GCSE

PHYSICS

Higher Tier Paper 2

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

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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/2H. 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 4.5–4.8 (Paper 2 may also draw on section 4.1). 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 08.1 and 09.1 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	(at least two) concentric circles centred on the wire	circles must not touch each other or the wire allow approximately circular	1	AO1 4.7.2.1
	arrows anticlockwise on the circles	the direction mark depends on circles being drawn at least one arrow is needed and all arrows must be anticlockwise any clockwise arrow loses this mark	1	AO1 4.7.2.1
01.2	**Q**		1	AO2 4.7.1.2, 4.7.2.1
	the field lines outside the solenoid point away from end **Q**	the reason mark depends on **Q** being chosen allow the field lines go from **Q** to **P** outside the solenoid allow the field inside the solenoid points towards **Q**	1	AO2 4.7.1.2, 4.7.2.1
01.3	the field lines (inside the solenoid) are parallel	allow straight lines in the same direction	1	AO1 4.7.1.2, 4.7.2.1
	the field lines are equally spaced	allow the same distance apart	1	AO1 4.7.1.2, 4.7.2.1
01.4	iron core: the magnetic field becomes stronger	allow the solenoid becomes a stronger magnet	1	AO1 4.7.2.1
	reversing the current: the direction of the magnetic field reverses	allow the poles swap / **P** becomes the north pole	1	AO1 4.7.2.1
		Total	**8**	
02.1	an object that absorbs all of the radiation incident on it	allow it does not reflect or transmit any radiation	1	AO1 4.6.3.1
02.2	the Earth absorbed radiation at the same rate as it emitted radiation	allow the energy absorbed each second equals the energy emitted each second allow the radiation absorbed and emitted are balanced / equal amounts are absorbed and emitted in the same time	1	AO1 4.6.3.2
02.3	less of the radiation from the Sun is reflected back into space	allow sea water absorbs more radiation than ice	1	AO2 4.6.3.2
	so the Earth absorbs radiation at a greater rate		1	AO2 4.6.3.2
	the Earth absorbs radiation faster than it emits radiation		1	AO1 4.6.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
	so the temperature of the Earth increases	allow until the Earth emits radiation at the same rate as it absorbs it (at a higher temperature)	1	AO2 4.6.3.2
		Total	**6**	
03.1	the total mass (of the trolley, the hanger and the masses) stays the same	allow the mass being accelerated is constant	1	AO1 4.5.6.2.2 RP
	so that the mass is a control variable / only the force changes	allow so that it is a fair test allow so that any change in acceleration is caused only by the change in force	1	AO3 4.5.6.2.2 RP
03.2	a = (0.70 − 0.40) ÷ 0.60	an answer of 0.50 (m/s^2) scores **2** marks	1	AO2 4.5.6.1.5 RP MS 3c
	a = **0.50** (m/s^2)	allow 0.5 (m/s^2) an answer of 1.2 (m/s^2) (0.70 ÷ 0.60) scores 0 marks	1	AO2 4.5.6.1.5 RP MS 3c
03.3	both points plotted correctly	allow ± half a small square	1	AO2 4.5.6.2.2 RP MS 4a, 4c
	a straight line of best fit passing through all the points	the line must not be forced through the origin	1	AO3 4.5.6.2.2 RP MS 4c
03.4	gradient = (0.90 − 0.10) ÷ (0.50 − 0.10) = 2.0	allow a gradient in the range 1.9 to 2.1 allow any correct pair of values read from the line	1	AO3 4.5.6.2.2 RP MS 4d
	total mass = 1 ÷ gradient	allow $F = ma$ so the gradient is 1 ÷ mass allow ECF from an incorrect gradient do not accept mass = force ÷ acceleration for a single result, e.g. 0.50 ÷ 0.90 = 0.56 kg	1	AO3 4.5.6.2.2 RP MS 3b

Question	Answers	Extra information	Mark	AO / Spec. Ref.
	total mass = **0.50** (kg)	allow 0.48 to 0.53 (kg) an answer of 0.50 (kg) scores **3** marks an answer of 2.0 (kg) (the gradient) scores 1 mark a gradient of 0.50 (change in force ÷ change in acceleration) used directly as the mass scores **2** marks max	1	AO3 4.5.6.2.2 RP MS 3c
03.5	friction (acts on the trolley)	allow a force of about 0.05 N is needed to overcome friction before the trolley accelerates allow air resistance / friction in the pulley allow the bench was not tilted to compensate for friction ignore human error / zero error	1	AO3 4.5.6.2.2 RP
		Total	**10**	
04.1	the extension of the spring is directly proportional to the force on it	allow the spring obeys Hooke's law allow $F = ke$	1	AO1 4.5.3
	so equal increases in force give equal increases in extension	allow each newton moves the pointer the same distance	1	AO2 4.5.3
04.2	$k = 10 \div 0.050$	allow any correct pair of values from the straight part of the line, e.g. $4.0 \div 0.020$ an answer of 200 (N/m) scores **2** marks	1	AO2 4.5.3 MS 4a, 3c
	k = **200** (N/m)	an answer of 2 (N/m) (extension in cm) scores 1 mark	1	AO2 4.5.3 MS 4a, 3c
04.3	$E_e = 0.5 \times 200 \times 0.040^2$	allow ECF from 04.2 an answer of 0.16 (J) scores **2** marks allow $E_e = 0.5 \times 8.0 \times 0.040$ (the area under the line)	1	AO2 4.5.3 MS 3c
	E_e = **0.16** (J)	an answer of 1600 (J) (extension in cm) scores 1 mark	1	AO2 4.5.3 MS 3c
04.4	above 10 N the extension is not (directly) proportional to the force	allow the limit of proportionality is at 10 N allow the line on the graph curves above 10 N	1	AO3 4.5.3 MS 4a

Question	Answers	Extra information	Mark	AO / Spec. Ref.
	so readings on the equally spaced scale would be wrong	allow equal increases in force would no longer move the pointer equal distances the graph alone does not establish that the spring is permanently deformed	1	AO3 4.5.3 MS 4a
		Total	**8**	
05.1	0 (kg m/s)	allow zero	1	AO1 4.5.7.2
05.2	momentum of **B** = 0.80 × 0.60 = 0.48 (kg m/s)	allow total momentum after = 0 an answer of 0.40 (m/s) scores **3** marks	1	AO2 4.5.7.1, 4.5.7.2 MS 3b, 3c
	1.2 × *v* = 0.48	allow momentum of **A** = momentum of **B** allow ECF from an incorrect momentum of **B**	1	AO2 4.5.7.1, 4.5.7.2 MS 3b, 3c
	v = **0.40** (m/s)	ignore a minus sign or a direction	1	AO2 4.5.7.1, 4.5.7.2 MS 3b, 3c
05.3	momentum is conserved, so the total momentum after the plunger is released is still zero		1	AO1 4.5.7.2
	so the momentum of **A** must be equal in size and opposite in direction to the momentum of **B**	allow the trolleys exert equal and opposite forces on each other (1) so they accelerate in opposite directions (1)	1	AO2 4.5.7.2
		Total	**6**	
06.1	the turning effect of a force	allow force × perpendicular distance from the pivot	1	AO1 4.5.4
06.2	*M* = 15 000 × 20	an answer of 300 000 (N m) scores **2** marks	1	AO2 4.5.4 MS 3c
	M = **300 000** (N m)	allow 3.0×10^5 (N m)	1	AO2 4.5.4 MS 3c
06.3	(when the crane is balanced) the anticlockwise moment = the clockwise moment	allow the principle of moments may be implied by a correct equation, e.g. *W* × 6.0 = 15 000 × 20 an answer of 50 000 (N) scores **3** marks	1	AO2 4.5.4 MS 3b, 3c
	W × 6.0 = 300 000	allow ECF from 06.2	1	AO2 4.5.4 MS 3b, 3c

Question	Answers	Extra information	Mark	AO / Spec. Ref.
	W = **50 000** (N)	allow 5.0×10^4 (N)	1	AO2 4.5.4 MS 3b, 3c
06.4	the moment of the load (about the tower) increases		1	AO2 4.5.4
	so the clockwise moment of the load is greater than the anticlockwise moment of the counterweight	allow the moments are no longer balanced allow there is a resultant moment (that turns the crane)	1	AO2 4.5.4
06.5	any **one** from: • move the load closer to the tower • move the counterweight further from the tower • use a heavier counterweight	ignore use a stronger cable	1	AO3 4.5.4
		Total	**9**	
07.1	the sound wave makes the diaphragm vibrate	allow the pressure variations / compressions and rarefactions move the diaphragm backwards and forwards	1	AO1 4.7.3.1, 4.7.3.3
	so the coil moves backwards and forwards in the magnetic field	allow the coil cuts the magnetic field lines	1	AO1 4.7.3.1, 4.7.3.3
	a potential difference is induced across the coil	allow generator effect / electromagnetic induction allow a current is induced	1	AO1 4.7.3.1, 4.7.3.3
	the direction of the induced potential difference reverses each time the coil changes direction	allow so the potential difference alternates	1	AO1 4.7.3.1, 4.7.3.3
07.2	a trace with a smaller amplitude	the trace must be a regular wave the two marks are independent	1	AO2 4.6.1.2, 4.7.3.3
	a trace with a shorter period	allow more waves across the screen	1	AO2 4.6.1.2, 4.7.3.3
07.3	the current in the coil is in a magnetic field, so there is a force on the coil	allow the motor effect	1	AO1 4.7.2.4
	the force reverses direction each time the current reverses, so the coil vibrates	allow the coil moves backwards and forwards	1	AO1 4.7.2.4
	the coil makes the diaphragm vibrate, which produces compressions and rarefactions in the air	allow pressure variations in the air allow cone for diaphragm	1	AO1 4.7.2.4

<table>
<tr><th>Question</th><th>Answers</th><th>Extra information</th><th>Mark</th><th>AO / Spec. Ref.</th></tr>
<tr><td>07.4</td><td>the peak potential difference is directly proportional to the number of rotations each second</td><td>allow as the number of rotations increases the peak potential difference increases for 1 mark</td><td>1</td><td>AO3
4.7.3.2
MS 1c</td></tr>
<tr><td></td><td>data used to show proportionality, e.g. doubling the number of rotations from 10 to 20 doubles the peak potential difference from 3.2 V to 6.4 V</td><td>allow peak potential difference ÷ rotations each second = 0.32 for every pair
do not accept data that only shows an increase</td><td>1</td><td>AO3
4.7.3.2
MS 1c</td></tr>
<tr><td colspan="3">Total</td><td>11</td><td></td></tr>
<tr><td>08.1</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></td><td>6</td><td>AO1
4.6.2.2
RP</td></tr>
<tr><td></td><td colspan="2">Indicative content
• place the plates the same distance from the heater
• switch on the heater
• record the starting temperature of each plate
• record the temperature of each plate at regular intervals, e.g. every minute
• for the same time, e.g. 5 minutes
• calculate the temperature increase of each plate
• the plate with the greater temperature increase in the same time is the better absorber
• use plates of the same metal, size and thickness
• the plates should start at the same temperature
• repeat, swapping the positions of the plates
• do not touch the heater or the plates when they are hot
To reach Level 3 the method must keep both plates the same distance from the heater (this may be implied by using the set-up shown in the figure), measure the temperature of each plate over the same time and compare the temperature increases.</td><td></td><td></td></tr>
<tr><td>08.2</td><td>A / matt black</td><td></td><td>1</td><td>AO3
4.6.2.2
RP</td></tr>
</table>

<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>its temperature increased more than plate B in the same time, e.g. 14.0 °C compared with 4.4 °C in 5 minutes</td><td>the reason mark depends on A being chosen
the reason must use data from the table
allow a comparison of any pair of temperatures at the same time</td><td>1</td><td>AO3
4.6.2.2
RP</td></tr>
<tr><td>08.3</td><td>$\Delta E = 0.080 \times 900 \times 14.0 = 1008$ (J)</td><td>an answer of 3.36 (W) scores 3 marks</td><td>1</td><td>AO2
4.1.1.3, 4.1.1.4
MS 3c</td></tr>
<tr><td></td><td>time = 5 × 60 = 300 (s)</td><td></td><td>1</td><td>AO2
4.1.1.3, 4.1.1.4
MS 3c</td></tr>
<tr><td></td><td>$P = 1008 \div 300 =$ 3.36 (W)</td><td>allow 3.4 (W)
an answer of 201.6 (W) (time in minutes) scores 2 marks
allow ECF from an incorrect energy</td><td>1</td><td>AO2
4.1.1.3, 4.1.1.4
MS 3c</td></tr>
<tr><td>08.4</td><td>as plate A gets hotter it transfers energy to the surroundings at a greater rate</td><td>allow it emits more (infrared) radiation as its temperature increases
allow it loses more energy to the air
ignore it absorbs less radiation</td><td>1</td><td>AO3
4.6.2.2
RP</td></tr>
<tr><td colspan="3">Total</td><td>12</td><td></td></tr>
<tr><td>09.1</td><td colspan="2"><table>
<tr><td>Level 3
(5–6 marks)</td><td>A detailed and coherent description of the life cycle in the correct order, from the formation of the star to its final stage, with a clear explanation of why the star is stable.</td></tr>
<tr><td>Level 2
(3–4 marks)</td><td>A description of most of the stages in the correct order, with some explanation of how the star forms or why it is stable.</td></tr>
<tr><td>Level 1
(1–2 marks)</td><td>Simple statements about some of the stages. The stages may not be in the correct order.</td></tr>
<tr><td>0 marks</td><td>No relevant content.</td></tr>
</table></td><td>6</td><td>AO1
4.8.1.1, 4.8.1.2</td></tr>
</table>

Question	Answers	Extra information	Mark	AO / Spec. Ref.
	Indicative content • a cloud of dust and gas (a nebula) • is pulled together by gravity • to form a protostar • the temperature of the protostar increases • until hydrogen nuclei fuse to form helium nuclei (nuclear fusion starts) • the star is now a main sequence star • the inward force due to gravity is balanced by the outward pressure (force) caused by the energy released by fusion • so the star is in equilibrium: it does not collapse or expand • the star contains a very large amount of hydrogen, so fusion and the balance of forces continue for billions of years • when the hydrogen runs out, the star expands to become a red giant • helium nuclei fuse to form heavier elements • the star then collapses to become a white dwarf (allow the red giant loses its outer layers, leaving the hot core as a white dwarf) • the white dwarf cools and fades; it would eventually become a black dwarf To reach Level 3 the answer must include how the star forms, the balance of forces during the main sequence and the stages after the main sequence in the correct order. An answer that gives a supernova, a neutron star or a black hole for a star the size of the Sun cannot reach Level 3.			
09.2	In a supernova	if more than one box is ticked, no mark	1	AO1 4.8.1.2
09.3	from the weather satellite to the navigation satellite the radius increases 4 times (7 000 km to 28 000 km)	allow a correct comparison of any two objects in the table	1	AO3 4.8.1.3 MS 1c
	but the orbital speed only halves (7.5 km/s to 3.8 km/s); if it were inversely proportional it would fall to a quarter (1.9 km/s)	allow radius × speed is not constant, e.g. 52 500 and 106 400, for **2** marks	1	AO3 4.8.1.3 MS 1c
09.4	velocity includes direction, and the direction of motion changes continuously around the orbit	allow the speed stays the same but the direction changes	1	AO1 4.8.1.3
	gravity provides a resultant force towards the Earth / centre of the orbit, causing this change in direction	allow centripetal force towards the centre do not accept gravity increases the speed in a circular orbit	1	AO2 4.8.1.3
		Total	**11**	
10.1	a ray from the top of the object passing through the centre of the lens without changing direction	allow a ray that is not continued beyond the lens	1	AO2 4.6.2.5 MS 5b

Question	Answers	Extra information	Mark	AO / Spec. Ref.
	a ray from the top of the object parallel to the principal axis, refracted at the lens away from the axis, with a construction line back to the principal focus on the object side	the construction line can be dashed or solid allow, instead of either ray, a ray directed towards the principal focus on the far side that leaves the lens parallel to the axis, with a construction line back parallel to the axis	1	AO2 4.6.2.5 MS 5b
	image drawn as an upright arrow from the axis to where the lines meet: 4 squares from the lens and 2 squares high	allow ± half a square the image mark depends on at least one correct ray	1	AO2 4.6.2.5 MS 5b
10.2	any **two** from: • virtual • upright • diminished / smaller than the object • on the same side of the lens as the object	mark independently of 10.1 (no ECF) do not accept real, inverted or magnified / enlarged	2	AO1 4.6.2.5
10.3	magnification = 2 ÷ 6	allow ECF from the image drawn in 10.1 an answer of 0.33 scores **2** marks	1	AO2 4.6.2.5 MS 1c, 3c
	magnification = **0.33**	allow 0.3 / ⅓ an answer of 3 (object height ÷ image height) scores 1 mark	1	AO2 4.6.2.5 MS 1c, 3c
10.4	the leaf reflects only green light	allow the leaf absorbs all colours except green / absorbs red light	1	AO1 4.6.2.6
	the red filter absorbs green light	allow the red filter only transmits red light	1	AO1 4.6.2.6
	so no light from the leaf passes through the filter (to the eye)	allow no light reaches the eye	1	AO2 4.6.2.6
10.5	$3.0 \times 10^8 = f \times 7.0 \times 10^{-7}$	allow $f = 3.0 \times 10^8 \div 7.0 \times 10^{-7}$ an answer of 4.3×10^{14} (Hz) scores **2** marks	1	AO2 4.6.1.2, 4.6.2.6 MS 1b, 3b, 3c
	f = **4.3×10^{14}** (Hz)	allow 4.29×10^{14} (Hz) allow 430 000 000 000 000 (Hz)	1	AO2 4.6.1.2, 4.6.2.6 MS 1b, 3b, 3c
		Total	**12**	
11.1	$E_k = 0.5 \times 1200 \times 20^2$	an answer of 8000 (N) scores **4** marks	1	AO2 4.1.1.2, 4.5.2, 4.5.6.3.4 MS 3b, 3c

Question	Answers	Extra information	Mark	AO / Spec. Ref.
	E_k = 240 000 (J)		1	AO2 4.1.1.2, 4.5.2, 4.5.6.3.4 MS 3b, 3c
	240 000 = F × 30	allow work done by the braking force = kinetic energy lost allow ECF from an incorrect kinetic energy	1	AO2 4.1.1.2, 4.5.2, 4.5.6.3.4 MS 3b, 3c
	F = **8000** (N)	alternative method: $a = 20^2 \div (2 \times 30)$ (1) a = 6.7 (m/s^2) (1) F = 1200 × 6.7 (1) F = 8000 (N) (1) allow 8040 (N) from a = 6.7	1	AO2 4.1.1.2, 4.5.2, 4.5.6.3.4 MS 3b, 3c
11.2	doubling the speed from 10 m/s to 20 m/s makes the braking distance 4 times greater (7.5 m to 30.0 m)	allow tripling the speed makes the braking distance 9 times greater	1	AO3 4.5.6.3.4 MS 1c
	if the student were correct, the braking distance would double (to 15 m)	allow braking distance ÷ speed is not constant	1	AO3 4.5.6.3.4 MS 1c
	so the student is not correct: the braking distance is proportional to the speed squared	allow because the kinetic energy is proportional to the speed squared	1	AO3 4.5.6.3.4 MS 1c
		Total	**7**	
		TOTAL FOR PAPER	**100**	