Unit Test 6241

(a) (i) Idea of **impact** with **energy**
fast electrons strike sample/ high energy/accelerated electrons /electrons fired at sample/ sample bombarded with /blasted with electrons from electron gun **(1)**

Removes an electron/ knock out electrons/ eqn $X \rightarrow X^+ + e^-$ **(1)** **(2 marks)**

(ii) magnetic field /magnet / electromagnet *NOT* charged plates
ALLOW magnetic plates **(1 mark)**

(b) (60.4 x 69) + (39.6 x 71) / 60.4 + 39.6 **(1)**
= 69.8 **(1)**

69.792 scores **1 (out of 2)** **(2 marks)**

(c) (i) B **(1)**
mass no. 10 **(1)**
OR
^{10}B / B^{10} **(2)**
If + is added max **(1)** ie *for mass number* **(2 marks)**

(ii) $..2s^2 2p^1$ **(1 mark)**

(iii) BCl_3
If an equation for formation of BCl_3 is given, look for BCl_3 and ignore rest **(1 mark)**

(Total 9 Marks)

ALLOW 3 or 4 sig figs – penalise once only

2 (a) (i)

MUST be some working

moles P = 93/31 = 3.0 **(1)**
moles PCl_3 also = 3.0 **(1)**
mass PCl_3 = 137.5 x 3.0 = 412.5 / 413 (g) **(1)**
OR alternative route
Max 2 *if wrong units*

(3 marks)

(ii) moles Cl_2 = 3/2 x 3 = 4.5 **(1)**
volume of Cl_2 = 4.5 x 24 = 108 (dm^3) **(1)** – *consequential on 1st mark* **(2 marks)**

(iii) Cl_2 *with* ***attempt*** *at reason* **(1)**
because gains electrons / ox. no. becomes more negative / oxidation number decreases / 0 → -1
OR
P loses electrons / oxidation number increases / 0 → +3 **(1)** **(2 marks)**

(b) (i) Outer shell of P in a molecule **(1)**
Cl lone pairs / six more electrons around each Cl **(1)**
Lone *pair must be in the same space.* **(2 marks)**

(ii) Trigonal pyramidal diag. **(1)**
Must be some attempt to show 3-D. A poor diagram can be rescued by a correct name.

100 – 108° **(1)** *NOT consequential* **(2 marks)**

(c) Tetrahedral **(1 mark)**

(Total 12 Marks)

3 **(a)** (i) bonding: (giant) **covalent (1)**
Diag. shows at least 5 carbon atoms correctly joined **(1)**
plus a hexagonal ring **(1)**
Must NOT be graphite **(3 marks)**

(ii) bonding: ionic **(1)**
shows alternating Na^+ and Cl^- ions *OR* a key **(1)**
More than one layer **(1)**
ALLOW correct unit cube for NaCl **(2)**
ALLOW **1 mark** *for single layer with at least 6 ions* **(3 marks)**

(b) Diamond : macromolecular/giant covalent structure/ many covalent bonds **to break (1)**

NaCl: attraction between oppositely charged ions to be overcome **(1)**

both require large amount of **energy** to break bonds/overcome attractions **(1)**
– *stand alone mark* **(3 marks)**

(c) **ions** mobile (in molten) / can move **(1)** *NOT* "free" *on its own*
fixed positions in solid / cannot move **(1)**
Max 1 if only one ion mentioned eg Na^+ **(2 marks)**

(Total 11 Marks)

4 **(a)** (i) energy/enthalpy/heat energy change per mole **(1)** *Change ≡ required* for removal of one electron / to form singly positive charged ion**(1)** from **gas atoms (1)**
Could get **2 marks** for $X(g) \rightarrow X^{+}(g) + e^{-}$

(3 marks)

(ii) increases *plus some attempt at an explanation* **(1)**
nucleus more positive / more protons/increased charge **(1)**
outer electrons in same shell / same shielding/electrons being lost from the same shell
OR atoms smaller so greater attraction/need more energy to be removed **(1)**

"Decreases" **0 (out of 3)** **(3 marks)**

(b) (i) $N^{-}(g) + e^{(-)} \rightarrow N^{2-}(g)$
species **(1)**
both state symbols **(1)** **(2 marks)**

(ii) (energy needed to overcome) repulsion **(1)** – *must relate to negatively charged species.*

between electron and negative ion **(1)**
ACCEPT "negative particles" if eqn in (i) correct
If "repulsion between electrons coming in and those already there" ALLOW 1st mark **(2 marks)**

(Total 10 Marks)

ALLOW multiples in (i), (ii) and (iii) and (c)

5 **(a)** (i) $Ca \rightarrow Ca^{2+} + 2e^{-}$ / $Ca - 2e^{-} \rightarrow Ca^{2+}$ **(1 mark)**

(ii) $2H_2O + 2e^{-} \rightarrow H_2 + 2OH^{-}$ **(1 mark)**

(iii) $Ca + 2H_2O \rightarrow Ca^{2+} + H_2 + 2OH^{-}$
Or $\rightarrow Ca(OH)_2 + H_2$

NOT consequential on (i) and (ii)

(1 mark)

(iv) (Vigorous) bubbles /fizzes/effervesces **(1)**
(white) ppt./suspension / cloudy / milky **(1)**
IGNORE "gas evolved"/ "hydrogen produced"/ names
IGNORE calcium dissolves/gets smaller
If flame described **1 max** **(2 marks)**

(b) Increases **(1 mark)**

(c) $2Na + Cl_2 \rightarrow 2NaCl$
species **(1)**
balancing **(1)** – *dependent on 1st mark* **(2 marks)**

(Total 8 Marks)

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6 **(a)** Iodine/ I_2 *OR* astatine/At_2 **(1 mark)**

Bromine/Br_2 **(1 mark)**

Chlorine/Cl_2 OR fluorine/F_2
If halides given ***max 2***
If symbols for atoms given ***max 2***
If symbols for ions given ***0*** **(1 mark)**

(b) (i) Ions produced **(1)**
to which H_2O bonds /become hydrated **(1)** **(2 marks)**

(ii) H^+ formed (in solution) / H_3O^+ **(1 mark)**

(c) hydrogen bonding in HF **(1)** – *stand alone*

stronger than vdW/dipole-dipole/dispersion forces in HI **(1)** – *must be an identified intermolecular force NOT "HI does not have hydrogen bonding"* **(2 marks)**

(d) +1 , +5 / 1+ , 5+ / I, V **(2)**
1, 5 **(1)**
-1, -5 **(0)**
Superscript pluses penalised once eg Cl^+, Cl^{5+} **(1)**
BUT Cl^+, Cl^{3+} **(0)** *ie two errors* **(2 marks)**

(Total 10 Marks)

Unit Test 6242

1. (a) hydrogen **(1)**
chlorine **(1)** **(2 marks)**

(b) anode: titanium **(1)**
cathode: steel **(1)** **(2 marks)**

(c) Anode: $2Cl^- \rightarrow Cl_2 + 2e^-$ **(1)** or half this

Cathode: $2H_2O + 2e^- \rightarrow H_2 + 2OH^- / 2H^+ + 2e^- \rightarrow H_2$ **(1)** or half them
There is no need for the minus sign on the electrons

Max 1 if equations linked to wrong electrodes

(2 marks)

(d)
- **Manufacture** of solvents / PVC / insecticides / herbicides / bleach / organo-chlorides
- As a bleach of textiles or paper
- Water supply treatment (not swimming pools, not purification of water)

Any one **(1)** **(1 mark)**

(Total 7 Marks)

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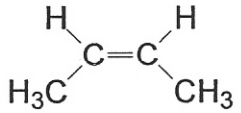
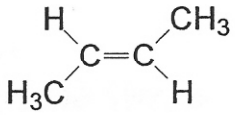
2. (a) (i) $CH_4 + Cl_2 \rightarrow CH_3Cl + HCl$ **(1)** **(1 mark)**

(ii) UV (radiation) / Sunlight **(1)** Not light **(1 mark)**

(b) (i)



(1)



(1) **(2 marks)**

(ii) restricted rotation around double bond **(1)**
Allow no rotation at room temperature

two different groups on **each** double bonded carbon **(1)** **(2 marks)**

(iii) 2,3-dichlorobutane **(1)** **(1 mark)**

(Total 7 Marks)

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3. **QWC**

(a) (i)

- (average kinetic) energy / speed of molecules/particles (not atoms) increases **(1)** not vibration energy alone
- **more** molecules have $E \geq / > E_{act}$ on collision **(1)**
- so greater **proportion** of /more **of** the collisions are successful **(1)** **(3 marks)**

(ii)

- shift left / towards reactants **(1)** (not favours)
- the (forward) reaction is exothermic **(1)**
  2^{nd} mark requires first not to be wrong **(2 marks)**

(iii)

- shift right **(1)** (not more ammonia)
- fewer gas molecules / gas moles on right **(1)**
  2^{nd} mark requires first not to be wrong **(2 marks)**

(b) (i)

- alternative route provided of lower E_{act} **(1)**
- so more collisions / more (colliding) molecules have $E \geq E_{act}$ (than had $E \geq E_{unact}$) **(1)** *Allow* > *or* ≥
- greater proportion of / more collisions are successful **(1)** **(3 marks)**

(ii) Iron **(1 mark)**

(iii) None **(1 mark)**

(c) $2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$ **(1)**
fertiliser **(1)** **(2 marks)**

(Total 14 Marks)

4. (a) (i) nucleophilic substitution **(1)**

(2 marks)

aqueous **(1)** *Ignore heat under reflux here*
Allow aqueous ethanol

(ii) elimination **(1)**

ethanolic / alcoholic **(1)**

heat (under reflux) **(1)** not h.u.r. , not warm **(3 marks)**

(b) (i) $nCH_2{=}CHCl \longrightarrow -(CH_2CHCl)_n-$

n's **(1)** *must balance*
structure of product clearly shown with continuation bonds **(1)** **(2 marks)**

(ii) Electrical insulation / water pipes / guttering / window frames / flooring/ specified clothing **(1)**
Do not allow buckets, bottles etc **(1 mark)**

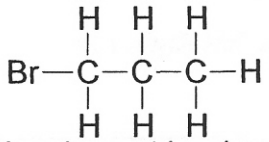
(iii) Either
Remain in landfill sites **(1)**
not biodegradable / strong C-Cl bond **(1)** (both are stand-alone marks)
or
If incinerated **(1)**
produce toxic fumes **(1)** (consequential on incineration)
if specified, must be correct eg HCl or dioxins, not chlorine **(2 marks)**

(c) (i) 61.0/12 15.3/1 23.7/14 i.e. divide by A_r **(1)**
5.08/1.69 15.3/1.69 1.69/1.69 i.e. divide by 1.69 to give 3:9:1 **(1)**
or
% C,H and N calculated from given formula **(1)**
which are the same as the data **(1)** **(2 marks)**

(ii) Ammonia **(1)** (Not formula)

$CH_3CHBrCH_3 + 2NH_3 \rightarrow CH_3CH(NH_2)CH_3/C_3H_9N + NH_4Br$
Organic species **(1)** (consequential on reasonably correct reagent)
balancing of equation as above **(1)** **(3 marks)**

(iii)



All bonds must be shown **(1 mark)**

(Total 16 Marks)

5 (a) enthalpy/heat (not energy) change for **one mole** of a compound / substance **(1)**
to be formed from its **elements (1)**
in **standard** states or under standard conditions of 1atm pressure and stated temperature (298 K). **(1)** **(3 marks)**

(b) (i) $\Delta H_c = [(-394) + (2 \times -286)] - (-75)]$
$= -891 \text{ kJ mol}^{-1}$
-891 kJ mol^{-1} with working **(3)**
-605 kJ mol^{-1} with working **(2)**
all other 'non-typo' values (max 1) for 2 x 286
-891 kJ mol^{-1} with no working **(1)** **(3 marks)**

(ii) (negative so) exothermic **(1 mark)**
(consequential on (i))

(c) $C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$
species **(1)**
balancing **(1)** **(2 marks)**

QWC (d) *Must compare the two fuels for full marks*
Only data-generated advantages and disadvantages to score.

- Methane is a gas and ethanol is a liquid plus a valid comment about storage in **vehicle,** e.g. methane requires **heavy** container to store gas under pressure / **large** container required to store gas, whereas easy to store liquid in fuel tank **(1)**

Any 2 of

- Methane cheaper per kJ of heat released (than ethanol)
- Methane cheaper (per tonne than ethanol)
- Methane produces more heat per gram (than ethanol)

Cheaper / more heat implies a comparison **(3 marks)**

(e) $C_2H_5OH + [O] \rightarrow CH_3CHO + H_2O$ **(1)** not CH_3COH

$C_2H_5OH + 2[O] \rightarrow CH_3COOH + H_2O$ **(1)** (allow CH_3CO_2H) **(2 marks)**
Allow $CH_3CHO + [O] \rightarrow CH_3COOH$ if CH_3CHO is a product in 1st equation

(f) conc. H_2SO_4 / Al_2O_3 / conc or syrupy H_3PO_4 or names **(1)**
For acids, conditions: heat (if temp stated conc sulphuric 150°C-200 °C phosphoric 50 to 100 °C) **(2 marks)**
For aluminium oxide, conditions: pass vapour over hot Al_2O_3 **(1)**

(Total 16 Marks)

Unit Test 6243/02

1 **(a)** Only penalise S.F in 2(c) and 3 (a) (iii), if necessary.
Penalise an incorrect unit once on the paper.

Penalise additional incorrect observations or gases.

Sodium chloride - Yellow/orange **(1)**

Potassium chloride - Lilac allow purple/mauve/violet **(1)** **(2 marks)**

(b) Potassium sulphate - White precipitate **(1)**

Potassium sulphite - No precipitate/no change/no reaction/pungent gas/choking gas/gas turns acidified potassium dichromate from orange to green **(1)**
Sulphur dioxide alone **(0)** **(2 marks)**

(c) Ammonium sulphate – (Red) litmus turns blue **(1)**
Ammonia/ allow NH_3 **(1)**

Potassium sulphate - Litmus stays red/no change/no reaction/no gas evolved **(1)** **(3 marks)**

(d) Sodium chloride – hydrogen chloride/allow HCl **(1)**
Misty/steamy/cloudy fumes/effervesence/litmus turns red **(1)**
If litmus bleached (0) for observation.
White fumes alone (0) for observation

Sodium bromide – bromine/hydrogen bromide/sulphur dioxide /allow Br_2/ HBr/SO_2 **(1)**
Brown/orange fumes/liquid/solution **(1)**
Not red on its own
Effervescence/litmus turns red/steamy fumes/litmus is slowly bleached. **(1)** **(5 marks)**

(Total 12 Marks)

2 (a) **QWC**

P Pipette mark: use of a ($25cm^3$) pipette for ethanedioic acid ✓ P

I Indicator mark: add a few drops of phenolphthalein to conical flask ✓ I

T Technique mark: add alkali to acid with swirling/allow shaking/mixing/magnetic stirrer but not stirring alone /drop by drop/slowly (near end point) /rinse out the pipette with acid /use of a white tile /read from bottom of meniscus /touch tip of pipette on side of flask /rinse flask with distilled water ✓ T
do not award this mark if the flask is rinsed with acid

V Volume mark: note(initial and)final volumes of alkali ✓ V

E End point mark: colour change – (colourless to pale) pink /first permanent pink colour (not purple) ✓ E

C consistency mark: repeat until titres are within 0.05-0.2(cm^3) of each other /repeat until concordant/consistent results ✓C
not just repeat x times **(6 marks)**

(b) **(i)** $\frac{25}{1000} \times 0.0500 = 0.00125$ **(1 mark)**

(ii) Answer to (i) x 2 = 0.00250 mark consequentially **(1 mark)**

(iii) Answer to (ii) x $\frac{1000}{25.50}$ = 0.0980 mark consequentially **(1 mark)**

(c) $M_r = 126$ **(1)**
$M_r \times \frac{250}{1000} \times 0.050$ **(1)** = correct answer to 3SF **(1)**
1.58(g) if use 126
1.13(g) if use 90 **(3 marks)**

(d) Volume NaOH increases **(1)**
Solution of ethanedioic acid is more **concentrated (1)** **(2 marks)**

(Total 14 Marks)

3 (a) (i) $5.00 \div 84.0 = 0.0595$ mol **(1 mark)**

(ii) $50.0 \times 4.18 \times 6.5$ **(1)** ignore sign

$\div 1000$ **(1)** = 1.36kJ mark consequentially
(1.49.kJ if use 55.0g **(1)**) **(2 marks)**

(iii) Answer to (ii) ÷ answer to (i) **(1)** /correct method.
(expected answer +22.6 to + 22.9 for 50.0g or +24.8 to +25.1 for 55.0g)
Answer with positive sign to 3 sfs **(1)** **(2 marks)**

(b) (i) Increase temperature for Na_2CO_3 and decrease for $NaHCO_3$ **(1)**
Larger ΔT with Na_2CO_3 (or consequential on (a)(iii) **(1)** **(2 marks)**

(ii) No heat lost/gained to/from surroundings/reaction is complete
shc of the solution is the same as water
Allow $1cm^3$ of solution has a mass of 1g **(1 mark)**
Do not allow shc is 4.18 J g^{-1} $^0C^{-1}$

(Total 8 Marks)

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4 (a) Potassium / sodium dichromate(VI)/$K_2Cr_2O_7$/$Na_2Cr_2O_7$
Allow potassium manganate(VII)/permanganate/$KMnO_4$/potassium chromate /K_2CrO_4 **(1 mark)**
(1 mark)

(b) (i) Exothermic

(ii) (Cold) **water moving** through the condenser/water cools the vapour **(1 mark)**

(iii) To prevent **ethanal** vaporising / **ethanal** is volatile **(1 mark)**

(iv) (Remove ethanal) because fumes/vapour/gas flammable/irritant/harmful, **not** *toxic* **(1 mark)**

(c) $\frac{44}{46} \times 5.0$ **(1)** = 4.8 g

$4.8 \times \frac{40}{100}$ = 1.9 g **(1)**

The second mark can be scored if candidates make use of 2 M_r values, 5.0g and 40% and the answer is less than 5.0g. **(2 marks)**

(Total 7 Marks)

5	(a)	(i)	Solvent/to allow mixing/dissolving		**(1 mark)**
		(ii)	$Ag^+(aq) + X^-(aq) \longrightarrow AgX(s)$ allow Cl^-, Br^- or I^- formulae **(1)** state symbols **(1)** allow state symbols if NO_3^- is in the equation.		**(2 marks)**
		(iii)	Ethanol/halogenoalkanes flammable / constant temperature/controlled temperature.		**(1 mark)**
QWC	(b)		Equal volumes/amounts/quantities of ethanol / silver nitrate **(1)** Equal moles/amounts (not volumes) of halogenoalkanes **(1)** Test tubes reach temperature of water bath before mixing. **(1)** Mix reagents simultaneously / start timing on addition of reagents **(1)** Any two of white, cream, yellow (precipitates) **(1)** Iodide forms first then bromide then chloride / shortest time **not** rate **(1)** If any additional reagents are added. **Max 4**	✓ V ✓ A ✓ E ✓ T ✓ C ✓ O	**MAX (5 marks)**

(Total 9 Marks)