T A S M A N I A N

C E R T I F I C A T E

O F E D U C A T I O N

Physical Sciences

Subject Code: SC786

2003 External Examination Report

General Comments

The paper proved to be a good assessment tool, with a number of candidates achieving excellent marks whilst letting the less able candidate successfully complete sufficient questions in most sections so that they gained enough marks to gain C ratings. There is still a number of candidates scoring less than 10 marks on each criteria, indicating they should not have opted to sit for the external examination.

The award for Criterion 2 is calculated from the input of each marker, who makes an assessment for this criterion. Assessments for this criterion were downgraded due to things like using incorrect units or no units (although this was less of a problem in the chemistry criteria), not indicating direction on vectors, using incorrect symbols for circuit components, not using states in chemical equations and not using established conventions for setting out problems, especially in chemistry.

(Candidates who set out their problems well made far fewer mistakes!)

Candidates should make sure their calculators are set in the 'degree' mode and not the default 'radian' mode.

Criterion 7

Question 1

Well answered except for the details about weight.

Question 2

Although this was quite well answered, it was clear a number of candidates struggle with the concepts of acceleration and velocity eg many candidates said acceleration was 0 and many did not indicate the opposite sign on the value of momentum at points A and C.

Question 3

a) Some candidates were confused about the relative lack of motion of the books before braking and so indicated that, as they moved, a force must have been applied to them.

b) Some candidates confused the weight of the vehicle as being a force that was causing or hindering acceleration.

Question 4

a) Some candidates confused these.

b) Poorly answered, with very few candidates scoring full marks for the simple diagram showing the addition of 2 vectors.

Question 5

a) Many candidates did not show the ammeter in series and voltmeter in parallel.

b) Well answered.

c) The sketch on graph was done well by almost all candidates.

d) This was generally well done and a fairly easy 3 marks.

Question 6

There was evidence in candidates' answers that some candidates were unaware of the correct convention for writing nuclear equations. Common errors included:

- putting the values for 'A' and 'Z' in the opposite places.
- using N rather than n for the symbol for the neutron.
- not using chemical symbols, just names in chemical equations.
-

b) A significant number of candidates failed to read "and one other particle", which led some strange nuclear reactions.

c) This was often left unanswered. Those candidates who attempted it frequently showed an understanding of the physics involved, but a worrying proportion were unable to express their answer clearly and relate it back to the question.

Question 7

Many candidates just explained the concept of a series circuit. This was not enough. Far too many candidates still think electrons flow up to the break in a series circuit so the 61st in the series circuit was blown, causing 15 not to work. Many answered using 2 parallel circuits with 15 and 60 lights respectively. Quite a few chose to leave out the diagram; the word 'may' may have promoted this.

Question 8

Nearly half the candidates who attempted this question showed all the graphs incorrectly as straight lines.

a) For both graphs points corresponding to positions A, B, C and D needed to be carefully plotted. Attention to detail was required in completing the graphs.

b) Well answered.

c) A significant proportion of the candidates did not realise that the potential energy was not affected by friction. On the kinetic energy graph candidates needed to make sure points B, C and D are progressively lower.

Criterion 8

Question 9

Well completed, although candidates had problems including negative acceleration in part b).

Question 10

Well handled.

Question 11

Again candidates had difficulty with the direction of components.

Question 12

Well handled – the problem was similar to those in previous years.

Question 13

Candidates did not deduct background count from initial and final counts. Also many candidates tried to use the decay formula, with little success.

Question 14

Well done.

c) Many candidates did not show directional arrows in correct proportion.

d) Poorly done – many tried to use energy equations for a simple force problem.

Question 15

There was a big variation in the quality of answers. Many did not differentiate clearly between distance and displacement.

Question 16

Many candidates had little understanding of parts (d) and (e). The basic fact that if $s = 0$ then $W = 0$ was not understood by most.

Question 17

This was a very straightforward projectile motion problem and very well done by those who were well prepared. A surprising number of candidates made little or no progress in this question. Many candidates incorrectly think that a projectile stops horizontally as well as vertically at the top of its flight.

Criterion 9

Question 18

This question was generally done well. Common errors included:

- omitting brackets for the aluminium hydroxide
- using inappropriate prefixes, eg dipotassium sulfate
- putting the electrovalency of lead in its formula, ie $Pb(II)I_2$.

Question 19

a) Answered well.

b) Confusion between electron-dot diagram and schematic atomic diagram.

c) Done well, although a number of candidates assigned possible elements instead of using the symbols given.

d&e) Answered well, although atoms and electrons were given a range of emotions eg ‘wanting’, ’desiring’, ‘happy’, etc!!

f) Done reasonably but many candidates failed to point out the importance of the low number of valence electron.

g) Done well.

Question 20

Generally poorly done. Few candidates realised this question required the definition of a compound and why an alloy, with its varying ratio of atoms, does not fit this definition.

Question 21

Reasonable, but unfortunately many candidates gave inadequate answers stating that $CaBr_2(l)$ was ionic and therefore conducted electricity, with no explanation.

Common errors included:

- Stating that the molecules in liquid bromine could not move, rather than that they were uncharged
- Saying that the current was carried by electrons rather than ions.
- Interchanging terms such as atom, ion, and electron.

Question 22

Overall a pleasing number of candidates gained full marks.

a&b) Generally well done.

c) Surprisingly many could not write the empirical formula. The most common mistake made was giving the molecular formula of F rather than G.

d) Disappointing! Several candidates had no idea of the reaction that occurred during the burning of a hydrocarbon.

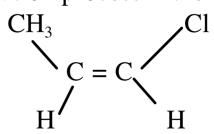
e) (i & ii) Incorrect variations on the chemical used included:- chloride (Cl^-), bromine, fluorine, hydrogen, hydrochloric acid and the hydroxide ion. This led to some very creative equations where balancing was non-existent.

iii) Most recognised this as an addition reaction although a large number wrote addition polymerisation.

Question 23

a) The isomers were reasonably well drawn, however, a number of candidates included the same isomer drawn in a different way.

b) Not well done. Many failed to orientate the molecule so that the repeating units become more obvious. Eg It is easier to show the polymerisation process if the molecule is written as:



rather than CH_3 - CH = CH - Cl

Question 24

a) More than half of the candidates had no idea what the term ‘allotrope’ meant.

b) There are a number of physical properties that are similar in graphite and tin including solid at room temperature, opaque, not soluble in water, grey or silver in colour (although one is dark grey and other silvery grey). However part c) was difficult to answer fully unless the property of electrical conductivity in the solid state was chosen.

c) This part was very disappointing with many giving a list of properties rather than focusing on the bonding. Very few successfully related the difference in bonding to the property mentioned in (b).

Criterion 10

Question 25

a) Done very well by almost all candidates.

b) Most candidates failed to indicate the electrovalency of copper in copper oxide. (It was copper (II).) Many failed to correctly name ammonia/nitrogen trihydride.

Question 26

a) & b) Too many candidates omitted states or gave incorrect ones. Many still do not recognise oxygen gas as diatomic.

c) A significant number of irrelevant or customised answers. 'Titration' is an experimental technique, not a type of reaction.

d) Candidates need to address the question; reference to colour changes of indicator solution served to confuse and was irrelevant. The word 'neutral' appeared often without referring to a pH of 7.

e) Most candidates did well, but wrong answers varied wildly (including polyatomic anions).

Question 27

a) Generally done poorly. Frequently candidates gave the incorrect and unbalanced equation:

$$Na_2SO_3(s) + HNO_3(aq) \rightarrow NaNO_3(aq) + HSO_3(s)$$

A substantial number did not know the formula for nitric acid. Many vague explanations were given, not supported by equations.

b) Attempted less often than a), but generally with better results. Candidates failed to address the fact that the substances were solids. A variety of additives were used but preference is for a sodium or potassium salt to precipitate the silver ion. Many candidates displaced the silver with solid copper. (Did question 31 help?) Candidates should comment that 'no reaction' occurs with $NaNO_3$.

In both parts of this question $NO_3^- \rightarrow NO_2(g)$ was a common, but incorrect response.

Question 28

a) Generally well done. Some silly arithmetic errors were made and some candidates used the atomic number instead of the relative atomic mass.

b) Generally well done. A number of candidates used 14 instead of 28 for the relative mass of nitrogen present.

Question 29

a) A few candidates used 90 g of sodium chloride. Obviously they did not read the question carefully in a stressful situation.

b) Not done particularly well. Candidates multiplied by the volume instead of dividing. Others failed to convert the volume into litres.

Question 30

a) Quite well done. Some candidates made the problem more difficult by converting masses to percentages to begin with. A surprising number gave the empirical formula as H_2C!

b) Generally well done.

Question 31

a) Poorly done. There seems to be a lack of understanding of net ionic equations.

b) Candidates often misunderstood what was required here and instead referred to what the equation stated. Good answers commented on things such as colour change, new precipitate formed or heat generated. Saying 'copper dissolves' is not acceptable.

c) Quite well done. Some candidates calculated the mass of silver nitrate rather than silver. The most common mistake was the failure to take the mole ratio into account. A common mistake also was converting grams to kilograms.

d) Surprisingly well done. Candidates seemed to have a good understanding of limiting reactants.

Question 32

a) Well done well.

b) Done reasonably well. A common error included multiplying the mass by Avogadro's Number and, more commonly, candidates failed to use the exponent key on their calculator correctly.

c) Done poorly. Most considered the ratio as being 5:2 (which is the ratio of atoms in 1 molecule of each gas) instead of 5:1 (the ratio of atoms of each gas in the balloons).

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SOLUTIONS TO 2003 PHYSICAL SCIENCES EXAM

Criterion 7

1. .

time	second	scalar
weight	newton	vector
resistance	ohm	scalar

2.

a)

i. It stays the same.

ii. It stays the same.

iii. It decreases from B to C.

b) Zero velocity in *any* direction.
Acceleration is 9.8 m s^{-2}, vertically downwards.

c) Same in magnitude, but opposite in direction at these points. (Up at A and down at C.)

3.

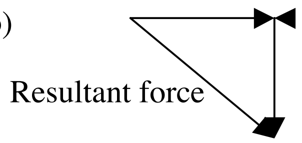
a) Newton's First Law, *The Law of Inertia*, is illustrated in this observation. When the car suddenly brakes the pile of books tend to keep moving at constant velocity in the direction that the car was moving. There is insufficient friction between the books and the seat to keep the books stationary.

b) Newton's Second Law is illustrated by this observation. (a =F/m) Because the mass of the car is *very* much less than the mass of the truck, the ratio of resultant force F to mass m for both vehicles is greater for the car.

4.

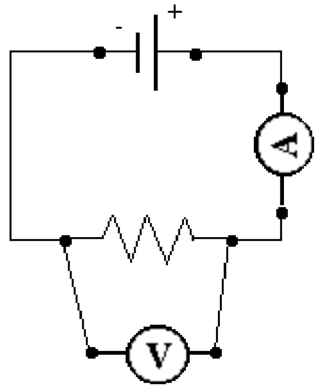
a) (i) For "just dropped", diagram B, for "moving at terminal velocity", (ii) diagram A.

b)



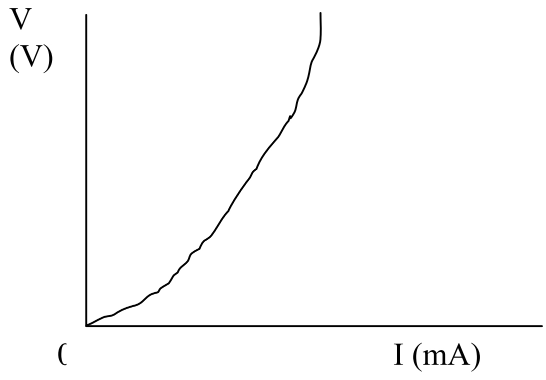
5.

a)



b) An ohmic conductor is one for which the ratio of potential difference applied to it divided by the current passing through it is a constant.

c)



(This is *a non-linear* graph.)

d) The resistance of a conductor can be obtained from the gradient of the V~I graph. If the conductor is ohmic, the resistance will be constant. For the resistance R to be in ohms, R (in ohms) = V(in volts) divided by I (in amperes)

6.

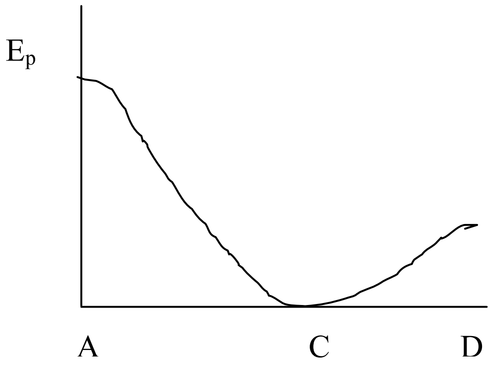
a) ${}^{99}_{43}Tc + {}^{1}_{0}n \rightarrow {}^{100}_{43}Tc$

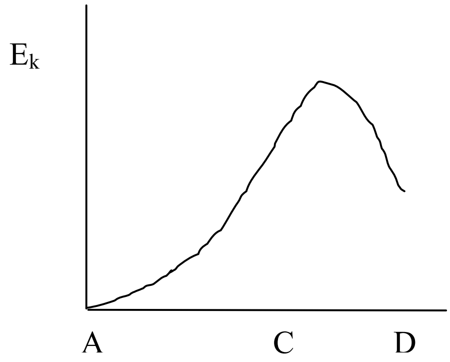
b) ${}^{100}_{43}Tc \rightarrow {}^{100}_{44}Ru + {}^{0}_{-1}e$

c) As the Tc-99 becomes Tc-100, simultaneously Tc-100 decays to form Ru-100 by beta particle emission. The half lives of these three radioisotopes are not identical and so the differing rates of formation and decay cause the ratios of the radioisotopes to constantly change.

7. The most likely scenario involves 5 strands of 15 globes, with each strand of 15 globes being in parallel with the other 4 strands, and the 15 globes in the strand being in series with one another. If a globe in a strand "dies" all 14 other globes in that strand will not light. If there is a defect in a branch containing 15 globes in series, then no current passes through that branch, thus preventing any globe in that branch from being operational.

8. *Please note that some disagreement exists on how best this question should be answered.*





b) Frictional resistance causes energy to be converted into heat and sound as the car moves from A to D. Thus the total energy, E_k plus E_p, of the cart decreases.

c) (i) The E_p graph is the same shape as the one above but does not rise as high at D.
(ii) The E_k graph is the same shape as the one above but does not rise as high at C or D.

Criterion 8

9.

a) a= (v-u)/t = (0-15.0)/2.50 = -6.00 m s^{-2} North. The deceleration is 6.00 m s^{-2} North.

b) s= ut + _at^2 = 15.0 x 2.5 +_(-6.00)$(2.5)^2$ m =18.8 m. This is the required distance travelled by the car.

10. 120 A = 120 C s^{-1}. In the 2.0 s, 240 C of charge passes. V=E/Q = (5760/240) = 24.0 V. Thus the required voltage is 24.0 V.

11.

a) s = ut + _ at^2 = 10.0 x 4.20 + _ 9.8x4.20^2 = 128.4 m

b) v = u + at = 10.0 + 9.8 x 4.2 = 51.2 m s^{-1}vertically downwards

12. *Assume "away" means to the right*. If this is an isolated system, the Law of Conservation of Momentum applies. The total momentum of the system is conserved.

Total momentum before the event = total momentum after the event

0 = 56.0 x 2.30 + 65.0v

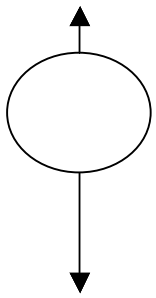
v = -56.0 x (2.30/65)

v = -1.98 m s^{-1}

After the "explosion", velocity of the other skater is 1.98 m s^{-1} to the left.

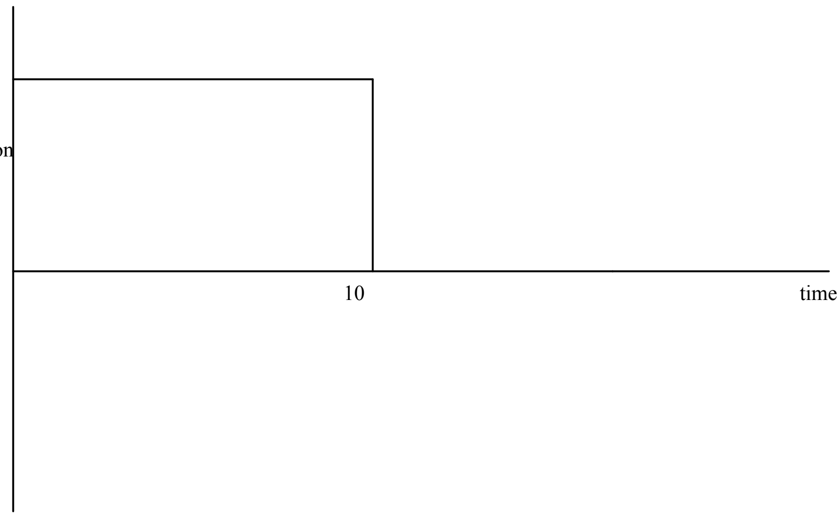
13. Actual count rate = (360-24) = 336 counts/minute at the beginning, and (45 -24) = 21 counts/minute at the end.
336/16 = 21. This is 4 half lives, or (4 x 2.35) days = 9.40 days.

14. a) $a = (v^2 - u^2)/2s = (3.73^2 - 1.80^{2)}/(2 \times 1.40) = 3.81$ m s^{-2} down
b) $\underline{\mathbf{F}} = m\underline{\mathbf{a}}$ = (4.00 x 3.81) N = 15.2 N down. This is the required resultant force.
c)



d. $\underline{\mathbf{F}} = \underline{\mathbf{F_r}} + \underline{\mathbf{W}}$
$F_r = W - F$
= (4.0 x 9.8 – 15.2) N up
= 24.0 N up

15. (a)



b. The areas under graph for first 10 s of motion cancel out giving zero *displacement* for this time but a total distance of 150 metres travelled.
c. $v_{av} = s/t$ = (150/20) m s^{-1} East = 7.5 m s^{-1} East. (The displacement is the area under the graph for the first 20 s of motion.)

16.
a. Assuming that the floor does not move: W =Fs = 600 x 0= 0 J
b. W = Fs = (600 x 0.45) = 270 J

c. P = W/t = 270/1.00 = 270 W
d. Chemical energy supplied = (5 x 270) J = 1 350 J
e. P = W/t = (80/100)(1 035/1.00) = 1 080 W

17. *Assume that the long jumper is moving to the right.*

a. Horizontal component = (8.0 x cos 20^0) = 7.52 m s^{-1} to the right. Vertical component = (8.0 x sin 20^0) = 2.74 m s^{-1} up.
b. In the vertical direction, v = u + at
   0 = 2.74 - 9.8t
   t = 2.74/9.8 = 0.28 s.
   Therefore, time of flight is twice as great, or 0.559 s
c. In the horizontal direction, s = ut = 7.52 x 0.559 = 4.21 m
d. At the highest point her velocity is 7.52 m s^{-1} to the right, as there is no velocity in the vertical direction.

Criterion 9

18. Missing in order from top to bottom are potassium sulfate, $Al(OH)_3$, sodium phosphate, and PbI_2

19.

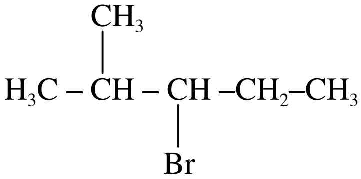
a) .(i) -1, (ii) The halogen group, or Group 17 (VII)
b) Y:Y or Y **-** Y
c) W_2X
d) An atom of W has one more electron than a noble gas atom. In chemical reactions where ionic bonds are formed, W becomes *isoelectronic* with a noble gas atom, which confers stability on it.
e) Z already has the electronic structure of a noble gas atom. There is thus little or no tendency to gain/lose electrons to become isoelectronic with a noble gas atom. This is energetically unfavourable.
f) X is possibly an alkali metal. Reactive metals atoms have few electrons (1, or 2) in their outer shells and tend to form positive ions by losing electrons in chemical reactions.
g) X and Y are non-metallic atoms. When they react they would form a covalent molecular, or a covalent network compound. These bonds are formed by *sharing* electrons rather than by the *loss* or *gain* of electrons.

20.
Bronze is a *mixture* of copper and tin and thus is not a chemical *compound* of these two elements. In effect, bronze is a *solid solution*. No *chemical* reaction takes place between the copper and tin atoms. Atoms of one element are trapped in the lattice of the other. No *chemical formula* can be written for bronze as its constitution (physical properties) vary according to the percentages of tin and copper present.

21.
Calcium bromide is an *ionic* compound, and when molten, the positive calcium and negative bromide ions are able to move under the action of electrical forces. These ions are no longer trapped in the crystalline lattice. Liquid bromine contains no ions to

migrate under the action of electrical forces. Its diatomic molecules have a zero net charge.

22. a) E is but-1-ene, G is 1,2-dichlorobutane



b) Molecular formula is $C_4H_8Cl_2$, empirical formula is C_2H_4Cl

c) $C_4H_8(g) + 6O_2(g) \rightarrow 4CO_2(g) + 4H_2O(g)$

d) (i) Chemical used is chlorine gas.

(ii) $C_4H_8(g) + Cl_2(g) \rightarrow C_4H_8Cl_2(g)$

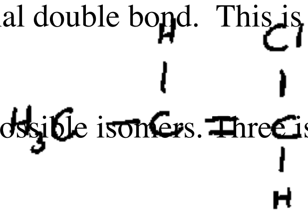
Using semi-structural formulae:

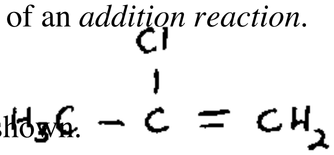
$H_2C = CHCH_2CH_3 + Cl_2 \rightarrow H_2ClCCHClCH_2CH_3$

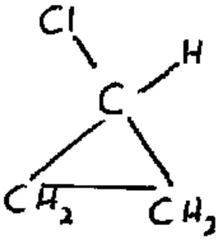
(iii) In this reaction, the double bond opens, and each chlorine atom from the break up of the $Cl_2(g)$ molecule bonds to one of the two carbon atoms forming the original double bond. This is an example of an *addition reaction.*

23 (a)

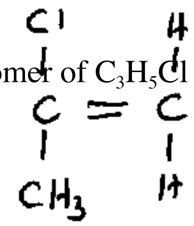
There are 4 possible isomers. Three isomers are shown.



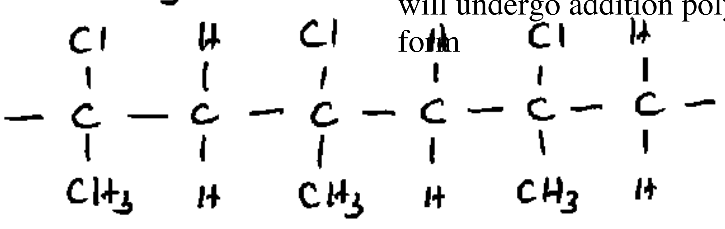




(b) An isomer of C_3H_5Cl represented by



will undergo addition polymerisation to form



24.

a) An allotrope is a form of an element with the same ***chemical*** properties but different ***physical*** properties due to differences in crystalline structure.
b) Both are reasonable conductors of electricity (tin is better than graphite).
c) Tin consists of a metallic structure of tin atoms, whilst graphite consists of a covalent network structure of carbon atoms arranged in hexagonal planar layers. Tin's electrical conductivity arises from delocalised electrons, which are free to move throughout the lattice, whilst the electrical conductivity of graphite arises from an electron in each carbon atom not being involved in chemical bonding between carbon atoms and consequently being mobile within a layer.

Criterion 10

25.

a) $3CuO(s) + 2NH_3(g) \rightarrow N_2(g) + 3H_20(g) +3Cu(s)$
b) The two reactants are solid copper (II) oxide and ammonia gas.

26.

a) $4Na\ (s) + O_2(g) \rightarrow 2Na_2O(s)$
b) $Na_2O(s) + H_20(l) \rightarrow 2NaOH(aq)$
c) Acid-base neutralisation.
d) As the hydrochloric acid is continually added to sodium hydroxide solution, the pH falls from above 7, (sodium hydroxide solution is an alkaline solution), passes through 7, when at pH 7 a neutral solution is obtained, and then falls below 7 as the solution becomes increasingly acidic.
e) Potassium, rubidium, caesium, or lithium.

27.

a) When nitric acid is added to both samples, there will be an effervescent reaction with sodium sulfite, but not with sodium nitrate. In the reaction that occurs, a pungent, colourless, acidic gas, sulfur dioxide, will be evolved.

$$Na_2SO_3(s) + 2HNO_3(aq) \rightarrow 2NaNO_3(aq) + H_20(l) + SO_2(g)$$

b) Add dilute hydrochloric acid to solutions of both solids. There will be no reaction between the hydrochloric acid and the sodium nitrate solution. However, the silver nitrate solution will react to form a dense white precipitate of silver chloride, AgCl(s).

$$AgNO_3(aq) + HCl(aq) \rightarrow AgCl(s) + HNO_3(aq)$$

28.

a. $M((NH_4)_2SO_4) = 2x18.0 + 32.1 +64.0 = 132.1\ g\ mol^{-1}$

b. % nitrogen = 100(28/132.1) = 21.2%

29.

a) $M(NaCl) = (23.0 + 35.5)\ g\ mol^{-1} = 58.5\ g\ mol^{-1}$
$n(NaCl) = m/M = 0.90/58.5 = 0.0154\ mol$
b. $C = n/V = 0.0154/0.10 = 0.154\ M$

30.

a) Mass of hydrogen = 2.30 – 1.97 = 0.33 g

$$n(C):n(H) = (1.97/12.0):(0.33/1.00) = 0.1642:0.33 = 1:2$$

Thus the required empirical formula is C_1H_2
$M(C_1H_2) = 14.0\ g\ mol^{-1}$
Thus there are 70/14 times as many atoms of each element in the molecular formula as in the empirical formula. The required molecular formula is C_5H_{10}

31.

a) $2Ag^+(aq) + Cu(s) \rightarrow Cu^{2+}(aq) + 2Ag(s)$ (The nitrate ions are spectator ions.)
b) Silvery coloured crystals appear on the surface of the copper. The solutions would turn blue due to the formation of $Cu^{2+}(aq)$ ions.
c) The equation reveals that 1 mol Cu produces 2 mol Ag
2.00 g of Cu = (2.00/63.5) mol = 0.0315 mol of Cu
0.0630 mol of silver is produced which is (0.063x107.9) g = 6.80 g
d) The limiting reactant is the amount of silver nitrate present. If this is consumed then further addition of copper is useless as there are no silver ions left to be reduced to form silver atoms.

32.

a) $M(CH_4) = 16.0\ g\ mol^{-1}$ $M(O_2) = 32.0\ g\ mol^{-1}$ Thus 32.0 g of oxygen and methane are both present.
b) 1 mol of molecules = 6.023×10^{23} molecules. In the methane balloon there are 1.204×10^{24} molecules and in the oxygen balloon there are 6.023×10^{23} molecules.
c) In each methane molecule there are 5 atoms whilst there are only 2 in each oxygen molecule. Thus the required ratio is $(5 \times 1.20 \times 10^{24}):(2 \times 6.023 \times 10^{23}) = 5:1$