AP PROBLEMS
EXPERIMENTAL PROBLEMS

7a) 2 pts

Mass of vaporized liquid (or substance)
Atmospheric pressure
Volume of flask
Temperature of vapor (water)

7b) 3 pts

Procedure for:
-mass: the mass difference between flask + air and flask + vaporized liquid
-volume: volume of flask by filling with water and then using graduated cylinder for measuring

7c) 1 pt

Mass/mole
Mole is determined by PV = nRT

7d) 2 pts

Molar mass is too high
-because the non-volatile impurity contributes additional mass (but insignificant volume)

8a) (1) I would subtract the mass of the clean copper strip from mass of the copper strip and compound (1.2874g - 1.2789g), then divide this answer by the gram atomic mass of I, 126.91g.
(2) I would subtract the mass of the copper strip after washing from the mass of the clean copper strip (1.2789g - 1.2748g). Then I would divide this answer by the molar mass of copper, 63.55g.

8b) I would find the least whole number ratio of moles of Cu and I by dividing the larger of the two by the smaller and finding the whole number ratio equal to that ratio.

8c) (1) If some unreacted iodine vapor condensed on the strip then the mass and moles of I calculated would be too high thereby resulting in an empirical formula with too much I in it.
(2) If some of the white copper iodide compound flaked off before weighing then the mass and moles of I calculated would be too small resulting in an empirical formula with too little I in it.

9a) 2 pts

Mix unknown and $BaCl_2$ as reactants

Collect precipitate/set up filtration

9b) 2 pts

Mass of unknown salt as reactant

(sulfate = "salt" = unknown salt, unless otherwise specified)

Mass $BaSO_4$ (must be specified) as dried precipitate/product

Note: "dried" must appear to earn all 4 points for A and B

9c) 2 pts

Mass $BaSO_4$ → moles SO_4^{-2} → mass SO_4^{-2}

Then take mass SO_4^{-2}/mass unknown

Notes: A list alone is acceptable. Method, if correct, is acceptable as list. Response must clearly distinguish between SO_4^{-2}, $BaSO_4$, and unknown sulfate. Only one of two points earned is mass of SO_4^{-2} incorrect but fraction for percent clearly indicates part (of original salt)/whole (of original salt)

9d) 2 pts

$MgCl_2$ is NOT an acceptable substitute for $BaCl_2$

$MgSO_4$ is to soluble

Note: 1 pt earned if response indicates $MgCl_2$ is acceptable and reason given is that Mg^{+2} behaves like Ba^{+2} to form insoluble SO_4^{-2} precipitate (response must previously specify $BaSO_4$ as product)

10a) Any two parts = 1 pt

Any three parts = 2 points

-sodium is softest of the three

-Na added to water leads to gas and base

-$Na + H_2O \rightarrow H_2 + NaOH$

10b) Any two parts = 1 point

Any three points = 2 points

-magnesium reacts with HCl

-$Mg + 2H^+ \rightarrow Mg^{+2} + H_2$

-reduction potentials Mg = -2.37 V Ag = 0.08 V

-Mg but not Ag reacts with HCl

10c) Unbalanced eqn = 1 pt

Balanced eqn = 2 pts

$Ag + 4H^+ + NO_3^- \rightarrow 3Ag^+ + NO + 2H_2O$

Or

$Ag + 2H^+ + NO_3^- \rightarrow Ag^+ + NO_2 + H_2O$

10d) 2 points

-a white precipitate forms

$Ag^+ + Cl^- \rightarrow AgCl_{(s)}$

11a) 2 pts

Equipment needed includes a thermometer, and a container for the reaction, preferably a container that serves as a calorimeter, and a volumetric glassware (graduates cylinder, pipet…)

11b) 2 pts

Measurements include the difference in temperature between just before the start of the reaction and the completion of the reaction, and amounts (volume, moles) of the acid and the base

11c) 2 pts

-determination of heat (evolved or absorbed)
-the sum of the volumes (or masses) of the two solutions
-the change in temperature and the specific heat of water are multiplied together to determine the heat of solution for the sample used ($q=m\Delta TCp$) for full credit, two of the three factors must be identified

11d) 2 pts

<u>Experimental errors</u>: heat loss to the calorimeter wall, to air, to the thermometer; incomplete transfer of acid or base from graduated cylinder; splattering of some of the acid or base so incomplete mixing occurred
<u>Experimentor errors</u>: dirty glassware, spilled solution, misread volume or temperature
1 pt for each of two experimental errors, 1 point for an experimentor error if only one experimental error is given

12a) 3 pts

Add water to mixture
$CaCO_3$ does not dissolve in water whereas $CaCl_2$ does
Filter the solution. The aqueous $CaCl_2$ solution passes through the filter paper and the $CaCO_3$ is collected on the paper

12b) 3 pts

Pipet an aliquot of known volume into a flask
Add excess $AgNO_3$ to precipitate AgCl
Filter, dry and weigh AgCl
wt AgCl/MW of AgCl=# moles AgCl = # moles NaCl
M = moles AgCl (or NaCl)/L of aliquot

Or

Take a known volume of solution. Evaporate solution to dryness and weigh the NaCl residue
wt NaCl/MW of NaCl = # moles NaCl
M = moles NaCl/L solution

Full credit for this problem could also be achieved by using a weight measurement of the solution (and obtaining the weight of the solvent), evaporating the solvent, weighing the residue and calculating the molality. Through the proper application of colligative properties, it is possible to obtain full credit

12c) 2 pts

Fractional distillation
(ordinary distillation receives 1 pt)

13a) $CoCl_2$ is blue or red depending on whether water is present.

13b) Of the remaining compounds AgCl is insoluble in water

13c) When $BaCl_2$ is added to 1.0 M Na_2SO_4 a white precipitate of $BaSO_4$ is formed.
$BaCl_{2(aq)} + Na_2SO_{4(aq)}\ BaSO_{4(s)} + 2NaCl_{(aq)}$

13d) NH_4Cl reacts with NaOH to release NH_3 which has a distinct odor.