Physical Sciences 5C

Subject Code: PSC5C

2005 External Examination Report

Part 1 of the Physical Sciences examination was used to trial marking of candidate scripts using computer technology. The completed papers were scanned. For each question, 2 or 3 markers used an agreed marking scheme as they marked all 1211 responses. In addition, 15% of the answers were double-marked to assess the uniformity of marking between examiners. The markers were pleased with this technique and showed good consistency in the marking.

Poor mathematical skills were evident in quite a number of parts of the paper. It is disappointing that a few candidates choose not to show the steps used in arriving at their answers. In these cases, if a minor mathematical error occurs that result in an incorrect answer, no credit can be given. Even if the phrase 'show calculations' is not used in the question, it is wise to show them in every case.

Communication skills of the candidates were varied greatly, ranging from clear and concise answers that were well presented to 'scrappy' work showing little logic in approach. Whilst care is taken by markers, candidates disadvantage themselves if they are careless in their presentation of responses.

The majority of candidates answered both Chemistry criteria very well, with attention to detail in the responses being important in differentiating the 'A' candidate. Questions requiring explanations are always discriminating, so candidates are encouraged to practise this type of question in their revision programme.

This is the final year of offering optional parts in the syllabus so candidates in future years will have to answer all parts of the paper. Minor changes to the syllabus will see the qualitative component of the course disappearing and a reduction in the amount of electricity taught.

PART 1 – Criteria 6 and 7

Unfortunately the incorrect unit for velocity was used in the questions throughout this part of the paper. It did not appear to disadvantage candidates, with a few candidates pointing out the mistake to the examiners!

Question 1 - *Criterion 7*

(a) This straightforward question was well done by most candidates.

(b) In Part (i), a significant number of candidates forgot to include direction, despite being reminded in the question. Mathematical errors were numerous, with markers regularly being told 12 x 6 = 60, or 36 or 18!! The term 'constant velocity' was either ignored or was not understood.

Part (ii) required candidates to work out the acceleration prior to using one of the equations of motion that include 's'. A large number of candidates made errors. Apart from the numerous candidates who made mathematical errors as they manipulated equations, some candidates ignored the '-' sign of the acceleration, some used the acceleration of the initial motion of the car rather than its deceleration and some candidates became confused by the variety of time intervals that were considered in the question.

Question 2 - *Criterion 7*

Those candidates who caught onto the idea in this question did it well, but many failed to get started. Too many gave the weight of the skydiver as 70 kg and many did not recognize the vector nature of force.

Question 3 - *Criterion 7*

Poorly answered. Surprisingly a large number of candidates do not have the basic $v \sim t$ and $a \sim t$ graphs in their information booklets for this straightforward situation. Too often the speed ~ time graph was given instead of the requested v ~ t graph, or a parabola of some sort. In Part (b), the acceleration of the ball often changed direction partway through the flight of the ball!!
It is always 9.8 m s^{-2} down. There were a surprising number of people who answered Part (a) correctly, but made errors in Part (b). The shading of the area to represent the displacement of the ball was well done.

The presentation of the graphs was generally poor, with direction not usually indicated, axes being poorly labelled and the actual graphs carelessly drawn.

Question 4 - *Criterion 7*

This question was generally well done although it showed up some disappointing algebraic skills. A very common error was: $80\,v = 60$

$\therefore \quad v = 1.33$

Question 5 – *Criterion 7*

a) Well done. Some candidates gave both vertical and horizontal accelerations in their answer but most just put 9.8 m s^{-2} down to get full marks. Units were sometimes omitted or incorrect.

b) This was again done well, with a variety of satisfactory techniques being used to answer the question correctly. Sometimes it was difficult to follow the technique used, making it hard to mark, eg finding a final vertical velocity after falling 2.75 m then substituting into t=(v-u)/a.

c) Again this was well done. The most common mistake was substituting in a = 9.8 m s^{-2} rather than 0 m s^{-2}.

Question 6 - *Criterion 7*

a) Most candidates recognised this as a 'Newton 1' situation. The usual errors associated with using Newton 1 in explanations were present – Newton's Law causing the parcels to fly through the air, or throwing the parcel forward. The best answers were the simple answers - they used the words 'continue to move' when discussing the motion of the parcel after the car braked, and they related their response to the question rather than just give a statement of Newton's First Law.

b) Generally well done but the question produced the unusual answers of Sally 'walking up and down the hill' or 'backwards and forwards'.

c) Well answered, with most candidates listing some of the forces acting on the car. They then proceeded to explain that the forces on the car must be balanced, but unfortunately many candidates seem unaware that equal forces are not necessarily balanced forces

Candidates often forgot to include the corrected statement in their answer. Just the inclusion of the word unbalanced to describe the forces was the best response.

Question 7 - *Criterion 6*

Well done by almost all candidates.

Well done by most. Some, however, interpreted the question superficially and thought the answer was simply '4 km'. The distance travelled in the 2 minutes 17 secs at 30.6 m s^{-1} was required.

This was reasonably well answered, with candidates using a variety of ways of arriving at a reasonable answer. Working out that the speedo was 4.6% out, which is <10%, meaning that there is compliance with the regulation, was one approach.

Satisfactory, although not many candidates used figures to support their discussion.

PART 2 – Criteria 6 and 8)

Overall many candidates did very well in this section. In general, diagrams were clear and expression of written answers was good. However, more than a dozen different spellings of malleability were noted.

Question 8 - *Criterion 8*

Generally well done. Despite the names and formulae of cations and anions being accessible to candidates on the formula sheet, some common errors included:

$Ba(MnO_4)_2$ was named as barium manganese oxide, not barium permanganate
Sodium thiosulfate's formula was written as Na_2SO_4 rather than $Na_2S_2O_3$

Mg_3N_2 was incorrectly called magnesium nitrite
Ammonium phosphate was written as $(NH_4)_4PO_4$, rather than $(NH_4)_3PO_4$

The unnecessary use of 'di' and 'tri' prefixes was relatively common.

Question 9 – *Criterion 8*

Satisfactory. A lot of candidates mentioned that atomic number = no. of electrons; this was not accepted unless the answer included the correct definition as the no. of protons. Some confused the two terms – atomic number and mass number. Discussion of integers or fractions to distinguish the two was common but irrelevant.

Question 10 – *Criterion 8*

a) Generally well done although some diagrams were unnecessarily complicated with colour, symbol keys and circles around individual elements. Others did not write in 'H' - either indicating a lack of understanding or laziness - which resulted in a loss of marks. A significant number confused propane with pentane.

b) Again well answered, although many simply wrote 'covalent' instead of distinguishing between 'molecular' and 'network'. Circular arguments (sulfur because it is covalent molecular) were not awarded full marks, unless justified.

Question 11 – *Criterion 8*

Generally very well done although some attempted to identify each element; this was not required.

Question 12 – *Criterion 8*

Several candidates did not attempt this question. Of those who did, the majority obtained full marks. However, a significant number failed to ensure that each carbon atom had 4 bonds.

Question 13 – *Criterion 8*

The first two compounds presented little problem. The Cl atom was often ignored in the last compound and many assumed a 4-carbon chain rather than a 5-carbon chain.

Question 14 – *Criterion 8*

Very well done indicating a good application of properties of compounds by most candidates. The only difficulty was those candidates who assumed (c) referred to Y rather than the compound formed by elements X and Z. The fact that Y was between X and Z in the table and that Y could have been the compound required may have caused the confusion.

Question 15 – *Criterion 8*

Some candidates mixed up the mass number and the atomic number, while many were unable to cope with a particle with 1 proton, 1 neutron and 0 electrons.

Question 16 – *Criterion 8*

a) Very well done

b) Surprisingly answers to this question often failed to adequately explain how the delocalised electrons accounted for the property chosen.

Question 17 – *Criterion 6*

If these questions were attempted, they were done well.

a) Most candidates chose electrical conductivity as a solid and malleability as the properties to be tested. The only discriminating factor in candidate responses was the reporting of the expected result, with candidates being required to report on the effect of the test on both a metal and galena.

Melting point and conductivity in the molten state were not satisfactory answers because this was beyond the range of what could be done in a school laboratory and the range of melting points overlap for metals and ionic substances.

Quite a few candidates reacted the galena with HCl. To gain full marks they really needed to compare the two gases that were possibly given off i.e. state that hydrogen sulfide was smelly and hydrogen would give a positive pop test. Most candidates who used this technique wrongly assumed that all metals react with HCl to produce hydrogen. Consequently there were some very poor answers that gained no marks.

Some other approaches that were awarded no marks include:

- Suggesting dissolving the sample in water on the assumption that all ionic solids were soluble and metals were not - PbS is insoluble and some metals react with water.
- Testing the electrical conductivity of aqueous solution since it was unlikely that with "normal" school equipment the candidate would get a conductivity reading.

b) Many candidates gave a number of properties desirable in a wire or in piping, hoping that one would be suitable. The candidates only gained full marks if they could relate the desired property to the function of the wire or pipe.

In Part (i) most pointed out that the function of a copper wire was to conduct electricity and so the plastic would have to conduct.

The greatest misconception in Part (ii) was that many believed that plastic would have to be a good conductor of heat so that the water would remain hot when in actual fact the reverse is the case. A number pointed out that in fact plastics would be superior because they were insulators. The most common answer was that the plastic would have to have a high mp so that it could carry hot water without melting. (To most candidates, it seems like anything over 100 degrees is a high temperature!).

A number of candidates talked about thermosetting and thermoplastics that are no longer in the course. This information was not relevant to the question and these answers were poorly done.

PART 3 – Criteria 6 and 9

The answers were of a pleasing standard with candidates showing understanding of all concepts in this section. Parts involving calculations were generally done better than those requiring explanations where applying concepts was involved.

In calculations, the following lack of skills applied to the whole cohort:

- carelessness in giving correct units (correct in one part, then wrong in the next section)
- errors in simple arithmetic (a missing zero or completely wrong subtractions)
- a significant number of candidates could not calculate the square of velocity even when the formula was quoted correctly
- directions were given even for scalars like energy, including work done
- a small number of candidates had trouble with calculating 10%
- carelessness in spelling was common, even when the words were supplied in the question.

In the optional part of the paper in Criterion 9, the 'radioactivity' question (Question 23), was far more popular than the 'electricity' question.

Question18 – *Criterion 9*

This was by far the most poorly done question. Candidates were, as a group, unable to relate the concepts of energy to give an overall conclusion. Most candidates could quote the Law of Conservation of Energy, but had trouble with or completely failed to make reference to the increase in mass. Those who did notice the increase recognised both GPE and KE increased, but failed to understand that work had to be done on the increased mass on the way back up and they suggested the snowball would launch itself into the air. No one commented on the unreasonableness of this. Many candidates quoted the Law of Conservation of Momentum and focused entirely on the product of mass and velocity, even though it was inappropriate here; others attempted to relate force and acceleration to the increased mass.

Credit was given if it was indicated that the snowball would return to its original position if the mass had been constant in the absence of energy loss as a result of friction. Marks were awarded at *any* reasonable attempt to explain the effect the added mass might have on Basil's plight.

Question 19 – *Criterion 9*

Generally done very well, although many were unable to square velocity even when quoting the KE formula correctly. A small number of candidates converted mass into grams and another small number confused the Mega with the Kilo prefix. In their attempts to find the force of friction, quite a few candidates were unable to calculate acceleration in Part (e) when they used the equations of motion rather than the work done (energy loss) by friction.

Question 20 – *Criterion 9*

Parts (a), (b) and (c) were done well, but Newtons were often quoted rather than Joules (the latter often quoted as ‘j’) and squaring of velocity in KE was again a problem. Part (d) was significantly more difficult, with only a small number of candidates able to account for both the 10% energy loss *and* account for the residual KE at ‘C’. There was confusion about which energy the 10% loss applied to and many candidates, when calculating the ‘total’ energy, added the GPE at ‘A’ to the KE at ‘B’.

Disturbingly, many candidates were happy to accept answers higher than 5 m and others simply gauged their answers by the height in the diagram.

Question 21 – *Criterion 9*

Parts (a) and (b) were generally done well. Quite a few candidates attempted to use involved processes incorporating the equations of motion to answer this question rather than just calculating the work done in opposing the force of gravity using work done = ΔE = mgh. Units were a challenge and direction was often ‘supplied’ just in case! In part (b), many used the formula for momentum rather than power.

Part (c) was not done well. Many candidates only quoted the difference between displacement and distance rather than focusing on the fact that the applied force had to have the same direction as the displacement. Quite a few gave the reason that it was because it made the Mathematics easier!

Question 22 - *Criterion 9*

a) The circuit diagram was generally well drawn with most candidates getting full marks. The most common error was not labelling all of the components.

b) Well done, Many incorrectly used I = V/R with R = 600? Part (ii) was also well done with few errors being made.

c) Well done. Use of the parallel resistor formula was an occasional error.

Question 23 – *Criterion 9*

a) Well done.

b) This question was not well understood. Many thought that the data variations are due to randomness and/or background variations whilst not mentioning the varying thickness of the sheet blocking the beta particles.

c) Well done. Many confused Thallium with Thorium.

d) Nearly all recognised that there were three half lives. Too many lost a mark for arriving at 12.5 g ie the third value in the series 50 g →25 g→12.5 g rather than 3 half lives.

Question 24 – *Criterion 6*

Candidates had good knowledge of the properties of radiation and radioactive materials but generally poor understanding. Those who chose the electricity questions gave superior answers. Quite a few candidates answered one electricity and one radioactivity question. Doing (b) and (c) or (b) and (d) were popular choices; it was apparent from the second combination that a lot of the candidates had used their "everyday" notions of electricity to answer option (d).

Part (a) was generally done quite poorly. Many candidates felt that the prime requirement was for a source to have a *short half-life*. There seemed to be a misunderstanding as to how the radioactive source was being used. The diagram appeared to lead the candidates to believe that the source was being sucked into the syringe. A common incorrect answer suggested the syringe would become radioactive but, after several half-lives, the radiation would be down to safe levels.

Few candidates really distinguished between radiation and radioactivity or had much notion of how something could be made radioactive. A number of candidates said that there would be no risk otherwise the manufacturers would not be allowed to do it!

(b) Generally well done. Candidates mostly just listed relevant properties.

(c) Very well done. It was easy for most candidates. A small number confused the names for parallel and series in (i) but got the rest correct.

(d) Part (i) was generally well done. Most candidates had a clear notion of needing a continuous circuit or the need to "earth" the circuit. There were some interesting variations though. 'Birds don't conduct electricity….doh!'; 'Birds have insulating pads on their feet'; 'Birds stand one foot so that the electricity doesn't pass through them'; 'They have learned how to land on the line in a certain way'. Part (ii) produced lots of very vague and confused answers. Only a fraction of candidates answered this question clearly and to the point.

PART 4 – Criteria 6 and 10

The straightforward nature of the questions meant that many candidates did very well in this section of the paper. The basic concepts examined seem well understood.

As mentioned earlier some candidates failed to answer the Criterion 6 question, due to the poor design of the paper.

In the optional part of this section the questions based on the qualitative chemistry part of the syllabus was far more popular. A small number of candidates failed to follow instructions and answered **both** optional questions.

In answering questions candidates often left out reasons, even though candidates were occasionally asked to 'show reasons'.

Question 25 – *Criterion 10*

Reasonably well answered, though converting from words to symbols and then balancing symbolic equations was a challenge for many.

Question 26 – *Criterion 10*

When the products were correctly identified, many candidates had problems in identifying the alkene and balancing the equation.

Question 27 – *Criterion 10*

Well answered, although many candidates did not correctly identify the units for molar mass.

Question 28 – *Criterion 10*

Well answered.

Question 29 – *Criterion 10*

The working to obtain the answer was often poorly shown. Too many candidates required a volume for the concentrated solution that was greater than the volume of the dilute solution.

Question 30 – *Criterion 10*

Well answered.

Question 31 – *Criterion 10*

The required **ionic** equation for the formation of $BaCO_3$(s) was often poorly done or not attempted.

Question 32 – *Criterion 10*

Not popular, but generally well done by those who attempted it.

Question 33 – *Criterion 6*

Generally well answered. A neutral solution cannot neutralise a basic solution. There was a lot of imprecise language in answers. Many candidates showed confusion between the degree of dissociation and the degree of concentration, failing to note in particular that "weak" is a technical term.

All correspondence should be addressed to:
Tasmanian Qualifications Authority
PO Box 147, Sandy Bay 7006
Ph: (03) 6233 6364 Fax: (03) 6224 0175
Email: reception@tqa.tas.gov.au
Internet: http://www.tqa.tas.gov.au

SUGGESTED SOLUTIONS TO PSC5C EXAM 2005

Part 1

Question 1

a. $a = (v-u)/t = (12.0 – 0)/4.00$ m s^{-2} east = 3.00 m s^{-2} east

b.

i. $s = ut + \_at^2 = (12.0 \times 6.00 + 0)$ m = 72.0 m east

ii. $a = (-12.0/3.5)$ m s^{-2} east. $\therefore s = ut + \_at^2 = [(12.0 \times 3.5) + \{\_ \times – (12.0/3.5) \times 3.5^2\}]$ m = (42.0 -21.0) m = 21.0 m east

Question 2

c. **W** = m**g** = (70.0 x 9.80) N_ = 686 N_

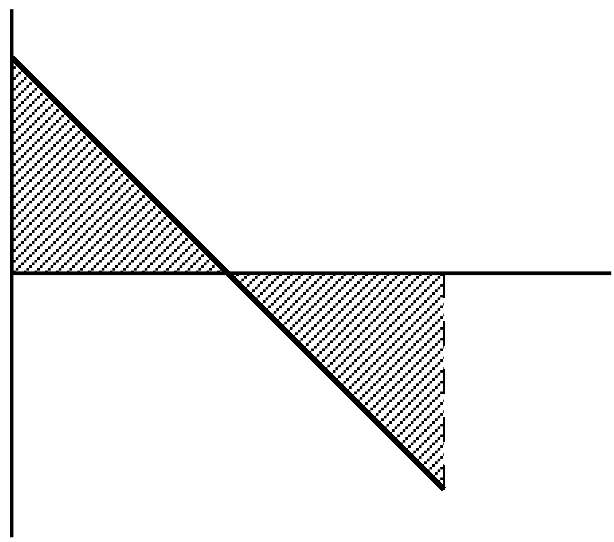
d. 686 N_ as there is no *resultant* force acting on him.

e. The *resultant* force acting on the sky diver is still the same (0), so air resistance still acts on him with an upwards force of 686 N. *(Newton's Second Law of Motion.)*

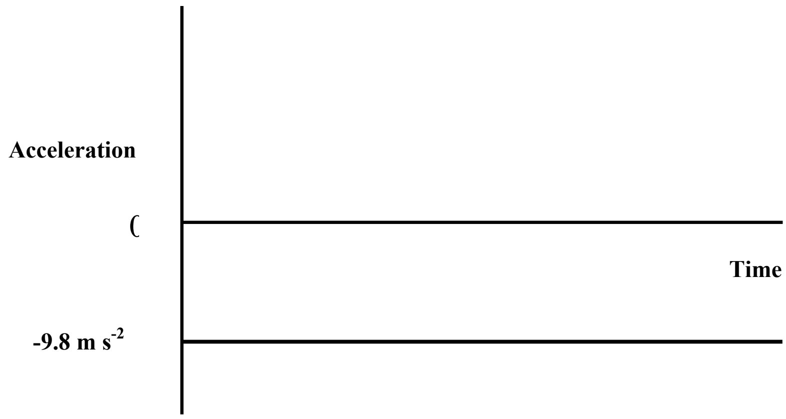
Question 3

a.

i. .



Displacement = area under graph = 0, as the 2 shaded areas cancel when added.



Question 4

Assuming that this is a closed system, the law of conservation of momentum applies.
∴Total momentum before ball is caught = Total momentum after ball is caught

∴60.0 x 0 + 20.0 x 3.00 = 80.0 x v

∴v = 60.0/80.0

∴v = 0.750 m s^{-1}

∴The velocity of Jocko and the ball, just after he catches it, is 0.750 m s^{-1}→ (to the right)

Question 5

a. 9.80 m s^{-2}_

b. In the *vertical* direction, using s = ut + _ at^2

∴2.75 = 0 + _9.80t^2

∴ t^2 = 2.79/4.9

∴ t = 0.749 s

c. In the *horizontal* direction:

s = ut + _at^2

∴s = (40.0 x 0.749) m ←

∴s = 30.0 m ←

As the width of the trucks is only 20.0 m the stunt rider clears the trucks by a margin of 10.0 m.

Question 6

a. If the car suddenly stops, the parcels tend to keep moving with the same velocity in their original direction of motion. (*Newton's First Law of Motion.*) Thus unless the parcels are secured, there is the risk of injury to the occupants inside the car.

b) Sally's *average speed* is her distance travelled/time taken = (10 0/5.00) km h^{-1} = 2.00 km h^{-1}. Sally's *average velocity* is zero because her *displacement* is zero as he returns to her starting point. (Average velocity = displacement/time taken.)

c) The statement should read, *"A car is travelling at a constant velocity. Therefore, there is no resultant force acting on it.*" If the car is travelling at constant velocity, it is not accelerating and consequently there is no *resultant* (unbalanced, net) force acting on it. *(Newton's Second Law of Motion.)* The vector sum of all the forces acting on the car is zero.

Question 7

a. 110.0 km h^{-1} = (110 x 1000)/(60 x 60) m s^{-1} = 30.6 m s^{-1}

b. 2 minutes 17.0 seconds = 137 s

$s = ut + \_at^2$

s = (30.6 x 137 + 0) m

∴= 4 192.2 m

∴= 4.19 km

c. 4.00 km ± 10% of 4.00 km = a range of 3.60 to 4.40 km

Thus the speedometer complies with the prescribed Australian standard. (The difference between the actual speed and that measured by the speedometer is about 4.5%.)

d. Motorists should not be penalised if their speed lies within a 10% range of that detected by the speed camera when they are travelling above 40 km h^{-1}. This is because a car's speedometer is not necessarily sufficiently accurate to measure the car's speed to greater accuracy than ± 10%. If a driver reads the 110 km h^{-1} on the speedometer, he/she could be travelling at 121 km h^{-1}. He/she will then be caught even though he/she thought their speed was not above the speed limit.

PART 2

Question 8

Name of compound	**Formula**
potassium chloride	KCl
barium permanganate	$Ba(MnO_4)_2$
sodium thiosulfate	$Na_2S_2O_3$
magnesium nitride	Mg_3N_2
ammonium phosphate	$(NH_4)_3PO_4$

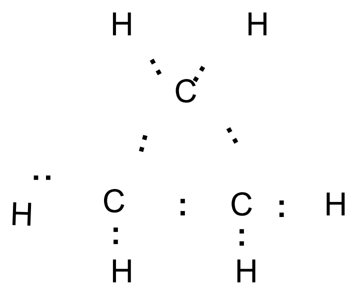
Question 9

The *atomic number* of an element is the number of protons in the nucleus of an atom of that element. All atoms of the same element have the same number of protons in their nuclei. The *mass number* is the number of nucleons (protons plus neutrons) present in the nucleus. This can vary in number as the number of neutrons changes according to the particular isotope considered.

Question 10

a.

Cyclopropane C_3H_6



Ethyne (acetylene) C_2H_2

H:C ::: C:H

b.

Substance	Bonding type (structure) at room temperature
iron	metallic
sulfur	covalent molecular
magnesium chloride	ionic
diamond	covalent network

Of the above, *sulfur* is the only covalent molecular solid. (The other substances listed have strong bonds between the atoms, or between the ions, as in the case of magnesium chloride.) The weak intermolecular forces in sulfur cause it to melt at a much lower temperature than the other 3 substances. Thus sulfur would have the lowest melting point.

Question 11

SYMBOL	ELECTRONIC STRUCTURE	SYMBOL	ELECTRONIC STRUCTURE	COMPOUND
A	2,1	B	2,6	A_2B
C	2,8,3	D	2,7	CD_3
E	2,8,8,2	F	2,8,6	EF
G	2,8,8, 1	H	2,8	No reaction likely

Question 12

1-chloropropene

```
H   H
|   |
C = C – CH3
|
Cl
```

3-chloroprop-1-ene

```
H   H
|   |
C = C – CH2
|       |
H       Cl
```

(Other options are 2-chloropropene and chlorocyclopropane)

Question 13

Chemical name of compound	Structural formula of compound

3,3 dimethylpentane	<pre> CH3
	            |
	CH3-CH2-C-CH-CH2
	            |
	            CH3</pre>

<table>
<tr><td>1,2-dibromocyclobutane</td><td>H   H
| |
H _ C _ C _ H
| |
H _ C_ C _ H
| |
Br Br</td></tr>
<tr><td>2-chloro-3-methylpent-2-ene</td><td>CH_3-C=CCl-CH_3
|
CH_2
|
CH_3</td></tr>
</table>

Question 14

a. Z is likely to be metallic, as metallic substances are the only ones that conduct electricity in both the solid and liquid states.
b. X as it does not conduct electricity in either solid or liquid states and this is the case with non-metallic elements.
c. Ionic, as when a metal reacts with a non-metallic element an ionic compound is usually formed.

Question 15

Isotope symbol	No. of protons	No. of neutrons	No. of electrons
$^{150}_{62}Sm$	62	88	62
$^{28}_{13}Al$	13	15	13
$^{2}_{1}H^{+}$	1	1	0

Question 16

a.
Property 1 is electrical conductivity

b. The sea of electrons results in the multi-directional nature of the metallic bond. Therefore, attractive forces between the metallic nuclei and the delocalised electrons give strength in all directions. Thus, there are no lines of weakness. That is, metals are not brittle but are malleable.

Question 17

a.

Test 1: Does galena conduct electricity in the solid state? Metals are the only substances that do this. (Brought about by the migration of electons when a potential difference is applied.)

Test 2: Is galena a good conductor of heat and is it malleable? Metals are characteristically good conductors of heat and are malleable.

b.

i. Copper is used for electrical wiring so a plastic substitute must be a good electrical conductor.

ii. The plastic copper plumbing replacement must be strong, ductile and malleable enabling it to be bent and shaped to suit the needs of the plumber. It also must be unreactive with water.

PART 3

Question 18

Basil is in no danger of being engulfed by the giant snow ball. If the total amount of energy possessed by the snowball remained constant, as it gains mass, the height to which it can rise is reduced. However, there would be friction between the snow and the snowball, and the snowball and the air, that reduces the useful amount of energy available to the snowball. When the snowball was released all its energy was E_p. As it falls, it loses E_p and gains E_k. However, its mass is increasing, so the height to which it can rise is reduced. $h = E_p/(mg)$

Question 19

a.

Initial E_k = (_ x 1500 x 25^2) J = 4.69 x 10^5 J

Final E_k = (_ x 1500 x 15^2) J = 1.69 x 10^5 J

$\therefore$ Loss in E_k = (_ x 1500)(25 + 15)(25 - 15) J = 3.00 x 10^5 J

b. This energy is lost in heat and sound as the car decelerates. (Friction between car tyres and road causes this.)

c. The work is done by the frictional force = loss in E_k = 3.00 x 10^5 J

W = Fs

$\therefore$3.00 x 10^5 =F x 25.0

$\therefore$F = (3.00 x 10^5/25.0) N = 1.20 x 10^4 N in a southerly direction.

Question 20

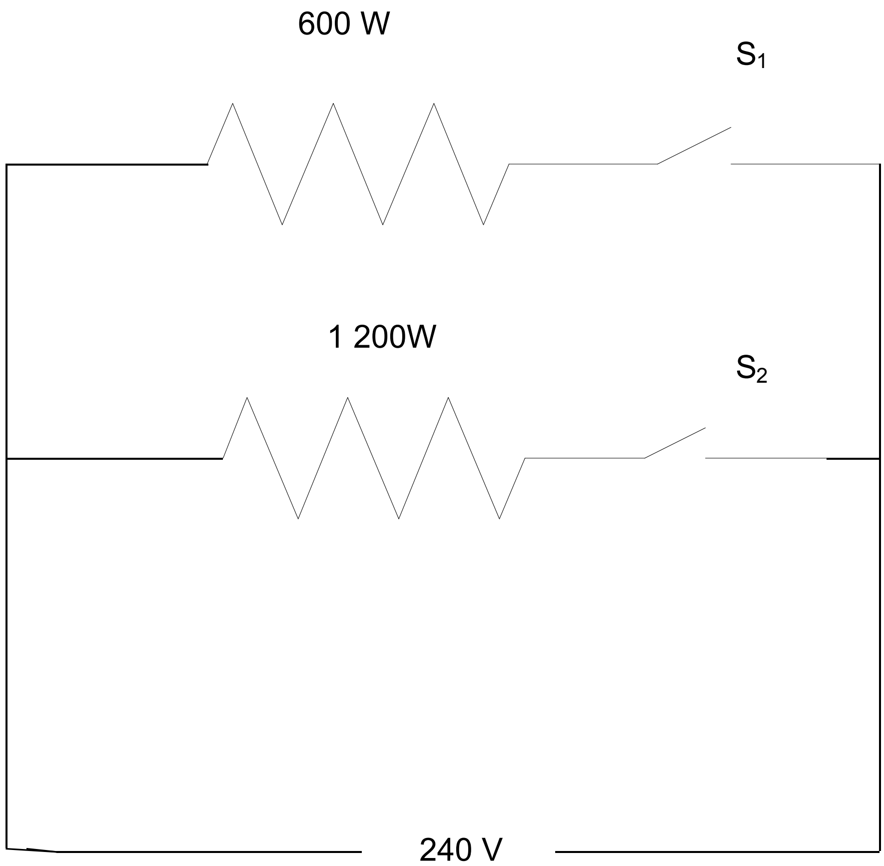
a. E_p = mgh = (200 x 9.8 x 5) J = 9 800 J
b. At B E_k = _mv^2 = (_ x 200 x 9 .00^2) J = 8 100 J.
c. ∴Energy lost = 1 700 J.
d. Energy lost in rising to C = 10% of 8 100 J = 810 J. E_k at C = (_ x 200 x 3.00^2) J = 900 J
Total energy at C= 7 290 J = 7 290 J. ∴E_p = 6 390 J
h = E_p/(mg) = 6 390/(200 x 9.8) m = 3.26 m

Question 21

a. The *work done* (W) by Jennifer = mgh = (62.5 x 9.8 x 2.75) J = 1.68 x 10^3 J
b. The *power developed* by Jennifer = W/t = (1.684 x 10^3)/2.5 = 6.74 x 10^2 W.
c. In climbing the stairs, Jennifer is working against gravity which acts *vertically downwards*. This is why the *vertical height* of the staircase and not some other distance measurement is required to determine the work done by Jennifer.

Question 22

a.



b.
i. The *current* in the 600 W coil, I = P/V = (600/240) A = 2.50 A

c. The *total current* that flows from the 240 V supply when the heater is on the "high" setting, I_{total} = (1 800)/240 A = 7.5 A

Question 23

a. A beta source is used because beta particles (high speed electrons), unlike alpha particles, are able to penetrate the sheet metal and be detected by the GM tube on the opposite side. If the sheet metal is to be thin enough, it would be preferable to use beta particles than gamma rays as the greater penetrating power of gamma radiation would not be required in this scenario.

b. There was a variation in the thickness of the sheet starting between 6 and 7 minutes. This lasted for about 5 minutes. Beta particles are readily absorbed by metallic sheets, so an increase in sheet thickness would case a corresponding decrease in count rate. There could also be variations in the background count rate.

c. ${}^{204}_{81}Tl \rightarrow {}_{-1}^{0}e + {}^{204}_{82}Pb$

d. 11.3 years is approximately 3 half lives, so 1/8 of the mass would be left, which is 6.25 g. 50 0 g → 25.0 g →12.5 g → 6.25 g. (11.3/3.98 = 2.99)

Question 24

a.

i. Gamma radiation would be most suitable as alpha would not pass through the plastic bag and beta radiation would be probably not penetrate the cavity of the syringe.

ii. There is no risk of the syringe or the plastic bag containing it becoming radioactive. Gamma radiation is high energy electromagnetic radiation and radioactive particles are not added to the bag or the syringe.

b.

i. An alpha emitter is ideal for ionizing the air because it is short range (low penetrating) radiation. Each alpha particle contains a 2+ charge.

ii. Unless the smoke detector is disassembled and its components scattered radiation cannot escape from the detector and harm people in the house. Even then, the source must come into contact with the person's body, or be held close to someone's eyes.

c.

i. Parallel

ii. Series.

iii. (240/16) V = 15 V

iv. If a globe in circuit **A** "blows" (fails) and is not replaced, there is no effect on the remaining globes. This is because each globe is connected to the power supply by an independent means.

v. If a globe in circuit **B** "blows" (fails) and is not replaced, all the remaining globes go out (are extinguished). In effect, the series circuit is broken if a globe fails.

d.

i. A bird landing on a high voltage wire is not shocked. There is a small current passing through the feathers of the bird which might cause them to be ruffled on a dry day. For the bird to be shocked, it must simultaneously touch 2 wires, or one wire and the ground, or a wire and the pylon from which the wires are hung.

ii. When a fuse "*blows*" it is foolish to replace it with one of a higher current rating to prevent the fuse from "*blowing*" again. This is because the fuse is a *current* limiting device. A fuse of a higher rating would allow a much larger current to pass (as occurs in a short circuit) and would not protect the electrical wiring and hence the appliance. A fire could occur.

PART 4

Question 25

a)

$$2Mg(NO_3)_2(s) \rightarrow 2MgO(g) + 4NO_2(g) + O_2(g)$$

b. $2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g)$

Question 26

$$C_xH_y + O_2(g) \rightarrow 2CO_2(g) + 2H_2O(g)$$

From the information given, $C_2H_4(g) + 3O_2(g) \rightarrow 2CO_2(g) + 2H_2O(g)$, so x = 2, and y = 4

Question 27

a) The molar mass of the compound, M = (24.3/0.270) g mol^{-1} = 90.0 g mol^{-1}.

b)

Ratios	H	C	O
Mass ratio	2.2:	26.7:	71.1
Mol ratio of atoms	2.2/1.00	26.7/12.0	71.1/16.0
	2.2:	2.225:	4.44
	1:	1:	2

∴Empirical formula is CHO_2

c. M(CHO_2) = 45.0 g mol^{-1}

∴The molecular formula is $C_2H_2O_4$

Question 28

1 mol of gold atoms = 6.02 x 10^{23} atoms of gold.
1.30 mol of gold atoms = (1.30 x 6.02x10^{23}) atoms of gold. This is 7.83 x 10^{23} atoms.
Thus 8.50 x 10^{23} atoms of gold are preferable.

Question 29

18.0 mol in 1 000 mL of the concentrated acid
c = n/v = 2.0 = n/0.25
∴n = 0.50 mol required
18.0 mol in 1 000 mL of the concentrated acid
∴0.50 mol in (1 000x0.50)/18.0) mol of the acid = 27.8 mL

Question 30

a. The *molar mass* of ammonium nitrate = (14.0 + 4.00 + 14.0 + 48.0) g mol^{-1} = 80.0 g mol^{-1}
b. The *percentage by mass* of combined nitrogen in ammonium nitrate = {(28.0/80.0) x 100}% =35.0%
c.
From the equation, 1 mol NH_3 produces 1 mol NH_4NO_3
∴17.0 g of NH_3 gives 80.0 g of NH_4NO_3
∴250 g NH_3 will give {(80.0/17.0)x250}g of NH_4NO_3 = 1 176 g NH_4NO_3 = 1.18 g (3 sig. figures)

Question 31 (Qualitative Analysis)

a.
i. Sodium carbonate solution was mixed with the barium chloride solution.
ii. $Na_2CO_3(aq) + BaCl_2(aq) \rightarrow BaCO_3(s) + 2NaCl(aq)$.
$Ba^{2+}(aq) + CO_3^{2-}(aq) \rightarrow BaCO_3(s)$
$Na^+(aq)$ and $Cl^-(aq)$ are the spectator ions.
b.
i. Sodium carbonate solution was mixed with the dilute hydrochloric acid.
ii.
$Na_2CO_3(aq) + 2HCl(aq) \rightarrow 2NaCl(aq) + H_2O(l) + CO_2(g)$
c. Magnesium nitrate will *not* react with silver nitrate solution to form a precipitate. Magnesium nitrate is soluble and an insoluble combination of ions must be present for a precipitate to occur. (All nitrates are soluble.)

Question 32 (Volumetric Analysis)

a.
$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$
$$Mg(OH)_2(s) + HCl(aq) \rightarrow MgCl_2(aq) + H_2O(l)$$
b.
$M(CaCO_3)$ = 100.0 g mol^{-1} 317 mg $CaCO_3$ = {317/(1000x100)} mol
1 mol $CaCO_3$ neutralizes 2 mol HCl
{317/(1000x100)} mol of $CaCO_3$ neutralizes {(2x.317)/(100)} mol HCl
c = n/v
2.00/1000 = (2x0.317)/100V
∴ v =3.17 mL

Question 33

a. The *concentration of hydrogen ions [H^+(aq)] in aqueous solution* is being measured in a pH measurement. pH = $-\log_{10}$\{H+(aq)]

b. A pH of 7.8 is *basic*.

c. If the swimming pool water had a pH between 7.2 and 7.8, heavy rain would lower the pH to be nearer 7.0. In effect the slightly alkaline swimming pool water is being diluted.

d. As the swimming pool water is now too basic, something acidic would have to be added to it to neutralize the excess acidity. The volume of acid used would depend on its type and concentration. Possibly hydrochloric acid could be used or a soluble substance such as sodium hydrogen sulfate.

e. A pH of in the range 7.2 to 7.8 is weakly basic and is not injurious to the skin or eyes of the human body.

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