GCSE

PHYSICS

Higher Tier Paper 1

Mark scheme Practice Paper Series – Set 2 SGC/S2/SP/1H

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This mark scheme is an original resource written for sciencegcse.co.uk to accompany the Set 2 practice paper SGC/S2/SP/1H. It is not an AQA mark scheme and has not been produced or endorsed by AQA. It follows the structure and conventions of AQA GCSE science mark schemes so that students and teachers can mark the practice paper in the same way that a real paper is marked.

Marking should be carried out using the Information to Examiners on the following pages. The paper has not been standardised, so raw marks should not be converted into grades using any published grade boundaries.

Specification references are to the AQA GCSE Physics (8463) specification, sections 4.1–4.4. AO = assessment objective; WS = working scientifically; MS = mathematical skills; RP = required practical.

Information to Examiners

1. General

The mark scheme for each question shows:

- the marks available for each part of the question
- the total marks available for the question
- the answer(s) expected, including alternative acceptable wording, in the **Answers** column
- guidance on which answers are and are not creditworthy in the **Extra information** column
- the assessment objective (AO) and specification reference for each marking point.

Award marks positively. Do not deduct marks for incorrect additional material unless it contradicts a correct answer (see 3.1). Marks are awarded for what the student has written, not for what they might have meant.

2. Emboldening and underlining

2.1 Where a list of acceptable answers is given and more than one mark is available, **any two from** (or similar) is used, followed by the acceptable answers.

2.2 A bold **and** indicates that both parts of the answer are needed to gain the mark.

2.3 Alternative answers acceptable for the same mark are separated by **or**. Different words that are acceptable within a marking point are separated by a forward slash (/).

2.4 Words in bold in the Answers column are the essential words that must be present, or their equivalent, for the mark to be awarded.

3. Marking points

3.1 Marking of lists
When a fixed number of responses is requested but extra responses are given, consider the whole list. Each incorrect response or contradiction cancels one otherwise available correct response, up to the mark limit; the score cannot fall below zero. Neutral material identified by **ignore** does not cancel a correct response. Do not apply this rule as a penalty for extra relevant detail in an extended answer.

3.2 Marking procedure for calculations
A correct final answer can receive the marks indicated in the question-specific scheme without every intermediate step being written. Do not award full marks if the working shown contradicts that answer. Where the question specifically requires a method, demonstration or working, apply that requirement. Credit correct stages when the final answer is wrong, including consequential steps where permitted. A printed unit may only be replaced by another unit when the numerical value is converted consistently.

3.3 Interpretation of 'it'
Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

3.4 Errors carried forward
Use an earlier incorrect value in a later part where ECF is allowed by the question-specific scheme. Within a calculation, credit later correct stages that use an earlier incorrect value consistently, subject to any stated limits. Do not repeatedly penalise the same error.

3.5 Phonetic spelling
Accept a misspelling when the intended scientific term is clear, including when a term is being recalled. Do not accept wording that could instead name a different scientific term.

3.6 Brackets
Words shown in brackets in the Answers column are not required to gain the mark but help to set the context.

3.7 Allow
Answers that are acceptable but which would not normally be expected are shown as **allow**.

3.8 Ignore
Statements shown as **ignore** are neither creditworthy nor penalised. Mark the rest of the answer normally.

3.9 Do not accept
Statements shown as **do not accept** are incorrect and, where they contradict or replace the expected answer, mean the mark is not awarded.

4. Level of response marking instructions

Extended-response questions (questions 07.1 and 10.4 in this paper) are marked using a level of response mark scheme. The scheme has three levels, each covering two marks, plus a level descriptor and indicative content.

Step 1 – Determine a level. Read the whole answer and decide which level descriptor best fits it. Use a 'best-fit' approach: an answer does not need to meet every part of a descriptor to be placed in that level, and a weak part of the answer need not prevent it from reaching the higher level if the overall quality matches the descriptor.

Step 2 – Determine a mark within the level. Award the higher mark in the level if the answer meets the descriptor fully and the points made are well linked; award the lower mark if the answer only just meets the descriptor or contains minor errors or omissions.

The indicative content is not a checklist: students need not include every point to reach the top level, and other relevant, correct points should be credited. An answer that lists points without linking them into a coherent answer should be placed in a lower level than one that develops and connects them.

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	the nucleus is very small and contains most of the mass of the atom		1	AO1 4.4.1.1, 4.4.1.3
	protons and neutrons are in the nucleus	allow protons have positive charge and neutrons have no charge	1	AO1 4.4.1.1, 4.4.1.3
	electrons are arranged in energy levels / shells around the nucleus	allow negatively charged electrons outside the nucleus	1	AO1 4.4.1.1, 4.4.1.3
01.2	**A** absorbed		1	AO1 4.4.1.1
	B emitted		1	AO1 4.4.1.1
01.3	it loses (one or more outer) electrons	do not accept it gains protons do not accept it gains electrons	1	AO1 4.4.1.2
01.4	$1.2 \times 10^{-10} \div 6.0 \times 10^{-15}$	an answer of 20 000 scores **2** marks	1	AO2 4.4.1.1 MS 1b
	= **20 000** (times)	allow 2×10^{4} / 2.0×10^{4} an answer of 5×10^{-5} scores 0 marks	1	AO2 4.4.1.1 MS 1b
		Total	**8**	
02.1	so that the temperature of the air stays the same / returns to room temperature	allow moving the plunger may change the temperature of the air ignore so that the reading is steady	1	AO3 4.3.3.2 WS 2.2
02.2	$p \times V$ calculated for two points from the graph, e.g. 300 × 20 = 6000 and 100 × 60 = 6000	readings must be taken from the graph	1	AO3 4.3.3.2 MS 4a
	$p \times V$ calculated for a third point, e.g. 200 × 30 = 6000		1	AO3 4.3.3.2 MS 4a
	$p \times V$ is constant, so the pressure is inversely proportional to the volume	allow doubling the volume halves the pressure, e.g. 30 to 60 cm^3: 200 to 100 kPa, with a second example, for **3** marks	1	AO3 4.3.3.2 MS 4a
02.3	100 × 60 = p × 15	an answer of 400 (kPa) scores **2** marks allow p = 6000 ÷ 15	1	AO2 4.3.3.2 MS 3b, 3c
	p = **400** (kPa)		1	AO2 4.3.3.2 MS 3b, 3c
02.4	pushing the plunger in quickly does work on the air, which increases the internal energy / temperature of the air	allow energy is transferred to the air	1	AO1 4.3.3.3 (HT)

Question	Answers	Extra information	Mark	AO / Spec. Ref.
	the particles move faster, so they hit the walls more often / with more force, so the pressure is greater than 200 kPa	allow the pressure is higher than pV = constant predicts because the temperature is higher	1	AO1 4.3.3.1
	the air then transfers energy to the surroundings / cools to room temperature, so the pressure decreases to 200 kPa	allow the particles slow down as the air cools	1	AO2 4.3.3.3 (HT)
02.5	with no leak, $p \times V$ would stay at 6000, so the pressure at 30 cm^3 should have been 200 kPa	allow 190 × 30 = 5700, which is less than 6000	1	AO3 4.3.3.2 WS 3.5
	when the volume returned to 60 cm^3, $p \times V$ = 92 × 60 = 5520, which is less than at the start (6000)	allow the pressure (92 kPa) was lower than at the start (100 kPa)	1	AO3 4.3.3.2 WS 3.5
	so the conclusion is supported: $p \times V$ fell from 6000 to 5700 to 5520, so air leaked out while the pressure inside was above atmospheric pressure	allow this shows the mass / number of particles of air decreased allow a change in temperature is unlikely because the plunger was moved slowly allow the student should repeat to check that the difference is not caused by errors in reading the volume or pressure max **2** marks if there is no justified conclusion	1	AO3 4.3.3.2 WS 3.5
		Total	**12**	
03.1	$E_e = 0.5 \times 320 \times 0.150^2$	an answer of 3.6 (J) scores **2** marks	1	AO2 4.1.1.2 MS 3c
	E_e = **3.6** (J)	an answer of 3 600 000 (J) (compression in mm) scores 1 mark	1	AO2 4.1.1.2 MS 3c
03.2	$E_k = 0.75 \times 3.6 = 2.7$ (J)	an answer of 9.5 (m/s) scores **3** marks allow ECF from 03.1	1	AO2 4.1.1.2, 4.1.2.2 MS 3b, 3c
	$2.7 = 0.5 \times 0.060 \times v^2$	allow $v^2 = 90$	1	AO2 4.1.1.2, 4.1.2.2 MS 3b, 3c
	v = **9.5** (m/s)	allow 9.49 (m/s) an answer of 11 (m/s) (75% not used) scores **2** marks	1	AO2 4.1.1.2, 4.1.2.2 MS 3b, 3c
03.3	doubling the compression makes the elastic potential energy four times greater	allow E_e is proportional to e^2 allow a correct calculation, e.g. E_e = 14.4 J	1	AO2 4.1.1.2
	so the kinetic energy of the ball is four times greater	allow E_k = 10.8 J	1	AO2 4.1.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
	E_k is proportional to v^2, so the speed doubles ($\sqrt{4} = 2$): the student is correct	allow a calculated speed of 19 m/s, which is twice 9.5 m/s allow ECF: a calculated speed that is twice the student's answer to 03.2 the conclusion must be supported by reasoning to score this mark	1	AO2 4.1.1.2
03.4	any **one** from: • (work is done against) friction between the ball and the tube • air resistance • the spring and the plate also gain kinetic energy • (some energy is transferred as) sound	allow energy is transferred to the thermal energy store of the ball / the tube / the surroundings ignore energy is lost	1	AO1 4.1.2.1
		Total	**9**	
04.1	100 000 000 = 25 000 × *I*	an answer of 4000 (A) scores **2** marks allow *I* = 100 000 000 ÷ 25 000	1	AO2 4.2.4.1 MS 3c
	I = **4000** (A)	an answer of 4 (A) scores 1 mark	1	AO2 4.2.4.1 MS 3c
04.2	$P = 4000^2 \times 2.0$	an answer of 32 000 000 (W) scores **2** marks allow ECF from 04.1	1	AO2 4.2.4.1 MS 3c
	P = **32 000 000** (W)	allow 3.2×10^7 (W)	1	AO2 4.2.4.1 MS 3c
04.3	100 000 000 = 400 000 × *I*	an answer of 0.125 (%) scores **5** marks allow 25 000 × 4000 = 400 000 × *I* allow ECF throughout	1	AO2 4.2.4.1, 4.2.4.3 MS 1c, 3b, 3c
	I = 250 (A)		1	AO2 4.2.4.1, 4.2.4.3 MS 1c, 3b, 3c
	$P = 250^2 \times 2.0 = 125\,000$ (W)	allow *V* = 250 × 2.0 = 500 V and *P* = 500 × 250 = 125 000 W	1	AO2 4.2.4.1, 4.2.4.3 MS 1c, 3b, 3c
	125 000 ÷ 100 000 000 (× 100)		1	AO2 4.2.4.1, 4.2.4.3 MS 1c, 3b, 3c
	= **0.125** (%)	allow 0.13 (%)	1	AO2 4.2.4.1, 4.2.4.3 MS 1c, 3b, 3c

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	(a high potential difference is) dangerous / for safety	allow 400 kV would be too dangerous to use in homes allow appliances are designed to work at 230 V	1	AO1 4.2.4.3
		Total	**10**	
05.1	They lose electrons.	if more than one box is ticked, no mark	1	AO1 4.2.5.1
05.2	the droplets all have the same (positive) charge		1	AO1 4.2.5.1
	so they repel each other (and move apart)	allow like charges repel	1	AO1 4.2.5.1
05.3	the (negatively charged) metal object has an electric field all around it	allow the field lines reach every side of the object	1	AO1 4.2.5.2
	a positively charged droplet in the field experiences a force (of attraction) towards the object	allow opposite charges attract	1	AO1 4.2.5.2
	the force acts along the field lines, which curve round to the back of the object, so droplets are pulled round to the back	allow the attraction is a non-contact force, so it still acts when the back is not in line with the spray gun	1	AO2 4.2.5.2
05.4	straight radial lines around the droplet / sphere	allow lines spread out equally in all directions	1	AO1 4.2.5.2
	arrows point outwards / away from the positive droplet	do not accept towards the droplet	1	AO1 4.2.5.2
05.5	charge on the paint cannot flow away (to the metal) because the paint is an insulator		1	AO2 4.2.5.1, 4.2.5.2
	so the painted parts become positively charged	allow positive charge builds up on the layer of paint	1	AO2 4.2.5.1, 4.2.5.2
	which repels the positive droplets / reduces the attraction, so more droplets go to the uncovered parts		1	AO2 4.2.5.1, 4.2.5.2
		Total	**11**	
06.1	current in the 100 Ω resistor = 2.0 ÷ 100 = 0.020 (A)	an answer of 200 (Ω) scores **3** marks	1	AO2 4.2.1.3, 4.2.2 MS 3c
	potential difference across the thermistor = 6.0 − 2.0 = 4.0 (V)	alternative method for the second and third marks: total resistance of the branch = 6.0 ÷ 0.020 = 300 (Ω) (1), so R = 300 − 100 (1)	1	AO2 4.2.1.3, 4.2.2 MS 3c

<table>
<tr><th>Question</th><th>Answers</th><th>Extra information</th><th>Mark</th><th>AO / Spec. Ref.</th></tr>
<tr><td></td><td>R = 4.0 ÷ 0.020 = 200 (Ω)</td><td>allow ECF from an incorrect current or potential difference
allow (4.0 ÷ 2.0) × 100 = 200 (Ω) for 3 marks</td><td>1</td><td>AO2
4.2.1.3, 4.2.2
MS 3c</td></tr>
<tr><td>06.2</td><td>the resistance of the thermistor decreases</td><td></td><td>1</td><td>AO1
4.2.1.4</td></tr>
<tr><td></td><td>so the current in the thermistor and the 100 Ω resistor increases</td><td>allow the thermistor takes a smaller share of the 6.0 V / the potential difference across the thermistor decreases</td><td>1</td><td>AO2
4.2.2</td></tr>
<tr><td></td><td>so the potential difference across the 100 Ω resistor increases: the voltmeter reading increases</td><td>allow (V = IR and) R is fixed, so the reading increases
a bare statement that the reading increases scores 1 mark; ‘the thermistor’s resistance decreases so the reading increases’ scores 2 marks</td><td>1</td><td>AO2
4.2.2</td></tr>
<tr><td colspan="3">Total</td><td>6</td><td></td></tr>
<tr><td>07.1</td><td colspan="2"><table>
<tr><td>Level 3
(5–6 marks)</td><td>The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.</td></tr>
<tr><td>Level 2
(3–4 marks)</td><td>The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.</td></tr>
<tr><td>Level 1
(1–2 marks)</td><td>The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.</td></tr>
<tr><td>0 marks</td><td>No relevant content.</td></tr>
</table></td><td>6</td><td>AO1
4.3.1.1
RP</td></tr>
<tr><td></td><td colspan="3">Indicative content
• measure the mass of the pebbles using a (top-pan) balance
• make sure the balance reads zero before it is used
• partly fill a measuring cylinder with water and record the volume
• add the pebbles carefully, so that no water splashes out
• make sure the pebbles are completely under the water
• record the new volume
• volume of the pebbles = new volume − starting volume
• or fill a displacement (eureka) can up to the spout, add the pebbles and collect the water displaced in a measuring cylinder
• read the volume at the bottom of the meniscus, with the eye level with the meniscus
• use many pebbles so that the volume is large enough to measure
• density = mass ÷ volume
• repeat with other samples of pebbles and calculate a mean
To reach Level 3 the method must measure the mass, find the volume by displacement and calculate density as mass ÷ volume.</td></tr>
</table>

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	25 (cm^3)		1	AO2 4.3.1.1 RP MS 1a
07.3	ρ = 65.0 ÷ 25	an answer of 2600 (kg/m^3) scores **3** marks allow ECF from 07.2 allow $0.0650 \div 2.5 \times 10^{-5}$ for the first two marks	1	AO2 4.3.1.1 MS 1a, 3c
	ρ = 2.6 (g/cm^3)	an answer of 2.6 scores **2** marks	1	AO2 4.3.1.1 MS 1a, 3c
	ρ = **2600** (kg/m^3)		1	AO2 4.3.1.1 MS 1a, 3c
		Total	**10**	
08.1	thicker insulation reduces the rate of energy transfer	allow the energy has to pass through more material	1	AO1 4.1.2.1
	a lower thermal conductivity reduces the rate of energy transfer (by conduction)	ignore heat is trapped	1	AO1 4.1.2.1
08.2	reduction in power = 1.6 − 1.3 = 0.30 (kW)	an answer of (£)0.65 scores **3** marks	1	AO2 4.1.1.4, 4.2.4.2 MS 1a, 3c
	energy saved each day = 0.30 × 8.0 = 2.4 (kWh)	allow (1.6 × 8.0) − (1.3 × 8.0) = 12.8 − 10.4	1	AO2 4.1.1.4, 4.2.4.2 MS 1a, 3c
	money saved = 2.4 × 27 = 64.8 (p) = (£)**0.65**	allow (£)0.648 allow 65p if the unit is changed to pence allow 1.6 × 8.0 × 27 = 345.6 (p) and 1.3 × 8.0 × 27 = 280.8 (p) for 2 marks allow ECF from an incorrect energy	1	AO2 4.1.1.4, 4.2.4.2 MS 1a, 3c
08.3	a renewable energy resource is (being) replenished as it is used / will not run out	allow wood can be regrown / trees can be replanted	1	AO1 4.1.3
	a non-renewable energy resource will run out / cannot be replaced (once it has been used)	allow it is a finite resource / it takes millions of years to form	1	AO1 4.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.4	any **two** from: • the temperature of the water fell by less for jacket **B** (14 °C) than for jacket **A** (20 °C), which seems to support the conclusion • but the starting temperatures were different, so it was not a fair test • hotter water (a bigger temperature difference with the surroundings) transfers energy faster, so jacket **A** would be expected to show a bigger decrease • the temperature of the room may have been different on the two days **plus** • a conclusion justified by these points, e.g. the family's conclusion is not valid / jacket **A** may be the better insulator / the test should be repeated with the same starting temperature	1 mark for each of up to two points 1 mark for the justified conclusion max **2** marks if there is no justified conclusion a conclusion that jacket **B** is the better insulator does not score the conclusion mark	3	AO3 4.1.2.1 WS 3.5
		Total	**10**	
09.1	gamma rays are (very) penetrating, so they can pass through the body to reach the tumour		1	AO1 4.4.2.1, 4.4.3.3
	gamma rays are ionising, so they damage / kill the cancer cells	allow damage the DNA of the cancer cells	1	AO1 4.4.2.1, 4.4.3.3
09.2	each beam in Plan **B** is weaker, so the healthy tissue along the path of each beam receives a smaller dose	allow the dose to healthy tissue is spread out	1	AO3 4.4.3.3
	the beams cross / overlap only at the tumour, so the tumour still receives the full dose	do not accept a bare restatement that the tumour receives the same dose: the idea that the beams cross only at the tumour is needed	1	AO3 4.4.3.3
	so less healthy tissue is damaged / there is a lower risk of healthy cells becoming cancerous	allow fewer side effects for the patient	1	AO3 4.4.3.3
09.3	alpha particles are strongly ionising, so they kill the tumour cells near the source		1	AO1 4.4.2.1
	alpha particles have a very short range in the body / are absorbed within a few cells	allow alpha particles are not very penetrating	1	AO1 4.4.2.1
	so (almost) all of the radiation is absorbed inside the tumour and very little reaches healthy tissue	allow the alpha particles do not travel far enough to reach healthy tissue	1	AO2 4.4.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.4	a half-life of a few minutes: the activity would decrease too quickly / most of the isotope would decay before it could be injected or destroy the tumour		1	AO3 4.4.3.2, 4.4.3.3
	a half-life of many years: the patient would remain radioactive for a long time, so healthy tissue (and other people) would be irradiated for longer	allow the source would keep emitting radiation long after the treatment is finished	1	AO3 4.4.3.2, 4.4.3.3
09.5	33 days = 3 half-lives	an answer of 0.75 (MBq) scores **2** marks allow 6.0 → 3.0 → 1.5 → 0.75 for 2 marks	1	AO2 4.4.2.3 (HT) MS 1c
	activity = $6.0 \div 2^3$ = **0.75** (MBq)	an answer of 1.5 (MBq) or 2.0 (MBq) scores 1 mark	1	AO2 4.4.2.3 (HT) MS 1c
		Total	**12**	
10.1	3	allow 236 − 233 = 3 shown	1	AO2 4.4.2.2, 4.4.4.1
10.2	in a reactor the chain reaction is controlled, so energy is released at a steady rate	allow control rods absorb neutrons so that only one neutron from each fission goes on to cause another fission	1	AO1 4.4.4.1
	in a nuclear weapon the chain reaction is uncontrolled, so a huge amount of energy is released very quickly in an explosion		1	AO1 4.4.4.1
10.3	any **three** from: • fission is the splitting of a large (unstable) nucleus, e.g. uranium-235, into two smaller nuclei • fusion is the joining of two light nuclei, e.g. hydrogen nuclei, to form a heavier nucleus • both processes release energy • fission usually needs the nucleus to absorb a neutron; fusion needs a very high temperature (and pressure) • fission releases neutrons that can cause a chain reaction • fusion of 1 kg of fuel releases more energy than fission of 1 kg of fuel • the products of fission are radioactive; fusion produces much less radioactive waste • some of the mass may be converted into energy in both processes	max 1 mark if only fission or only fusion is described 3 marks needs at least one direct comparison	3	AO1 4.4.4.1, 4.4.4.2

<table>
<tr><th>Question</th><th>Answers</th><th>Extra information</th><th>Mark</th><th>AO / Spec. Ref.</th></tr>
<tr><td>10.4</td><td>
<table>
<tr><td>Level 3 (5–6 marks)</td><td>A detailed and coherent evaluation is given, which uses information from Table 2 and the student's own knowledge to compare the two options. Advantages and disadvantages of both options are considered and the answer comes to a conclusion that is consistent with the reasoning.</td></tr>
<tr><td>Level 2 (3–4 marks)</td><td>An attempt is made to compare the two options, with some advantages and disadvantages and some use of the information in Table 2. The logic may be inconsistent at times but builds towards a conclusion.</td></tr>
<tr><td>Level 1 (1–2 marks)</td><td>Simple statements are made about one or both options, with little or no comparison. A conclusion, if given, is not linked to the reasoning.</td></tr>
<tr><td>0 marks</td><td>No relevant content.</td></tr>
</table>
</td><td></td><td>6</td><td>AO3
4.1.3, 4.4.4.1</td></tr>
</table>

Question	Answers	Extra information	Mark	AO / Spec. Ref.
	Indicative content **Tidal barrage** • renewable: the tides will not run out • no fuel is needed / no fuel costs • no carbon dioxide is emitted while generating, so it does not add to global warming • no radioactive waste • cheaper to build (£1.6 billion compared with £12 billion) and lasts twice as long (120 years) • the tides are predictable, so the output can be planned • but the mean output is much smaller (84 MW, about 13 times less than the nuclear power station) • it only generates for about 8 hours each day, which may not be when electricity is needed • the cost for each MW of mean output is higher (about £19 million compared with about £11 million) • it damages the habitats in the estuary / the mudflats where birds feed • allowing for its longer working life, the build cost for each MW of mean output for each year of working life is similar or slightly lower for the barrage (about £0.16 million compared with about £0.18 million), and the barrage has no fuel or waste-storage costs **Nuclear power station** • a very large output that is available all the time / reliable • no carbon dioxide is emitted while generating • uranium is a non-renewable resource that must be mined • radioactive waste must be stored for thousands of years • there is a (small) risk of a serious accident • expensive to build and to decommission • uses only a small area of land **Conclusion** • any justified conclusion, e.g. the nuclear power station is better for meeting a large, steady demand, but about 13 barrages would be needed to give the same mean output; the barrage is better for the environment in the long term To reach Level 3 the answer must compare both options, use data from Table 2 and give a justified conclusion.			
		Total	**12**	
		TOTAL FOR PAPER	**100**	