested Solutions

QCE Chemistry Units 1&2

Paper 2

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SECTION 1

QUESTION 1 (14 marks)

a) B, C and F

They each show one type of particle only.

[2 marks]
1 mark for identifying the three diagrams.
1 mark for providing an explanation.

b) B

Any one of:

- hydrogen gas (H_2)
- oxygen gas (O_2)
- nitrogen gas (N_2)
- fluorine gas (F_2)
- chlorine gas (Cl_2)

[2 marks]
1 mark for identifying the diagram.
1 mark for providing one possible name and molecular formula of the gas.

c) C

[1 mark]
1 mark for identifying the diagram.

d) F

[1 mark]
1 mark for identifying the diagram.

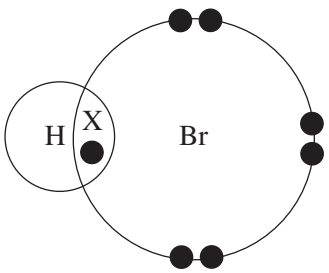
e) D and E

[1 mark]
1 mark for identifying both diagrams.

f) **D:** water
E: methane

[2 marks]
1 mark for identifying D.
1 mark for identifying E.

g) i)



[1 mark]
1 mark for drawing the Lewis structure.

ii) covalent bonding

[1 mark]
1 mark for stating the type of bonding.

iii) A strong acid is an acid that dissociates completely in water.

[1 mark]
1 mark for defining strong acid.

iv) *For example:*

An indicator such as methyl orange could be used. If the indicator appears red, this would indicate that hydrobromic acid is a strong acid.

[1 mark]
1 mark for outlining a suitable test.
Note: Other suitable indicator types include bromophenol blue (appearing yellow to indicate a strong acid) or thymol blue (appearing red to indicate a strong acid).

v) pH 1

[1 mark]
1 mark for determining the pH.

QUESTION 2 (2 marks)

For example, any two of:

- Biofuels are renewable, while fossil fuels are finite (and depleting).
- Biofuels are less expensive to produce than fossil fuels.
- Biofuels produce fewer greenhouse gases than fossil fuels.

[2 marks]
1 mark for each correct suggestion.

QUESTION 3 (2 marks)

Stationary phase: solid

Mobile phase: liquid

[2 marks]
1 mark for identifying that the stationary phase is solid.
1 mark for identifying that the mobile phase is liquid.

QUESTION 4 (5 marks)

a) Bond polarity refers to when electrons are shared unevenly due to different electronegativities of the elements bonded together.

[1 mark]
1 mark for defining the term.

b) i) Hydrogen fluoride has a very strong polar bond as fluorine is the most electronegative element and the hydrogen nucleus is 'bare' (unprotected by electrons) due to fluoride's extreme electronegativity. This results in strong intermolecular forces of attraction (hydrogen bonds), which require a high boiling point to break.

[2 marks]
1 mark for stating that hydrogen fluoride is highly polar.
1 mark for explaining that hydrogen bonds in hydrogen fluoride result in a high boiling point.

ii) Molecule size affects the boiling point. As molecules become larger (from hydrogen chloride to hydrogen iodide), intermolecular dispersion forces increase.

[1 mark]

1 mark for determining that there is a relationship between molecule size and dispersion forces.

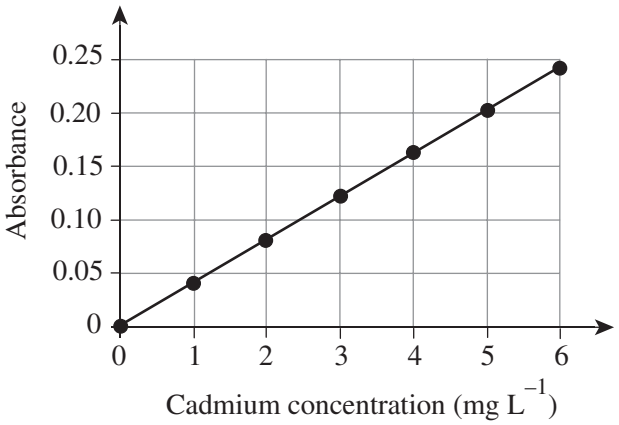
c) Yes, hydrogen halides are soluble in water. They are all polar, meaning that they are attracted to polar water molecules.

[1 mark]

1 mark for stating that hydrogen halides are soluble in water because they are polar.

QUESTION 5 (10 marks)

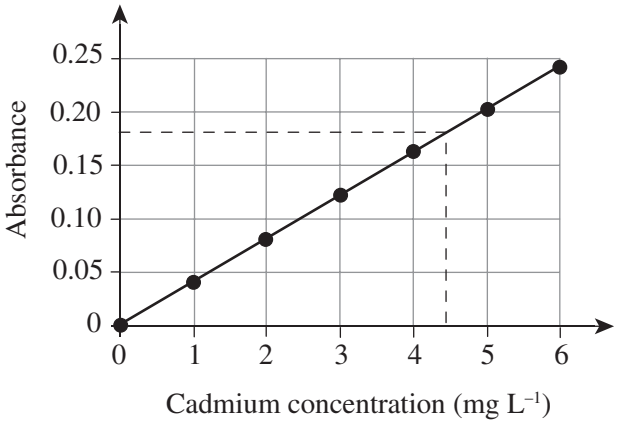
a) i)



[1 mark]

1 mark for drawing the graph using an appropriate scale and axis titles.

ii)



Reading from the graph, the cadmium concentration is 4.4 mg L^{-1}.

[1 mark]

1 mark for determining the concentration.

*Note: Consequential on answer to **Question 5ai)**. Accept responses in the range 4.3–4.5 mg L^{-1}. Students are not required to draw on the graph to obtain full marks.*

b) Finding the percentage abundance by subtracting the total percentage abundance of the other isotopes from 100 gives:

% abundance = 100 – 0.19 – 0.25 – 88.45 = 11.11%

Letting the relative isotopic mass of ^{142}Ce be x, calculating for x gives:

$$\frac{(0.19\times135.91)+(0.25\times137.91)+(88.45\times139.91)+11.11x}{100}=140.12$$

$$x=141.91$$

[3 marks]

1 mark for calculating the percentage abundance.
1 mark for determining the equation to calculate the relative atomic mass.
1 mark for calculating the relative isotopic mass.

c) Electrons exist in specific energy levels and can transition between these levels. When an electron transitions from a higher level to a lower level, a specific amount of energy (a photon) is released. Specific energy levels correspond to specific frequencies/wavelengths so a line is observed, not a continuous spectrum. The green line is produced by the transition from level 4 to level 2.

[5 marks]

1 mark for stating that electrons exist in specific energy levels.
1 mark for stating that electrons can transition between levels.
1 mark for describing what occurs when an electron transitions to a lower level.
1 mark for identifying the relationship between energy and frequency and linking it to the spectrum observed.
1 mark for identifying the transition.

QUESTION 6 (11 marks)

a) **A:** $MgCl_2$
B: H_2
C: $Mg(NO_3)_2$
D: CO_2
X: Li, Na, K **OR** NH_4

[5 marks]

1 mark for each correct response.

b) i) $Mg(s)+2HCl(aq)\rightarrow MgCl_2(aq)+H_2(g)$

[2 marks]

1 mark for identifying the products and reactants.
1 mark for balancing the equation.
Note: States are not required to obtain full marks.

ii) $2H^+(aq)+CO_3{}^{2-}(aq)\rightarrow H_2O(l)+CO_2(g)$

[2 marks]

1 mark for identifying the products and reactants.
1 mark for balancing the equation.
Note: States are not required to obtain full marks.

iii) $Mg^{2+}(aq)+CO_3{}^{2-}(aq)\rightarrow MgCO_3(s)$

[2 marks]

1 mark for identifying the products and reactants.
1 mark for balancing the equation.
Note: States are not required to obtain full marks.

QUESTION 7 (8 marks)

a) curve III

The volume of carbon dioxide produced would be half the volume produced in the experiment represented by curve I as there are half as many moles of nitric acid. A lower concentration of acid at the same temperature means that there would be fewer collisions per second between reactants and the reaction rate would be slower. Therefore, a curve that is less steep than and half the height of curve I is produced.

[2 marks]
1 mark for identifying the curve.
1 mark for explaining the factors responsible for the difference in the curve.

b) curve IV

The volume of carbon dioxide produced would be half the volume produced in the experiment represented by curve I as there are half as many moles of nitric acid. The higher temperature results in more frequent and more effective collisions (collisions that are more likely to exceed activation energy) between reactants, so the reaction rate would be faster. Therefore, a curve that is steeper than, half the height of and shorter than curve I is produced.

[2 marks]
1 mark for identifying the curve.
1 mark for explaining the factors responsible for the difference in the curve.

c) curve V

The volume of carbon dioxide produced would be one quarter of the volume produced in the experiment represented by curve I as there is one quarter the amount of moles of nitric acid. A lower concentration of acid at the same temperature means that there would be fewer collisions per second between reactants and the reaction rate would be slower. Therefore, a curve that is less steep than and a quarter of the height of curve I is produced.

[2 marks]
1 mark for identifying the curve.
1 mark for explaining the factors responsible for the difference in the curve.

d) curve II

The volume and concentration of nitric acid is the same as the experiment represented by curve I, so the same volume of carbon dioxide would be produced. Powdered marble provides greater surface area, so there would be more collisions per second between reactants and the reaction rate would be faster. Therefore, a curve that is steeper than curve I is produced.

[2 marks]
1 mark for identifying the curve.
1 mark for explaining the factors responsible for the difference in the curve.

QUESTION 8 (8 marks)

a)

Experiment number	Mass of ethanol burned (g)	Temperature change (°C)	Mass of water heated (g)	Amount of ethanol burned (mol)	Energy transferred to the water (kJ)
1	0.390	19.5	40.0	**0.00846**	**3.26**
2	0.490	23.6	40.0	**0.0106**	**3.95**
3	0.510	24.5	40.0	**0.0111**	**4.10**
4	0.560	26.9	40.0	**0.0122**	**4.50**
5	0.730	33.6	40.0	**0.0158**	**5.62**
6	0.600	31.1	40.0	**0.0130**	**5.20**
7	0.410	20.3	40.0	**0.00890**	**3.39**
8	0.680	31.7	40.0	**0.0148**	**5.30**

[4 marks]

Note: Award 4 marks for calculating all 16 required values.
Award 3 marks for calculating at least 12 required values.
Award 2 marks for calculating at least 8 required values.
Award 1 mark for calculating at least 4 required values.
Deduct a maximum of 1 mark for answers that are not provided correct to three significant figures. The amount of ethanol burned is found by dividing mass burned by molar mass (46.08). The energy transferred to water is found by using $Q = mc\Delta T$.

b) experiment 6

[1 mark]

1 mark for identifying the experiment.

c) The value is negative because combustion is an exothermic reaction, meaning it releases heat.

[1 mark]

1 mark for explaining why the enthalpy of combustion of ethanol is negative.

d) $$\text{maximum percentage error (ethanol)} = \frac{0.010}{0.390} \times 100 = 2.56\%$$

$$\text{maximum percentage error (water)} = \frac{0.10}{40.0} \times 100 = 0.25\%$$

[1 mark]

1 mark for calculating the maximum percentage error for both masses.
Note: Working is not required to obtain full marks.

e) *For example, any one of:*

- Errors are due to the crude design of the apparatus.
- Heat is lost through the air by convection.
- Heat is lost from the metal can.
- Combustion in air, which is 21% oxygen, was incomplete combustion.

[1 mark]

1 mark for suggesting a suitable reason.

QUESTION 9 (5 marks)

a) $n(I^-) = cV = 0.250 \times 0.03670 = 0.00918$ mol

[1 mark]
1 mark for calculating the amount.

b) The $Sn^{4+} : I^-$ ratio in the equation is 1 : 2.

$$n(Sn^{4+} \text{ in } 20.00 \text{ mL}) = \frac{n(I^-)}{2} = \frac{0.00918}{2} = 0.00459 \text{ mol}$$

[1 mark]
1 mark for calculating the amount.
*Note: Consequential on answer to **Question 9a)**.*

c) $n(Sn^{4+} \text{ in } 200 \text{ mL}) = 10 \times n(Sn^{4+} \text{ in } 20.00 \text{ mL}) = 10 \times 0.00459 = 0.0459$

[1 mark]
1 mark for calculating the amount.
*Note: Consequential on answer to **Question 9b)**.*

d) i) $m(SnO_2) = n \times M = 0.0459 \times 150.71 = 6.92$ g

[1 mark]
1 mark for calculating the mass.
*Note: Consequential on answer to **Question 9c)**.*

ii) $$\%(SnO_2) = \frac{m(SnO_2)}{m(\text{cassiterite sample})} = \frac{6.92}{9.00} \times 100 = 76.9\%$$

[1 mark]
1 mark for calculating the percentage.
*Note: Consequential on answer to **Question 9di)**.*

