OCR
Oxford Cambridge and RSA

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GCSE (9–1)

Physics B (Twenty First Century Science)

J259/03: Breadth in physics (Higher Tier)

General Certificate of Secondary Education

Mark Scheme for November 2020

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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Annotations

Annotation	Meaning
	Correct response
	Incorrect response
	Omission mark
BOD	Benefit of doubt given
CON	Contradiction
RE	Rounding error
SF	Error in number of significant figures
ECF	Error carried forward
L1	Level 1
L2	Level 2
L3	Level 3
NBOD	Benefit of doubt not given
SEEN	Noted but no credit given
I	Ignore

Abbreviations, annotations and conventions used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

Annotation	Meaning
/	alternative and acceptable answers for the same marking point
✓	Separates marking points
DO NOT ALLOW	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
( )	Words which are not essential to gain credit
__	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

Subject-specific Marking Instructions

INTRODUCTION

Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

You should ensure that you have copies of these materials.

You should ensure also that you are familiar with the administrative procedures related to the marking process. These are set out in the OCR booklet **Instructions for Examiners**. If you are examining for the first time, please read carefully **Appendix 5 Introduction to Script Marking: Notes for New Examiners**.

Please ask for help or guidance whenever you need it. Your first point of contact is your Team Leader.

The breakdown of Assessment Objectives for GCSE (9-1) in Physics B:

	Assessment Objective
AO1	**Demonstrate knowledge and understanding of scientific ideas and scientific techniques and procedures.**
AO1.1	Demonstrate knowledge and understanding of scientific ideas.
AO1.2	Demonstrate knowledge and understanding of scientific techniques and procedures.
AO2	**Apply knowledge and understanding of scientific ideas and scientific enquiry, techniques and procedures.**
AO2.1	Apply knowledge and understanding of scientific ideas.
AO2.2	Apply knowledge and understanding of scientific enquiry, techniques and procedures.
AO3	**Analyse information and ideas to interpret and evaluate, make judgements and draw conclusions and develop and improve experimental procedures.**
AO3.1	Analyse information and ideas to interpret and evaluate.
AO3.1a	Analyse information and ideas to interpret.
AO3.1b	Analyse information and ideas to evaluate.
AO3.2	Analyse information and ideas to make judgements and draw conclusions.
AO3.2a	Analyse information and ideas to make judgements.
AO3.2b	Analyse information and ideas to draw conclusions.
AO3.3	Analyse information and ideas to develop and improve experimental procedures.
AO3.3a	Analyse information and ideas to develop experimental procedures.
AO3.3b	Analyse information and ideas to improve experimental procedures.

Question			Answer	Marks	AO element	Guidance
1	(a)		(D) bubble wrap reduces conduction / has low thermal conductivity ✓ thicker insulation / more layers reduces heat loss (so slower than C) ✓ **OR** (E) bubble wrap reduces conduction / has low thermal conductivity ✓ metal foil reduces heat loss by radiation ✓	**2**	**3.2a**	**ALLOW** one mark for C **and** bubble wrap reduces conduction / has low thermal conductivity **ALLOW** bubble wrap doesn't conduct instead of low conductivity. **IGNORE** convection **ALLOW** foil reflects thermal radiation.
	(b)	**(i)**	experiment gives the same results / same data ✓ if performed by another person / with similar equipment / in a different lab ✓	**2**	**1.1**	
		(ii)	Any **one** from: size / shape / thickness / material of tin ✓ volume / mass of water ✓ temperature of surroundings ✓	**1**	**2.1**	**ALLOW** amount of water

Question			Answer	Marks	AO element	Guidance
2	(a)	(i)	(use of biofuels has) increased ✓	1	3.1a	Increase could be shown by use of data.
		(ii)	Any **one** from: use of biofuels has been encouraged/government incentives, ✓ more cost effective ✓ to reduce carbon (dioxide) emissions, ✓ to make use of by-products/waste materials. ✓	1	3.1a	**IGNORE** renewable **ALLOW** cheap/not expensive. **ALLOW** to reduce/prevent climate change
	(b)	(i)	Any **one** from: trend shows (large) increase in wind ✓ trend shows nuclear staying the same/ (slight) increase ✓ **AND** any **one** from: (supports statement because) if trends continue we will use more wind than nuclear ✓ (does not support statement because) we do not know if the trends will continue in the future ✓	2	3.1b	**ALLOW** nuclear not (significantly) changed **ALLOW** evaluation based on both trends e.g. the evidence / it support this statement because wind is increasing and nuclear is not [2]
		(ii)	data includes nuclear which is not renewable ✓	1	3.2b	**DO NOT ALLOW** biofuel is not renewable.
		(iii)	any value from 9(%) to 10(%) ✓	1	2.2	

Question			Answer	Marks	AO element	Guidance
3	(a)		electrons (in atoms) ✓ lose energy ✓	2	1.1	**ALLOW** electrons change energy levels (2 marks) **DO NOT ALLOW** beta decay or emission of particles
	(b)	(i)	(ultraviolet radiation is) ionising ✓ damages / mutates DNA or cells OR causes cancer/tumours ✓	2	1.1	 **ALLOW** kills cells
		(ii)	(ultraviolet radiation) cannot penetrate the steel casing ✓	1	3.2 b	**ALLOW** radiation absorbed by steel casing **ALLOW** steel casing reflects (ultraviolet radiation inside the container).
	(c)		Any **two** from: (alpha radiation) not penetrating enough (to disinfect all of the water) ✓ alpha-emitting isotope could contaminate water supply ✓ activity of alpha source will fall with time ✓ risk of handling alpha <u>source</u> ✓	2	1.1	 **ALLOW** alpha radiation cannot penetrate water **DO NOT ALLOW** alpha particles remain in the water **IGNORE** alpha cannot penetrate the steel case **ALLOW** alpha source may have a short half-life

Question			Answer	Marks	AO element	Guidance
4	(a)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 3.17×10^{29} award 3 marks** recall momentum = mass × velocity ✓ $2.73 \times 10^{24} \times 116\,000$ ✓ 3.17×10^{29} (kg m/s) ✓	3	**1.2** **2 × 2.1**	**ALLOW** 3.2×10^{29} **ALLOW** up to 2 marks for the correct calculation using data for the wrong planet Planet 2: $6.26 \times 10^{25} \times 89\,000 = 5.57 \times 10^{30}$ (kg m/s) **or** 5.6×10^{30} Planet 3: $3.87 \times 10^{25} \times 59\,000 = 2.28 \times 10^{30}$ (kg m/s) **or** 2.3×10^{30}
	(b)	**(i)**	velocity depends on/has direction ✓ (due to force of gravity) direction changes ✓	**2**	**1.1**	**ALLOW** velocity is a vector quantity **ALLOW** force of gravity is always towards the centre of the orbit.
		(ii)	force of gravity is weaker at larger radius ORA ✓ so slower speed needed to maintain a stable orbit/constant radius ORA ✓	**2**	**1.1**	**ALLOW** centripetal force/force/gravity gets weaker with distance **ALLOW** so (a faster planet) would not stay in orbit / so not strong enough to change direction (of a faster planet)

Question			Answer	Marks	AO element	Guidance
5	(a)	(i)	our eyes (only) detect a (narrow) **range** of frequencies ✓ this range does not include radio waves ✓	2	1.1	**ALLOW** wavelength for frequency **ALLOW** the frequency is out of range **ALLOW** the frequency is **too** low **ALLOW** the frequency is below the visible range = 2 marks **ALLOW** radio waves are not in the range of frequencies our eyes can detect = 2 marks
		(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 0.67 award 4 marks** 446 MHz = 446 × 10^6 Hz ✓ = 3.0 × 10^8 ÷ 446 × 10^6 ✓ = 0.67264…. (m) ✓ = 0.67 (m) (2sf) ✓	4	1.2 2.1 × 2 1.2	ALLOW substitution **and** calculation using **their** conversion ALLOW **their** calculated value seen **and** converted to 2 s.f.
	(b)		<u>oscillations</u> (in the electrical circuits) ✓	1	1.1	

Question			Answer	Marks	AO element	Guidance
6	(a)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 5.0 (m/s^2) award 3 marks** recall acceleration = change in velocity ÷ time ✓ 25 x 0.5 = 12.5 ✓ (25 × 0.5 **OR** 12.5) ÷ 2.5 ✓ = 5.0 (m/s^2) ✓	4	**1.2 x 2** **2.1 × 2**	**ALLOW** final answer to be either negative or positive. **ALLOW** 5 **ALLOW** max 3 if incorrect **calculation** of change in speed
	(b)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If 5000 ≤ answer ≤ 18000 award 4 marks** recall momentum = mass × velocity **AND** rearrange force = change in momentum ÷ time ✓ estimate of mass ✓ (16 × estimate of mass) ÷ 2.2 ✓ 5000 to 18000 (N) (inclusive) ✓	4	**1.2 x 2** **2.1 × 2**	Values given based on mass for car being between 700kg to 2500kg. **ALLOW** recall Force = mass x acceleration **AND** a = ∆V ÷ t **ALLOW** (±) 7.27 (m/s^2) seen

Question			Answer	Marks	AO element	Guidance
7	(a)		(measure mass using) balance **AND** (measure volume using) measuring cylinder ✓ **AND** any **two** from: accuracy of balance specified, e.g. 1 g or 0.1 g ✓ method to compensate for mass of container ✓ read volume at eye level to avoid parallax error ✓ read volume from bottom of meniscus ✓	**3**	**1.2**	
	(b)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 7.18×10^{-4} award 2 marks** $0.12 \times 0.13 \times 0.046$ / 0.0007176 / 7.176×10^{-4} ✓ 7.18×10^{-4} ✓	**2** **2.1** **1.2**		
	(c)		put sample of yoghurt in a syringe ✓ read volume from <u>scale</u> on syringe ✓ **OR** fill container to top and ensure top is level ✓ refill container with water and then measure volume of <u>water</u> with <u>measuring cylinder</u> ✓	**2**	**3.3a**	**ALLOW** other sensible suggestions reasonable idea to accurately contain a sample in a measurable volume or a known volume ✓ specifies method for measuring this volume ✓ **IGNORE** pour it in a container

Question			Answer	Marks	AO element	Guidance
8	(a)	(i)	(measure length of tray with) ruler / tape measure ✓ (measure time using) timer / stop clock / stopwatch ✓ **AND** any **one** from: measure time to travel several lengths of tray ✓ video the waves and replay in slow motion ✓	3	1.2	**ALLOW** e.g. paper marked in centimetres **IGNORE** measure the time / measure the distance
		(ii)	Any **one** from: method to drop tray identically, e.g. rest end of tray on book, then remove book ✓ alternative method to generate waves, e.g. use vibrating dipper/bar as in a ripple tank ✓	1	3.3b	**ALLOW** drop tray from same height **or** tip the tray to the same angle / stated angle **IGNORE** vague methods e.g. use a machine to drop the tray **ALLOW** e.g. use a ripple tank/apparatus with a set frequency **or** use a vibrating motor
	(b)	(i)	point plotted to within half a small square ✓	1	2.2	
		(ii)	as depth increases speed increases ✓ description of non-linear relationship / idea that the variables are not proportional ✓	2	3.1a	
		(iii)	Line drawn up from x-axis and along to y-axis ✓ any value between 0.1 and 0.2 ✓	2	2.2	Rationale for these values is that the candidate should recognise it is a curve and extrapolate using a curve, not a straight line.

Question			Answer	Marks	AO element	Guidance
9	(a)		(some energy is transferred by) radiation / electromagnetic waves / gamma rays ✓ (some energy is transferred to/from a store of) kinetic energy of the particles ✓	2	1.1	**DO NOT ALLOW** thermal energy (given in (b)(ii)) **ALLOW** the KE of the neutron
	(b)	(i)	Any **two** from: More neutrons so more fission ✓ More uranium for the neutrons to hit ✓ The neutron(s) released in one fission go on to cause more fissions ✓	2	1.1	**ALLOW** neutron**s** released in one fission go on to cause further reactions / split more nuclei = 2 marks
	(b)	(ii)	(coolant A) because difference in density is larger than difference in specific heat capacity ✓ calculation to support argument (e.g. s.h.c. of B is 8.7 times greater than A, but density of A is 12.8 times greater than B) ✓	2	3.2b	**ALLOW** A has lower shc but it is **a lot** more dense **Alternative approach:** A removes more energy per m^3 per °C e.g. 150 x 11000 = 1.65 MJ/m^3 °C but 1300 x 860 = 1.118 MJ/m^3 °C

Question			Answer	Marks	AO element	Guidance
10	(a)		Any **one** from: (vibration in P-waves is) parallel / same direction, ✓ (vibration in S-waves is) perpendicular / right angles ✓ **AND** to direction of travel / propagation / energy transfer / AW ✓	**2**	**1.1**	independent mark
	(b)	**(i)**	S-waves do not travel through liquids / <u>only</u> travel through solids✓ liquid in Earth's core has blocked / reflected S-waves ✓	**2**	**2.1**	**IGNORE** references to P-waves
		(ii)	waves reflect from boundaries ✓ waves pass through mantle by reflection / refraction / diffraction ✓	**2**	**2.1**	**ALLOW** wave passing through mantle and reflecting from crust or core on diagram = 2 marks

Question			Answer	Marks	AO element	Guidance
11	(a)		resultant force must be zero ✓	1	1.1	**ALLOW** net force is zero **IGNORE** balanced / all forces are equal
	(b)	(i)	downwards arrow drawn ✓ labelled weight / force of gravity / contact force ✓	2	2.1	**ALLOW** gravity
		(ii)	They (both) **accelerate** upwards ✓ **OR** Elastic rope contracts/shortens/tension becomes zero, pulling the metal ring up ✓	1	2.1	

Question			Answer	Marks	AO element	Guidance
12	(a)		wavelength / colour (of emitted light) depends on temperature ✓ the stars have different temperatures ✓	2	1.1	**ALLOW** C has shortest wavelength / B has longest wavelength **ALLOW** C is the hottest / B is the coolest / blue is hotter than red ORA **ALLOW** hottest star / C has shortest wavelength / is bluer **OR** coolest star / B has longest wavelength / is redder =2 marks **IGNORE** different colours have different wavelengths - stem
	(b)	(i)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 625 award 3 marks** recall / rearrange time = distance ÷ speed ✓ ($6 \times 10^{18} \div 3.0 \times 10^{8}$ =) 2×10^{10} (s) ✓ ($2 \times 10^{10} \div 3.2 \times 10^{7}$ =) 625 (years) ✓	3	1.2 2 × 2.1	**ALLOW** 1 mark for 2×10^{n}, $n \neq 10$ **ALLOW** 2 marks for 6.25×10^{n}, $n \neq 2$
		(ii)	(all electromagnetic radiation) travels at the same speed (in space) ✓	1	2.1	**ALLOW** travels at the speed of light

Question			Answer	Marks	AO element	Guidance
13	(a)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 224 award 4 marks** 5.0 cm = 0.050 m ✓ Select equation: $E = ½ kx^2$ ✓ Substitute (and rearrange); $k = 2 \times 0.28 / 0.05^2$ ✓ 224 (N/m) ✓	**4**	 **1.2** **1.2** **2.1 × 2**	**ALLOW** 3 marks if unit conversion omitted (0.0224)
	(b)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 4 award 3 marks** recall $½ mv^2$ and rearrange to give: $v = \sqrt{(2E/m)}$ ✓ substitute: $v = \sqrt{(2 \times 0.32 / 0.040)}$) ✓ 4.0 (m/s)) ✓	**3**	 **1.2** **2.1 × 2**	 **ALLOW** 2 marks for 16
	(c)	**(i)**	work done = force × distance moved ✓	**1**	**1.2**	**ALLOW** W = Fs
		(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 0.0625 award 4 marks** calculate GPE gain: 0.040 × 10 × 0.50 / 0.20 (J) ✓ calculate thermal energy transfer: (0.25 - 0.20 =) 0.05 J ✓ substitute into work done equation: 0.05 = F × 0.80 ✓ calculate F: 0.0625 (N) ✓	**4**	**2.1**	

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