**1.** (a)    Average / mean mass of 1 atom (of an element)  
1/12 mass of one atom of 12C

*If moles and atoms mixed, max = 1*

**1**

*Mark top and bottom line independently.  
All key terms must be present for each mark.*

**1**

***OR***

Average / mean mass of atoms of an element  
1/12 mass of one atom of 12C

***OR***

Average / mean mass of atoms of an element ×12  
mass of one atom of 12C

***OR***

(Average) mass of one mole of atoms  
1/12 mass of one mole of 12C

***OR***

(Weighted) average mass of all the isotopes  
1/12 mass of one atom of 12C

***OR***

Average mass of an atom / isotope (compared to C−12) on a scale in which an atom of C−12 has a mass of 12

*This expression = 2 marks.*

(b)      

**1**

**1**

= 72.4

*72.4 only*

**1**

(c)     (72)Ge+ or germanium+

*Must show ‘+’ sign.*

*Penalise wrong mass number*

**1**

(d)     70

*If M1 incorrect or blank CE = 0/2*

*Ignore symbols and charge even if wrong.*

**1**

Lowest mass / lowest m/z

*Accept lightest.*

*Accept fewest neutrons.*

**1**

(e)     Electron(s) transferred / flow (at the detector)

*M1 must refer to electron flow at the detector.*

*If M1 incorrect CE = 0/2*

**1**

(From detector / plate) to the (+) ion

*Do not allow from a charged plate.*

**1**

(f)     They do not have the same electron configuration / they have different number of electrons (in the outer shell)

*Ignore electrons determine the properties of an atom.*

*Ignore they are different elements or different number of protons.*

**1**

**[11]**

**2.** (a)     Silicon / Si

*If not silicon then CE = 0 / 3*

**1**

covalent (bonds)

*M3 dependent on correct M2*

**1**

Strong or many of the (covalent) bonds need to be broken / needs a lot of energy to break the (covalent) bonds

*Ignore hard to break*

**1**

(b)     Argon / Ar

*If not argon then CE = 0 / 3. But if Kr chosen, lose M1 and allow M2+M3*

**1**

Large(st) number of protons / large(st) nuclear charge

*Ignore smallest atomic radius*

**1**

Same amount of shielding / same number of shells / same number of energy levels

*Allow similar shielding*

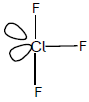
**1**

(c)     Chlorine / Cl

*Not Cl2, Not C****L****, Not Cl2*

**1**

(d)     (i)



*Or any structure with 3 bonds and 2 lone pairs*

*Ignore any angles shown*

**1**

****

*Or a structure with 2 bonds and 1 lone pair*

**1**

(ii)     Bent / v shape

*Ignore non-linear, angular and triangular*

*Apply list principle*

**1**

(iii)    Cl2 + F2  ClF3

*No multiples*

*Ignore state symbols*

**1**

**[11]**

**3.**      (a)     (i)      Cu + **4**HNO3 → Cu(NO3)2 + **2**NO2 + **2**H2O

*Or multiples*

*Ignore state symbols*

**1**

(ii)     **M1**     HNO3 (+) **5**

**M2**     NO2 (+) **4**

*Ignore working out*

*M1 Credit (V)*

*M2 Credit (IV)*

**2**

(iii)     HNO3 + H+ + e– → NO2 + H2O

OR

NO3– + 2H+ + e– → NO2 + H2O

*Or multiples*

*Ignore state symbols*

*Ignore charge on the electron unless incorrect and accept loss of electron on the RHS*

**1**

(b)     (i)      **In either order**

**M1** Concentration(s) (of reactants and products)  
remain(s) constant / stay(s) the same / remain(s)  
the same / do(es) not change

**M2** Forward rate = Reverse / backward rate

*For M1 accept [ ] for concentration*

*NOT “equal concentrations” and NOT “concentration(s) is/are the same”*

*NOT “amount”*

*Ignore “dynamic” and ignore “speed”*

*Ignore “closed system”*

*It is possible to score both marks under the heading of a single feature*

**2**

(ii)     **M1**

The (forward) reaction / to the right is endothermic  
or takes in / absorbs heat

OR

The reverse reaction / to the left is exothermic or gives  
out / releases heat

**M2 depends on correct M1 and must refer to temperature/heat**

The equilibrium shifts / moves left to right to oppose the increase in temperature

*M2 depends on a correct statement for M1*

*For M2, the equilibrium shifts/moves*

*to absorb the heat OR*

*to lower the temperature OR*

*to cool the reaction*

**2**

(iii)     **M1 refers to number of moles**

There are fewer moles (of gas) on the left OR more  
moles (of gas) on the right.  
OR there is one mole (of gas) on the left and 2 moles  
on the right.

**M2 depends on correct M1 and must refer to pressure**The equilibrium shifts / moves right to left to oppose the  
increase in pressure

*M2 depends on a correct statement for M1*

*For M2, the equilibrium shifts/moves to lower the pressure.*

**2**

**[10]**

**4.**     (a)     (i)      **4**FeS2 + **11**O2  **2**Fe2O3 + **8**SO2

**2**             **5**½                      **(1)**              **4**

*Or multiples of this equation*

**1**

(ii)     **M1**    **(+) 4**

**M2    – 1**

*Ignore working*

*M1, credit (+) IV*

*M2, credit – I*

**2**

(b)     **M1** Lower/smaller/decreases/reduced yield  
***OR*** equilibrium shifts (right) to left

**M2** (Forward) reaction is exothermic OR reverse reaction is endothermic

**M3** (By Le Chatelier’s principle) equilibrium responds/shifts/moves  
(R to L)  
to lower the temperature  
***OR*** to absorb the heat  
***OR*** to cool the reaction

*If M1 is blank, mark on and credit M1 in the text.*

*If M1 is incorrect, only credit correct M2*

*Mark M2 independently – it may be above the arrow in the equation*

*For M3, not simply “to oppose the change/temperature”*

**3**

(c)     **M1** Fe2O3 + 3CO  **2**Fe + **3**CO2

*Or multiples*

*Ignore state symbols*

**M2** Reducing agent  
***OR*** Reduce(s) (Fe2O3/iron(III) oxide)  
***OR*** Electron donor  
***OR*** to remove the oxygen (from iron(III) oxide to form CO2)  
***OR*** reductant

*For M2, credit “reduction”*

**2**

**[8]**

**5.** (a)     (i)      ½Cl2 + I −   ½ I2 + Cl−

***Only*** *these two equations.*

OR

Cl2 + **2**I−   I2 + **2**Cl−

**1**

(ii)     (Solution turns from colourless to) brown / red-brown solution

*Allow grey / black solid.*

*Ignore “purple”.*

**1**

(b)     **2**Cl2 + **2**H2O   **4**HCl + O2(**4**H+ + **4**Cl−)

*Credit multiples.*

**1**

(c)     M1 **The relative size (of the molecules / atoms)**Chlorine is smaller than bromine OR has fewer electrons / electron shells  
***OR*** It is smaller / It has a smaller atomic radius / it is a smaller molecule / or has smaller Mr(or converse for bromine)

*Ignore general Group 7 statements.*

*For* ***M1*** *ignore whether it refers to molecules or atoms.*

M2 **How size of the intermolecular force affects energy needed**The forces between chlorine / Cl2 molecules are weaker (than the forces between bromine / Br2 molecules leading to less energy needed to separate the molecules)  
(or converse for bromine)  
***OR*** chlorine / Cl2 has weaker / less / fewer forces between molecules ***OR*** chlorine / Cl2 has weaker / less / fewer intermolecular forces  
(or converse for bromine)

***CE=0*** *for reference to (halide) ions.*

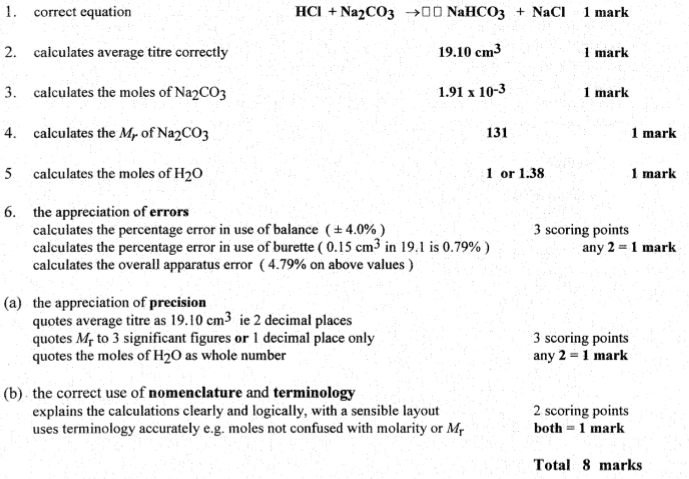
*QoL for clear reference to the difference in size of the force between molecules.*

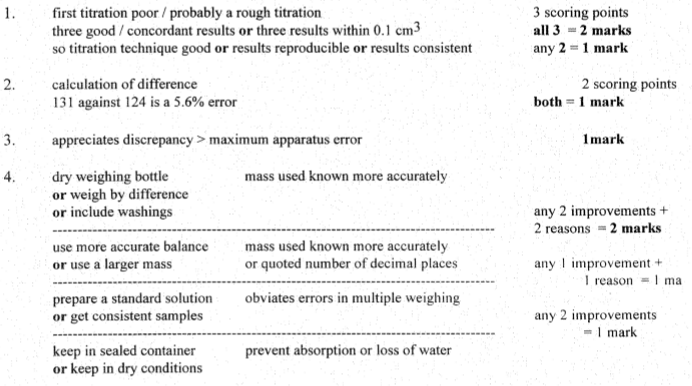
*Penalise* ***M2*** *if (covalent) bonds are broken.*

**2**

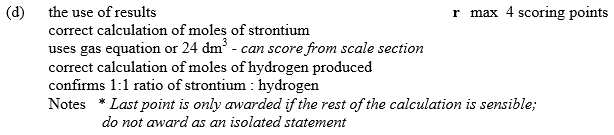
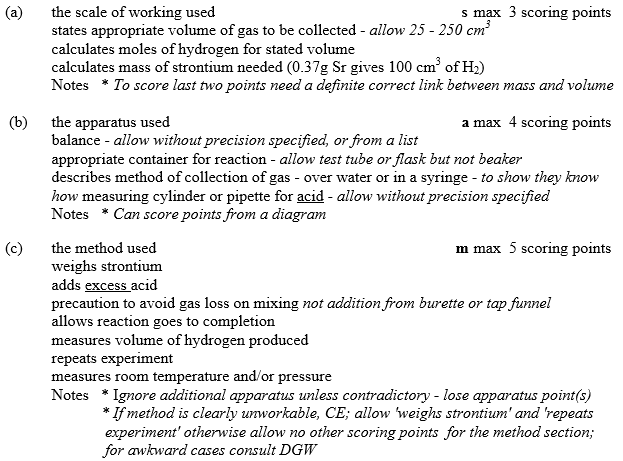
**[5]**

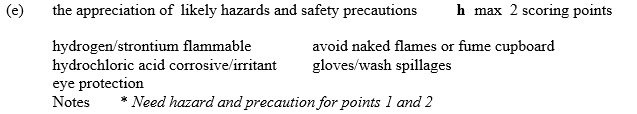
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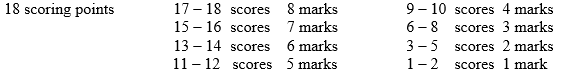




7.







8. A

9. B

10. A

11. B

12. A

13. A

14. D

14. D

16. C

17. D

18. D

19. C

20. C