01. 0620_m21_ms_42 Q: 4

Question	Answer	Marks
(a)	$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$ $ZnCl_2$ or H_2 as a product (1) correct equation (1) states (1)	3
(b)	to make sure all the (hydrochloric) acid reacts	1
(c)	filtration	1
(d)	a solution that can dissolve no more solute (1) at a given temperature (1)	2
(e)	solubility (of $ZnCl_2$ / solids) decreases (as temperature decreases)	1
(f)	zinc oxide zinc carbonate	2
(g)	Ca will also react with water	1
(h)(i)	neutralisation	1
(h)(ii)	$0.100 \times 25 / 1000 = 0.0025(0)$ (1) $0.0025 \times 2 = 0.005(00)$ (1) $0.005 \times 1000 / 20 = 0.25(0)$ (1) $M_r = 40$ (1) $0.25 \times 40 = 10.(0)$ (1)	5

02. 0620_w21_ms_42 Q: 1

Question	Answer	Marks
(a)	1 mark for each correct row State / touching / random movement / regularly arranged Gas / – / ✔ / – Liquid / ✔ / ✔ / – Solid / ✔ / – / ✔	3
(b)(i)	boiling happens at a specific temperature (1) boiling has bubbles (1)	2
(b)(ii)	condensation (1) sublimation (1)	2
(c)	one horizontal line level with Y (1) two separate decreases before and after horizontal line (1)	2
(d)(i)	dissolving	1
(d)(ii)	precipitation	1

03. 0620_p20_ms_40 Q: 6

(a) filter / centrifuge / decant; [1]
(partially) evaporate / heat / boil; [1]
allow to crystallise / cool / let crystals form; [1]
dry crystals / dry between filter paper / leave in a warm place to dry; [1]

(b) **(i)** number of moles of HC*l* used = 0.04 □ 2 = 0.08; [1]
number of moles $CoCl_2$ formed = 0.04; [1]
number of moles $CoCl_2.6H_2O$ formed = 0.04; [1]
maximum yield of $CoCl_2.6H_2O$ = 9.52; [1]
allow: 9.5
allow: ecf on number of moles of HC*l*

number of moles of HC*l* used = 0.08 note: must use their value
allow: ecf
number of moles of $CoCO_3$ in 5.95 g of cobalt(II) carbonate = 5.95/119 = 0.05; [1]

(ii) 0.05 > 0.04 or stated in words;
allow: ecf on number of moles of $CoCl_2$ formed [1]

04. 0620_w20_ms_42 Q: 2

Question	Answer	Marks
(a)	HNO_3	1
(b)(i)	to make sure all the (sulfuric) acid reacts	1
(b)(ii)	no (more) fizzing (1) ($FeCO_3$) stops dissolving or a solid remains / is visible (in the mixture) (1)	2
(b)(iii)	rinse the residue (with distilled water)	1
(b)(iv	a solution that can dissolve no more solute (1) at the specified temperature (1)	2
(b)(v)	iron(II) oxide / iron(II) hydroxide	1

Question	Answer	Marks
(c)	mass of $FeSO_4$ = 152 (1) mass of H_2O = 278 – 152 = 126 (1) mol of H_2O = 126 / 18 **and** x = 7 (1)	3
(d)(i)	precipitation	1
(d)(ii)	cream precipitate	1
(d)(iii)	$Ag^+(aq) + Br^-(aq) \rightarrow AgBr(s)$ AgBr (as only product) (1) Ag^+ and Br^- (as reactants)(1) state symbols(1)	3
(e)	M1 mol of NaCl = 2.34 / 58.5 = 0.04(00) M2 mol of Cl_2 = M1/2 = 0.04(00)/2 = 0.02(00) M3 0.02(00) × 24000 = 480 (cm^3)	3
(f)(i)	ions (1) (ions) are fixed (in a lattice) (1) ions are mobile (1)	3
(f)(ii)	chlorine	1
(f)(iii)	oxidation (1) electrons are lost (1)	2
(f)(iv)	dissolve it (in water)	1

05. 0620_s19_ms_42 Q: 5

(a)	**M1** 0.0025 / 2.5 □ 10^{-3} (moles of H_2SO_4) (1) **M2** 0.0025 / 2.5 □ 10^{-3} (moles of $CuSO_4 \cdot 5H_2O$) (1) **M3** 0.625(g) (1)	3
(b)	some copper(II) sulfate remains in solution / some copper(II) sulfate does not form crystals **OR** some of the crystals decomposed **OR** some crystals lost in transfer	1
(c)	**M1 no more** bubbling / fizzing / effervescence (1) **M2 solid** or **powder** stops dissolving (1)	2
(d)	**M1** (lumps have) smaller surface area **OR powder** has larger surface area (1) **M2** (lumps have) fewer collisions per unit time / less collision frequency **OR powder** has more collisions per unit time / more collision frequency	2
(e)	copper(II) oxide **or** copper(II) hydroxide	1
(f)	filtration	1
(g)(i)	**M1** containing the maximum amount of **dissolved** solute / no more solute can **dissolve** (1) **M2** at any given temperature (1)	2

(g)(ii)	when crystals form on a glass rod withdrawn from solution / on a sample of solution placed on microscope slide etc.	1
(g)(iii)	(heating to dryness) would remove water **of crystallisation**	1

06. 0620_w18_ms_43 Q: 4

(a)	**M1** (Mol KOH =) 0.00125 / 1.25 □ 10^{-3} **M2** (Mol H_2SO_4 =) 0.000625 / 6.25 □ 10^{-4} **M3** (Conc H_2SO_4 =) 0.03125 / 3.125 □ 10^{-2} (mol / dm^3)	3

(b)	**SUMMARY** **M1** repeat **M2** heat (liquid or solution should be implied) **M3** when to stop heating **M4** what to do after heating **M5** method of drying crystals (crystals or solid should be implied) **M1** repeat without indicator using same volumes **M2** evaporate / heat / warm / boil / leave in sun **M3** until most of the water is gone / some water left / saturation(point) / crystallisation point / evaporate **some** of the water **M4** leave / (allow to) cool / allow to crystallise **M5** details of drying	**5**
(c)(i)	**M1** bubbles / effervescence / fizzing **M2** solid or magnesium dissolves / solid or magnesium disappears	**2**
(c)(ii)	lilac flame	**1**
(c)(iii)	white precipitate	**1**
(d)(i)	$Mg(OH)_2 + H_2SO_4 \rightarrow MgSO_4 + 2H_2O$ **M1** formula of **both** $Mg(OH)_2$ and $MgSO_4$ **M2** equation fully correct	**2**
(d)(ii)	$Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$ **M1** formula of $ZnSO_4$ **M2** equation fully correct	**2**
(d)(iii)	$Na_2CO_3 + H_2SO_4 \rightarrow Na_2SO_4 + CO_2 + H_2O$ **M1** formulae of **both** Na_2CO_3 and Na_2SO_4 **M2** equation fully correct	**2**

07. 0620_s17_ms_41 Q: 3

(a)(i)	no (more) effervescence	**1**
(a)(ii)	magnesium carbonate	**1**
(a)(iii)	(a solution in which) no more solute will dissolve	**1**
	at that temperature	**1**
(a)(iv)	the solubility deceases as the temperature decreases	**1**
(b)(i)	moles of water = 2.52 / 18 = 0.14 (mol)	**1**
(b)(ii)	moles of anhydrous magnesium sulfate = 0.02 (mol)	**1**
(b)(iii)	ratio = 0.02 / 0.02 : 0.14 / 0.02 = 1 : 7	**1**

(b)(iv)	$MgSO_4.7H_2O$ **M1** $MgSO_4$ **M2** rest of the formula correct	**2**
(c)	mix and stir the two solutions	**1**
	filter (to obtain residue)	**1**
	wash (the residue) using water	**1**
	dry the residue between filter papers / in a warm place	**1**
(d)	$Pb^{2+}(aq) + SO_4^{2-}(aq) \rightarrow PbSO_4(s)$ **M1** correct species **M2** correct state symbols	**2**

08. 0620_p16_ms_40 Q: 6

(a) filter / centrifuge / decant; [1]
(partially) evaporate / heat / boil; [1]
allow to crystallise / cool / let crystals form; [1]
dry crystals / dry between filter paper / leave in a warm place to dry; [1]

(b) (i) number of moles of HCl used = 0.04 × 2 = 0.08; [1]
number of moles $CoCl_2$ formed = 0.04; [1]
number of moles $CoCl_2.6H_2O$ formed = 0.04; [1]
maximum yield of $CoCl_2.6H_2O$ = 9.52; [1]
allow: 9.5
allow: ecf on number of moles of HCl

number of moles of HCl used = 0.08 note: must use their value
allow: ecf
number of moles of $CoCO_3$ in 5.95 g of cobalt(II) carbonate = 5.95/119 = 0.05; [1]

(ii) 0.05 > 0.04 or stated in words;
allow: ecf on number of moles of $CoCl_2$ formed [1]

09. 0620_s16_ms_41 Q: 3

(a)	1 $Na_2S_2O_3$ 2 H_2O 3 HCl **OR** 1 HCl 2 H_2O 3 $Na_2S_2O_3$ **OR** 1 H_2O 2 $Na_2S_2O_3$ 3 HCl **OR** 1 H_2O 2 HCl 3 $Na_2S_2O_3$;	**1**
(b)(i)	**M1** volumes 40 : 10 : 10; **M2** time = 14;	**2** 1 1
(b)(ii)	**M1** more particles per unit volume / particles are closer together; **M2** increases the rate of collisions / there are more collisions per unit time;	**2** 1 1
(c)	**M1** particles gain more energy **and** move faster; **M2** increasing rate of collisions / more collisions per unit time; **M3** higher proportion of particles have sufficient energy to react / collisions have sufficient energy to react / are above the activation energy;	**3** 1 1 1

10. 0620_s16_ms_43 Q: 4

(a)(i)	**M1** movement of electron(s) from potassium to iodine; **M2** one electron transferred;	**2** 1 1
(a)(ii)	**M1** regular arrangement / (giant) lattice of alternating; **M2** positive potassium ions / K^+ **and** negative iodide ions / I^-;	**2** 1 1
(a)(iii)	**M1** strong (forces of) attraction (between oppositely charged ions) / ionic bonds are strong; **M2** which require lots of energy to overcome / break;	**2** 1 1
(b)(i)	**M1** dissolve solids (in water) and mix / combine / add; **M2** filter; **M3** wash the residue (with water); **M4** leave to dry / place in oven / dry between filter papers;	**4** 1 1 1 1
(b)(ii)	$Pb^{2+} + 2I^- \rightarrow PbI_2$ formulae of ions correct; rest correct;	**2**
(c)(i)	start colour: colourless; end colour: brown;	**2** 1 1
(c)(ii)	**M1** iodide / I^-; **M2** it is oxidised **OR** it loses electrons / it increases oxidation number / it reduces the chlorine;	**2** 1 1

11. 0620_w16_ms_43 Q: 2

(a)	2,2 / 2.2	**1**
(b)	BeO	**1**
(c)(i)	positive ions / cations labelled or named in text electrons labelled or named in text attraction between positive ions and negative electrons	**1** **1** **1**
(c)(ii)	(conduction due to) moving electrons / mobile electrons	**1**
(d)(i)	Be^{2+}	**1**
(d)(ii)	$Be(OH)_2 + 2HCl \rightarrow BeCl_2 + 2H_2O$ formula of $BeCl_2$ all formulae correct and balancing correct	**2**
(d)(iii)	$2NaOH + Be(OH)_2 \rightarrow Na_2BeO_2 + 2H_2O$ formula of Na_2BeO_2 all formulae correct and balancing correct	**2**

12. 0620_s15_ms_31 Q: 6

(a)(i)	M1 proton acceptor; M2 does not accept (protons) readily **OR** less able to accept protons (than strong bases);	 **2**	**A** alternative words to 'acceptor' e.g. 'receiver' **I** references to pH **A** 'hydrogen ion' or 'H^+' for proton **I** accepts fewer / less protons
(a)(ii)	M1 same <u>concentration</u> of both bases; M2 measure their pH; M3 the higher pH is the stronger base;	 **3**	 **A** suitable method e.g. universal indicator or pH paper or pH meter **I** litmus or methyl orange or phenolphthalein **I** titration methods for M2 and M3 **A** suitable colours of both weak strong bases e.g. ethylamine is (greeny)blue, NaOH is dark**er** blue / purple **A** alternative methods for M2 and M3 e.g. measure conductivity (M2) and higher conductivity is the stronger base (M3) e.g.add aluminium / *Al* (M2) and stronger base gives faster rate of effervescence / more fizzing / more bubbling (M3)
(b)(i)	$2CH_3CH_2NH_2 + H_2SO_4 \rightarrow (CH_3CH_2NH_3)_2SO_4$ species; balancing; the salt is ethylammonium sulfate;	 **3**	**A** multiples **I** state symbols **A** one mark for correct product **A** close spellings **A** diethylammonium sulfate

(b)(ii)	sodium hydroxide / calcium hydroxide / NaOH / $Ca(OH)_2$;	**1**	**A** any Group 1 or Group 2 hydroxide or oxide
(c)(i)	*Any **two** from:* (particles move in) random motion; (particles) collide; (particles) move from a region of high concentration to low concentration;	 **2**	 **A** alternative phrases for collide **A** down a concentration gradient
(c)(ii)	C; M2 it has a lower (relative) molecular mass (than HBr); M3 ethylamine diffuses faster (than HBr);	 **3**	 **A** ethylamine is less dense **A** ethylamine is a lighter molecule but **I** 'ethylamine is lighter' **I** ethylamine is a smaller molecule **A** ethylamine **molecules** or **particles** move faster **A** ECF for M2 and M3 if A is given e.g. HBr diffuses faster for M3 because it is a lighter molecule for M2 **A** ECF for M2 if B is given e.g. they diffuse at same rate for M3 because molecules weigh the same for M2

13. 0620_s15_ms_32 Q: 5

(a)	method A; hydrochloric acid / HC*l* / hydrogen chloride solution; nickel carbonate + hydrochloric acid → nickel chloride + water + carbon dioxide;	3	hydrochloric acid / HC*l* can only score if written in the reagent space i.e. **R** hydrochloric acid / HC*l* in equation if reagent space is blank **I** hydrogen chloride (therefore 'hydrogen chloride + HC*l*' would get mark 2 BOD) **I** nickel carbonate **A** fully correct balanced chemical equation i.e. $NiCO_3 + 2HCl \rightarrow NiCl_2 + CO_2 + H_2O$ for the third mark **R** combination of words and formulae in the same equation for the third mark **I** concentration of acid for marks 2 and 3
(b)	method C; any (aqueous / dilute / solution of soluble) bromide including potassium bromide / KBr, hydrogen bromide / HBr i.e. all bromides except silver, lead and mercury; $Pb^{2+} + 2Br^- \rightarrow PbBr_2$;	3	**A correct** formula of soluble bromide **I** lead nitrate **I** state symbols **A** multiples

(c)	method B; sulfuric acid / hydrogen sulfate / H_2SO_4 ; $2LiOH + H_2SO_4 \rightarrow Li_2SO_4 + 2H_2O$ species; balancing;	4	**I** concentration of acid for mark 2 **I** indicators / lithium hydroxide **I** state symbols **A** multiples

14. 0620_w15_ms_33 Q: 7

(a)	*moles of KOH used* (= 0.025 × 2.53 =) 0.06325 / 0.063; *number of moles of H_2SO_4 needed to neutralise the KOH* = 0.031625 / 0.032; *concentration of dilute sulfuric acid* = 1.121/1.1 (mol / dm^3);	**3**
(b)(i)	repeat experiment using same volume / amount of (same) H_2SO_4; and same volume / amount of (same) KOH; **or** (add activated) charcoal / carbon; filter out the charcoal; **or** mix volumes / amounts of H_2SO_4 and KOH in the ratio 1:2; of the same concentration;	**2**
(b)(ii)	make solution of potassium sulfate as above; add same volume / amount of acid again; **or** same volume / amount of KOH; add double the volume / amount of H_2SO_4; 25 cm^3 KOH + 56.4 cm^3 H_2SO_4 = [2] **or** same volume / amount of H_2SO_4; add half the volume / amount of KOH; 12.5 cm^3 KOH + 28.2 cm^3 H_2SO_4 = [2] **or** mix equal volumes / amounts of H_2SO_4 and KOH ; of the same concentration; mix solutions containing equal numbers moles of KOH and H_2SO_4 = [2]	**2**

(c)	*test:* reactive metal / name or formula of suitable metal, e.g. Mg / Fe / Zn; *result:* bubbles or gas or hydrogen or H_2 evolved / dissolves; *test:* insoluble carbonate or name / formula of suitable insoluble carbonate, e.g. $CaCO_3$; *result:* bubbles or gas or carbon dioxide or CO_2 evolved / dissolves provided that carbonate is insoluble; *test:* alkali or name / formula of suitable alkali, e.g. NaOH / KOH; *result:* temperature change; *test:* alkali or name / formula of suitable alkali, e.g. NaOH / KOH and indicator; *result:* colour change; *test:* insoluble base or name / formula of suitable insoluble base; *result:* dissolves; *test:* indicator, e.g. blue litmus; *result:* colour change (colour need not be specified); *test:* measure pH / pH paper / UI paper / pH meter; *result:* pH 0–3 or indicator red / orange or pH lower than pH of K_2SO_4;	**2**

15. 0620_s14_ms_32 Q: 7

(a) repeat without indicator / repeat using same volumes of acid and alkali **or** use carbon / charcoal to remove indicator (1)

evaporate / heat / warm / boil / leave in sun (1)

until most of the water has gone / some water is left / saturation (point) / crystallisation point (1)

leave / allow to cool / allow to crystallise (1)

filter (off crystals) / wash(with distilled water) / dry crystals with filter paper / dry crystals in warm place / oven / windowsill (1) [5]

(b) 0.062 (1)

0.031 (1)

3.97 g (1)

55.4% (1) [4]

(c) **(i)** (to prove) **all** water driven off or evaporated or boiled / no water remains / to make salt anhydrous (1)

(ii) $m_1 - m_2$ = mass of water (1)

(calculate) moles of water **AND** moles of hydrated or anhydrous salt (1)

1:1 ratio / should be equal (1) [3]

16. 0620_w14_ms_32 Q: 1

(a) foodstuffs or drugs [1]

(b) **(i)** simple distillation
fractional distillation **or** diffusion
fractional distillation
filtration **or** evaporation
chromatography [5]

(ii) M1 dissolving
M2 filtration
M3 evaporation or heat (to crystallisation point)
M4 crystallisation or allow leave to cool [4]
or
M3 crystallisation
M4 filtration

OR: Adding to H_2SO_4 method

M1 Add excess mixture to acid (or until no more dissolves)
M2 Filtration
or
M1 Add excess acid to mixture
M2 With heat

M3 evaporation or heat (to crystallisation point) Stop marking if heated to dryness.
M4 crystallisation or allow leave to cool
or
M3 crystallisation
M4 filtration

[Total: 10]

17. 0620_w14_ms_33 Q: 5

(a) (i) rate decreases [1]
concentration of sodium chlorate ((I))/reactant decreases [1]

(ii) (initial) gradient greater/steeper (must start at origin) [1]
same final volume of oxygen [1]

(iii) (to prevent)photochemical reaction/(to prevent)reaction catalysed by light/light breaks down or decomposes sodium chlorate((I)) [1]

(iv) particles have more energy/particles move faster/ [1]
more collisions [1]
collisions more frequent or more often/greater chance of collision/collision rate increases/more particles have energy to react/more collisions are successful or effective [1]

(b) (i) $2Cl^- \rightarrow Cl_2 + 2e(^-)$ / $2Cl^- - 2e(^-) \rightarrow Cl_2$ [1]

$2H^+ + 2e(^-) \rightarrow H_2$ / $2H^+ \rightarrow H_2 - 2e(^-)$ [1]

hydrogen formed at cathode/– and chlorine at anode/+ [1]

Na^+ and OH^- **or** sodium ions and hydroxide ions left in solution/form/become sodium hydroxide [1]

(ii) $Cl_2 + 2NaOH \rightarrow NaClO/NaOCl + NaCl + H_2O$ [2]
Species (1) Balancing (1)

[Total: 14]

18. 0620_w14_ms_33 Q: 8

(a) (changes from) blue (1) to pink (1) [2]

(b) no more (solid) dissolves **or** no more cobalt(II) carbonate dissolves **or** no more effervescence **or** bubbling **or** fizzing [1]

filter(residue)/centrifuge/decant [1]

evaporate/heat/warm/boil/leave in sun **AND** until most of the water has gone/some water is left/until it is concentrated/saturation (point)/crystallisation point/crystals form on glass rod or microscope slide/crystals start to form [1]

Leave/allow to cool/allow to crystallise/filter (off crystals)/wash(with distilled water)/dry crystals with filter paper/dry crystals in warm place **or** dry in oven **or** dry on windowsill [1]

(c) number of moles of HC*l* in 50 cm^3 of acid, concentration 2.2 mol/dm^3 = 0.11 [1]

maximum number of moles of $CoCl_2.6H_2O$ which could be formed = 0.055 [1]

mass of 1 mole of $CoCl_2.6H_2O$ = 238 g

maximum yield of $CoCl_2.6H_2O$ = 13.09 g [1]

percentage yield = 48.2% **or** ecf mass of $CoCl_2.6H_2O$ above/13.09 × 100% to 1 dp [1]

[Total: 10]

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19. 0620_s13_ms_31 Q: 7

(a) (i) add carbon / animal charcoal [1]
filter [1]

OR

repeat experiment without indicator [1]
using same quantity / volume of acid [1]

(ii) add magnesium metal / carbonate / oxide / hydroxide to (hot) (hydrochloric) acid [1]

cond: until in excess **or** no more dissolves **or** reacts [1]

cond: filter (to remove unreacted solid) [1]

(b) number of moles of HCl = 0.020 x 2.20 = 0.044 [1]
number of moles of LiOH = 0.044
concentration of LiOH = 0.044/0.025 = 1.769 (mol / dm^3) [1]
accept 1.75 to 1.77 need 2 dp
correct answer scores = 2

(c) (for LiCl.2H$_2$O)
mass of one mole = 78.5 [1]
percentage water = 36 / 78.5 x 100 [1]
45.9 so is LiCl.2H$_2$O [1]
only award the marks if you can follow the reasoning and it gives 45.9% of water

note: if correct option given mark this and ignore the rest of the response

allow: max 2 for applying a correct method to another hydrate, [1] for the method and [1] for the correct value, working essential

[Total: 10]

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20. 0620_s12_ms_31 Q: 2

(a) nitric acid; [1]
sodium hydroxide / carbonate / hydrogen carbonate; [1]

copper(II) oxide / hydroxide / carbonate; [1]

any named soluble chloride; [1]
accept: *hydrochloric acid* / *hydrogen chloride*
silver(I) nitrate / ethanoate / sulfate; [1]
must be soluble silver salt **not** *silver oxide* / *carbonate*

zinc(II) sulfate [1]

(b) **(i)** Ag$^+$(aq) + Cl^-(aq) → AgCl(s) [2]
equation correct state symbols missing [1]

(ii) $ZnCO_3 + H_2SO_4 \rightarrow ZnSO_4 + CO_2 + H_2O$ [2]
correct formula for zinc sulfate = 1

[Total: 10]

(a) (i) melting point is below 25°C; [1]
boiling point above 25°C; [1]
accept: argument based on actual values
note: 25°C is between mp and bp = [2]

(ii) strontium loses 2e; [1]
sulfur gains 2e; [1]

(iii) hydrogen chloride / hydrochloric acid; [1]
accept: sulfurous acid or sulfur dioxide

(iv) molten strontium chloride has ions / ionic compound; [1]
which can move; [1]
sulfur chloride has no ions / only molecules / molecular / covalent; [1]

(b) (i) strontium carbonate does not dissolve / no effervescence; [1]
note: not just reaction is complete

(ii) to remove excess / unreacted / undissolved strontium carbonate; [1]

(iii) water of crystallisation needed / $6H_2O$ in crystals / would get anhydrous salt / would not get hydrated salt / crystals dehydrate; [1]
not: just to obtain crystals

(c) number of moles of HCl used = 0.05 × 2 = 0.1 [1]
number of moles of $SrCl_2.6\ H_2O$ which could be formed. = 0.05 [1]
mass of one mole of $SrCl_2.6H_2O$ is 267 g
theoretical yield of $SrCl_2.6H_2O$ = 0.05 × 267 = 13.35 g [1]
percentage yield = 6.4 / 13.35 × 100 = 47.9% [1]
accept: 48%
allow: ecf

[Total: 15]