Examiners report

This was by far the most challenging question on the paper, with a difficulty index of 24%, and many teachers commented about it on the G2 form. It appears that at SL many candidates were not familiar with the term “intramolecular” and in addition failed to assume that the pure liquid compound was being referred to, both of which seemed to create a degree of confusion. It did however appear more accessible to the better candidates, with a discrimination index of 0.18.

6. *[1 mark]*

Markscheme

C

Examiners report

The question proved surprisingly challenging, as indicated by a high number of blank responses and a difficulty index of 55%. This would seem to indicate that a disturbing number of candidates are not aware of the charges on the common ions. It was however a good discriminator with a discrimination index of 0.55.

7a. *[1 mark]*

Markscheme

in the solid state ions are in fixed positions/there are no moveable ions / *OWTTE*;

Do not accept answer that refers to atoms or molecules.

Examiners report

This was expected to be a high-scoring question but this was not found in practice. In Part (a) there were many references to delocalised/mobile electrons and also molecules and atoms. It did not appear that the structural properties of ionic substances are well understood.

7b. *[1 mark]*

Markscheme

$2O^{2} \rightarrow O_2 + 4e$ / $O^{2} \rightarrow \frac{1}{2}O_2 + 2e$;

Accept e instead of e .

Examiners report

There were many attempts in (b) which involved the sodium ion rather than the oxide and those who chose oxide often had difficulty in producing a balanced equation.

7c. *[1 mark]*

Markscheme

basic;

Allow alkaline

Examiners report

The best answered part of this question was Part (c) though a significant percentage described it as a weak base.

7d. *[1 mark]*

Markscheme

$Na_2O + H_2O \rightarrow 2NaOH / Na_2O + H_2O \rightarrow 2Na^+ + 2OH$;

Do not accept $\rightleftharpoons$

Examiners report

The best answered part of this question was Part (c) though a significant percentage described it as a weak base.

8a. *[1 mark]*

Markscheme

$(K_c =) [SO_3]^2 / [O_2][SO_2]^2$;

Examiners report

Nearly all candidates deduced the equilibrium constant expression for the reaction given in (a) (i).

8b. *[2 marks]*

Markscheme

yield (of SO_3) decreases;

forward reaction is exothermic / reverse/backwards reaction is endothermic / equilibrium shifts to absorb (some of) the heat;

Do not accept exothermic reaction or Le Châtelier's Principle.

Do not allow ECF.

Examiners report

there were many good and complete answers here for (a) (ii). Some candidates did not state that the forward reaction was exothermic or the reverse reaction was endothermic, when trying to decide the effect of an increase in temperature on the yield of SO_3.

8c. *[1 mark]*

Markscheme

no effect;

Examiners report

In (a) (iii) most candidates correctly stated that the catalyst would not have any effect on the value of K_c.

8d. *[2 marks]*

Markscheme

no effect;

the rates of both the forward and reverse reactions increase equally;

Examiners report

In part (iv) many candidates correctly stated that the catalyst would not have any effect on the position of equilibrium, but some did not explain why.

8e. *[1 mark]*

Markscheme

increase in the oxidation number;

Examiners report

In (b) (i) some candidates defined oxidation as the loss of electrons but not in terms of oxidation numbers, as required by the question.

8f. *[3 marks]*

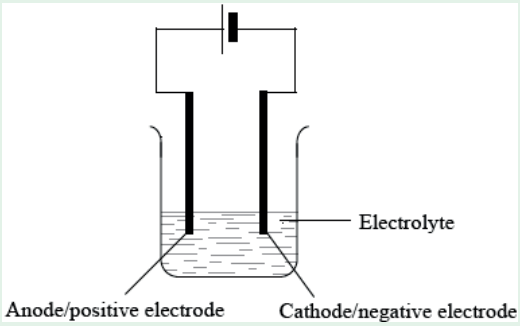
Markscheme

Annotated diagram of cell showing:

power supply/battery;

electrolyte;

cathode/negative electrode **and** anode/positive electrode;



Examiners report

Some candidates described a voltaic cell instead of an electrolytic cell in (b) (ii). In some cases the electrodes were wrongly labelled or wrongly connected to the battery and the electrolyte was missing.

8g. *[2 marks]*

Markscheme

(solid) ions in a lattice / ions cannot move;

(molten) ions mobile / ions free to move;

Examiners report

A large number of candidates stated that solid sodium chloride did not conduct electricity because it did not contain electrons in (iii). However some gave the correct answer indicating the free/moving ions as the particles responsible for the conductivity.

8h. *[5 marks]*

Markscheme

reduction occurs at the cathode/negative electrode **and** oxidation occurs at the anode/positive electrode;

Cathode/negative electrode: $Na^+ + e \rightarrow Na$;

Anode/positive electrode: $2Cl \rightarrow Cl_2 + 2e$ $/Cl \rightarrow \frac{1}{2}Cl_2 + e$;

*Award **[1 max]** if the two electrodes are not labelled/labelled incorrectly for the two half-equations.*

Overall cell reaction: $Na^+(1) + Cl\ (1) \rightarrow Na(1) + \frac{1}{2}Cl_2(g)$

*Award **[1]** for correct equation and **[1]** for correct state symbols.*

Allow NaCl(l) instead of Na^+(l) and Cl (l).

Examiners report

Part (b) (iv) was generally well answered. Most candidates lost a mark because they did not give the correct state symbols in the overall reaction.

8i. *[1 mark]*

Markscheme

Al does not corrode/rust / Al is less dense/better conductor/more malleable;

Accept Al is a lighter (metal compared to Fe).

Accept converse argument.

Examiners report

Most candidates gave a correct answer as to why aluminium is preferred to iron in many uses in (b) (v).

8j. *[2 marks]*

Markscheme

electrolytic cell converts electrical energy to chemical energy **and** voltaic cell converts chemical energy to electrical energy / electrolytic cell uses electricity to carry out a (redox) chemical reaction **and** voltaic cell uses a (redox) chemical reaction to produce electricity / electrolytic cell requires a power supply **and** voltaic cell does not;

electrolytic cell involves a non-spontaneous (redox) reaction **and** voltaic cell involves a spontaneous (redox) reaction;

in an electrolytic cell, cathode is negative and anode is positive **and** *vice-versa* for a voltaic cell / electrolytic cell, anode is positive and voltaic cell, anode is negative / electrolytic cell, cathode is negative and voltaic cell, cathode is positive;

voltaic cell has two separate solutions **and** electrolytic cell has one solution / voltaic cell has salt bridge and electrolytic cell has no salt bridge;

electrolytic cell, oxidation occurs at the positive electrode/anode **and** voltaic cell, oxidation occurs at the negative electrode/anode and *vice-versa*;

Examiners report

There were very good answers indicating the main differences between an electrolytic cell and a voltaic cell in (vi).

9. *[1 mark]*

Markscheme

D

Examiners report

[N/A]

10. *[1 mark]*

Markscheme

C

Examiners report

[N/A]

11. *[1 mark]*

Markscheme

A

Examiners report

One G2 comment stated that none of the answers were correct for this question and stated that the question was not clear as there was no mention of intermolecular force considerations. The question itself simply involved looking at two features for both substances, carbon and carbon dioxide – firstly whether the bonding is ionic or covalent and secondly whether the melting point is high or low. It was not necessary to include intermolecular force considerations to answer this question, as clearly from the choices given A is the most appropriate answer. Clearly both carbon and carbon dioxide involve covalent bonding and carbon will involve a high melting point (particularly in the case of the allotropes, graphite and diamond, though of course the melting points of graphite and diamond are higher than that of fullerene) whereas the melting point for carbon dioxide will be low. 69% of candidates gave A as the correct answer.

12. *[1 mark]*

Markscheme

A

Examiners report

[N/A]

13. *[1 mark]*

Markscheme

C

Examiners report

One G2 comment stated that the terms cation and anion are not stated on the syllabus. Although strictly correct, it would be assumed that these terms would be introduced to students in the classroom as they are universally used in chemistry (e.g. even the term carbocation is widely used in explaining certain nucleophilic substitution reaction mechanisms).

14. *[1 mark]*

Markscheme

B

Examiners report

[N/A]

15. *[1 mark]*

Markscheme

C

Examiners report

There were a number of comments on this question and many teachers stated that although they assumed that the required answer was C. i.e. electrons, many felt that as molten aluminium was involved, the cations are mobile and thus could conduct electricity, so A. could be another answer. Although the correct answer C. (electrons) was given by the majority of candidates (71.18%), it was decided at Grade Award to also accept A. as clearly some candidates may have approached the question in the sense articulated by several teachers.

16a. *[2 marks]*

Markscheme

Ionic:

(electrostatic) attraction between oppositely charged ions/cations and anions/positive and negative ions;

Do not accept answers such as compounds containing metal and non-metal are ionic.

Metallic:

(electrostatic attraction between lattice of) positive ions/cations/nuclei and delocalized electrons / (bed of) positive ions/cations/nuclei in sea of electrons / *OWTTE*;

Examiners report

Question 1 tested a number of concepts and very few students were able to gain all the marks available. Part (a) was fairly well done and students could explain ionic and metallic bonding although weak students did not explain the bonding but simply stated that ionic was between metal and non metal etc.

16b. *[1 mark]*

Markscheme

T: 4 **and** *m*: 3 **and** *p*: 3;

Examiners report

Surprisingly in part (b) (i) a number of students could not state the number of significant figures and many stated that 25.00 was 2 SF instead of 4.

16c. *[1 mark]*

Markscheme

$n = (65.0/65.02) = 1.00\ (\text{mol})$;

No penalty for using whole number atomic masses.

Examiners report

Part (b) (ii) required the calculation of the amount of substance in moles, and was generally well done although some did not realise the value was in kg and so had a value 1000 times too small.

16d. *[4 marks]*

Markscheme

$n(\text{N}_2) = \left(\frac{3}{2} \times 1.00 =\right)\ 1.50\ (\text{mol})$;

$T = ((25.00 + 273.15) =)\ 298.15\ \text{K}/(25.00 + 273) = 298\ \text{K}$;

$p = 1.08 \times 1.01 \times 10^5\ \text{Pa}/1.08 \times 1.01 \times 10^2\ \text{kPa}/1.09 \times 10^5\ \text{Pa}/1.09 \times 10^2\ \text{kPa}$;

$V = \frac{nRT}{p} = \frac{(10^3)(1.50)(8.31)(298.15/298)}{(1.08 \times 1.01 \times 10^5)} = 34.1\ (\text{dm}^3)$;

*Award **[4]** for correct final answer.*

*Award **[3 max]** for 0.0341 (dm^3) or 22.7 (dm^3).*

*Award **[3 max]** for 34.4 (dm^3).*

*Award **[2 max]** for 22.9 (dm^3).*

*Award **[2 max]** for 0.0227 (dm^3).*

*Award **[2 max]** for 0.034 (dm^3).*

Examiners report

In part (b) (iii) a number of students lost marks for forgetting to convert temperature or pressure and also to multiply the amount by 1.5. Also many forgot to convert the pressure into kPa if they wanted their answer in dm^3. However, most students could obtain at least one of the marks available.

16e. *[1 mark]*

Markscheme

sodium could react violently with any moisture present / sodium is (potentially) explosive / sodium (is dangerous since it is flammable when it) forms hydrogen on contact with water / *OWTTE*;

Do not accept answers such as sodium is dangerous or sodium is too reactive.

Examiners report

In part (c) (i) many did not relate the removal of sodium to the potential for it to react with water and instead gave a far too vague of answer that it was reactive. However, the very best students were able to answer this hypothesis type question and stated that sodium reacts with water. This proved a good discriminator at the top end of the candidature.

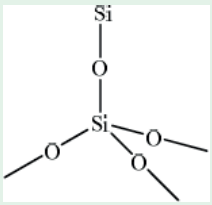
16f. *[2 marks]*

Markscheme

Structure:

drawing of giant structure showing tetrahedrally arranged silicon;

Minimum information required for mark is Si and 4 O atoms, in a tetrahedral arrangement (not 90 ° bond angles) but with each of the 4 O atoms showing an extension bond.



Bonding:

(giant/network/3D) covalent;

Examiners report

Part (c)(ii) was very poorly answered and the majority of students believed that $\mathrm{SiO_2}$ had a similar structure to $\mathrm{CO_2}$. The very few students that drew a giant structure often did not then show a tetrahedral arrangement of the atoms, however most did realise that the bonding was covalent.

16g. *[1 mark]*

Markscheme

$\left(\frac{34.1}{0.0400}\right) = 853\ \mathrm{dm^3 s^{-1}} / \left(\frac{1.50}{0.0400}\right) = 37.5\ \mathrm{mol\ s^{-1}}$;

Accept 851 $dm^3 s^{-1}$.

Units required for mark.

Examiners report

Part (d) was generally well answered and most students calculated a rate from their results although some lost the mark for incorrect or absent units.

16h. *[1 mark]*

Markscheme

more energetic collisions / more species have energy $\geqslant E_a$;

Allow more frequent collisions / species collide more often.