Cambridge Assessment International Education

Cambridge Pre-U

PHYSICS **9792/02**

Paper 2 Written Paper **October/November 2020**

MARK SCHEME

Maximum Mark: 100

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the October/November 2020 series for most Cambridge IGCSE™, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct / valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Science-Specific Marking Principles

1	Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
2	The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.
3	Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection).
4	The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.
5	<u>‘List rule’ guidance</u> For questions that require ***n*** responses (e.g. State **two** reasons …): • The response should be read as continuous prose, even when numbered answer spaces are provided. • Any response marked *ignore* in the mark scheme should not count towards ***n***. • Incorrect responses should not be awarded credit but will still count towards ***n***. • Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should **not** be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response. • Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science.

6	<u>Calculation specific guidance</u> Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states ‘show your working’. For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values. For answers given in standard form (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient (a) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme. Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.
7	<u>Guidance for chemical equations</u> Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme. State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

Question	Answer	Marks
1(a)	(a device) that is supplied with / converts thermal energy	**1**
	converts(some of energy) into useful / mechanical work / energy	**1**
1(b)(i)	(electrical energy output =) $2.25 \times 10^9 \times 12.0 \times 3600$ **or** 9.72×10^{13} (J)	**1**
	(energy input =) $\dfrac{\text{total energy output}}{\text{efficiency}}$ **or** $9.72 \times \dfrac{10^{13}}{0.375}$ **or** (power input =) $\dfrac{\text{total power output}}{\text{efficiency}}$ **or** $\dfrac{2.25 \times 10^9}{0.375} = 6.00 \times 10^9$	**1**
	2.59×10^{14} (J)	**1**
1(b)(ii)	(power wasted in =) $(2.25 \times 10^9) / (0.375) - 2.25 \times 10^9$ **or** $2.25 \times 10^9 \times 0.625 / (0.375)$ **or** 3.75×10^9 (W)	**1**
	$(\Delta\theta =)\ \dfrac{E}{mc}$ **or** $\dfrac{3.75 \times 10^9}{38000 \times 4180}$	**1**
	23.6 (K)	**1**

Question	Answer	Marks
2(a)	undergoes a large amount of plastic deformation before breaking **or** requires a large quantity of energy to break it	**1**
2(b)(i)	(region where) strain is directly proportional to stress **or** where strain-stress graph is a straight line that passes through the origin	**1**

Question	Answer	Marks
2(b)(ii)	(extension =) $\frac{Fl}{EA}$ **or** (A =) ¼πd^2 **or** $\frac{4Fl}{E\pi d^2}$ **or** $(4 \times 60.0 \times 2.50) / (1.85 \times 10^{11} \times \pi \times (6.10 \times 10^{-4})^2)$	1
	2.77×10^{N} (m)	1
	2.77×10^{-3} (m)	1
2(c)	(plastically deformed object) does not returns to its original form	1
	when stress / force / load is removed	1
	sheets of atoms slide over each other **or** atoms drop down into the next space **or** move to a new position **or** dislocations move **or** long chains uncoil	1

Question	Answer	Marks
3(a)(i)	(weight = $960 + (2.4 \times 9.81)$) = 984 (N)	1
3(a)(ii)	$2T\cos(11.5°) = 984$ **or** $2T\sin(78.5°) = 984$ **or** $2T\cos(11.5°) = 960 + (2.4 \times 9.81)$	1
	502 (N)	1
3(b)(i)	(ΔE =) $mg\Delta h$ **or** $W\Delta h$ **or** 960×3.50	1
	3.36×10^{3} (J)	1
3(b)(ii)	tension increases **and** angle (of rope) changes	1
	cosine of angle (with vertical) decreases **or** angle (of rope to vertical) increases	1
3(b)(iii)	area under graph (according to the scale)	1
3(c)(i)	rope / lower pulley has to be lifted up / has weight / load has kinetic energy / strain energy in stretched rope	1

Question	Answer	Marks
3(c)(ii)	force applied less than (weight of the) load **or** operator does not need to lift himself / herself **or** it is easier to pull than to lift **or** lift weight to any height	**1**

Question	Answer	Marks
4	**any point from** no water after t = 4.0 s maximum speed of trolley = 1.76 m s^{-1} area under graph is distance travelled the trolley travels a distance of 2.88 m whilst accelerating the trolley travels a distance of 4.35 m whilst decelerating the trolley travels a distance of 7.25 m in 7.0 s gradient of graph is acceleration acceleration increases at the beginning up to 4.0 s initial acceleration = 0.267 m s^{-2} at 4.0 s, the acceleration is 0.80 m s^{-2} (after 4.0 s) the deceleration is 0.20 m s^{-2} $M_{trolley} = F_{friction}$ / deceleration = 0.5 / 0.2 = 0.25 kg m_{water} (initially) = 2.0 × $m_{trolley}$ **or** m_{water} (initially) = 0.50 kg **or** V_{water} (initially) = 5.0 × 10^{-4} m^3 Thrust larger than resistive force $F_{forward} - F_{resistance}$ = mass trolley × acc → $F_{forward}$ = 0.25 N $F_{fwd} - F_R = M \times 0.267 \rightarrow M = (0.25 - 0.05) / 0.267$ M (initial total mass) = 0.75 kg maximum momentum of trolley = 0.25 × 1.76 = 0.44 kg m s^{-1} water expelled at 0.125 kg s^{-1} **or** 1.25 × 10^{-4} m^3 s^{-1} water expelled at speed of 0.25 / 0.125 = 2.0 m s^{-1} cross-sectional area of nozzle = 1.25 × 10^{-4} / 2.0 = 6.25 × 10^{-5} m^2 **or** radius of nozzle = 4.46 × 10^{-3} m	**8**

Question	Answer	Marks
4	can determine when trolley comes to rest by continuing line of graph trolley comes to rest at 12.75 s or after a further 8.75 s **Max. 8** **max. 3 ex4** **max. 4 ex5**	

Question	Answer	Marks
5a	$\left(I = \dfrac{24.0}{12.0} \text{ and } R = \dfrac{12.0}{2.00} = \right) 6.00\,\Omega$	1
5(b)(i)	circuit diagram of potential divider / potentiometer, battery and lamp connected correctly	1
	ammeter and voltmeter correct	1
	description of how to vary voltage (from 0 to 12 V) **and** read voltmeter and ammeter	1
	description of how to vary voltage from 0 to 12 V **and** whole length of potentiometer wire used (in some way) / take repeated readings	1
5(b)(ii)	graph of continually increasing gradient starting at (0, 0) **and** ending at (I_O, 12.0 V)	1
	gradient at (I_O, 12.0 V) > 0 **and** (I_O =) 2.00 (A)	1

Question	Answer	Marks
5(c)(i)	**Either** ($R_{\parallel}$ =) 10.0 (Ω) **and** (R_{tot} =) 30.0 (Ω)	**1**
	($V_{15.0}$ =) $\frac{10.0}{30.0} \times 12.0$ **or** 4.0 (V)	**1**
	0.267 (A)	**1**
	Or ($R_{\parallel}$ =) 10.0 (Ω) **and** (R_{tot} =) 30.0 (Ω)	**(1)**
	($I_{15.0}$ =) $\frac{12.0}{30.0} \times \frac{30.0}{”45.0}$ **or** 0.400 (A)	**(1)**
	0.267 (A)	**(1)**
5cii	resistance (of parallel pair / circuit) decreases **and** voltage across parallel pair decreases **or** more voltage / p.d. across 20.0 Ω	**1**
	current decreases	**1**

Question	Answer	Marks
6(a)(i)	two (identical / similar progressive) waves travelling in opposite directions combined	**1**
	with positions of maximum variation / displacement / vibration / field **and** positions of no variation / displacement / vibration / field / **or** pattern does not move **or** no net transfer of energy	**1**
6(a)(ii)	microwave combines with / superposes / interferes with its own reflection	**1**
6(a)(iii)	(distance = λ / 4 = (0.0310) / 4) = 7.75×10^{-3} (m)	**1**

Question	Answer	Marks
6(b)(i)	microwaves are transverse **and** sound waves are longitudinal	1
	microwaves oscillate perpendicular to the direction of propagation in many directions, longitudinal waves vibrate parallel (in one direction) to direction of propagation	1
6(b)(ii)	minima at 0°, 180° and 360° **and** maxima at 90° and 270°	1
	clear |sin θ| graph with obvious inverted cusps at 0°, 180° and 360°	1

Question	Answer	Marks
7(a)	$(I =)\ \Delta Q / \Delta t$ **or** $\dfrac{6.24\times10^{-8}}{0.325x10^{-3}}$ **or** $\dfrac{6.24\times10^{-8}}{3.25\times10^{-4}}$	1
	1.92×10^{-4} (A)	1
7(b)(i)	(photon) energy supplied to electron exceeds work function **or** frequency greater than threshold frequency	1
	negative sphere loses photoelectrons (and discharges) **or** loses electrons due to the photoelectric effect	1
	(negative) electrons attracted to positive sphere **or** not enough energy to overcome attractive force **or** tends to make sphere <u>more</u> positive **or** sphere X has reached stopping potential	1
7(b)(ii)	one photon absorbed by each electron **or** only the quantity of energy of one photon is absorbed **or** kinetic energy of electrons = photon energy – work function	1
	photon energy is a constant (for monochromatic radiation)	1
7(b)(iii)	some electrons do more work (than others) as they escape **or** they collide with more atoms / electrons as they escape **or** they come from deeper within the metal	1

Question	Answer	Marks
7(b)(iv)	$E = hf$ **or** $E = hc / \lambda$	1
	$(\Delta E =)\ hc\left(\frac{1}{1.28\times10^{-7}} - \frac{1}{2.56\times10^{-7}}\right)$ **or** $6.63 \times 10^{-34} \times 3.00 \times 10^{8} \times \left(\left(\frac{1}{1.28\times10^{-7}} - \frac{1}{2.56\times10^{-7}}\right)\right)$	1
	or 7.77×10^{-19} **or** $(\Phi =)\ \frac{6.63\times10^{-34}\times3.00\times10^{8}}{2.56\times10^{-7}} - 1.24 \times 10^{-19}$ 9.01×10^{-19} (J)	1

Question	Answer	Marks
8(a)(i)	${}^{238}_{92}\mathrm{U}$	1
	(+) ${}^{1}_{0}\mathrm{n}$	1
8(a)(ii)	β^- **and** β^-	1
	93	1
8(b)(i)	splitting up of a (large) nucleus / nuclide	1
	after absorbing a neutron / being hit by neutron **or** neutrons collide with more nuclei	1
8(b)(ii)	fission releases neutron(s)	1
	neutrons prompt further fission **or** neutrons collide with further nuclei	1
8(c)	(number of half-lives =) $\frac{9.64\times10^{4}}{2.41\times10^{4}}$ **or** 4.0	1
	(proportion remaining =) 0.0625	1

Question	Answer	Marks
9(a)(i)	(charge = (+)2*e* = 2 × (+) 1.60 × 10^{-19} C =) 3.2 × 10^{-19} (C)	**1**
9(a)(ii)	((2*e*)*V* = 5.48 MeV ⇒ 5.48 × 10^{6} V / 2 =) 2.74 × 10^{6} (V) **or** 2.74 M(V)	**1**
9(a)(iii)	$\frac{1}{2} mv^2 = 5.48 \times 10^{6} \times 1.60 \times 10^{-19}$ **or** $\frac{1}{2} mv^2 = 8.768 \times 10^{-13}$ **or** $(v =) \sqrt{(2 \times 8.768 \times 10^{-13} / 6.64 \times 10^{-27})}$	**1**
	$(= \sqrt{2.641 \times 10^{14}}\ \mathrm{m^2\,s^{-2}} =)\ 1.63 \times 10^{7}\ (\mathrm{m\,s^{-1}})$	**1**
9(a)(iv)	**any two from:** alpha has twice the electrical charge of beta / **or** more mass alpha is slower **and** nearer air molecules for longer (greater interaction with air molecules) so alpha loses energy faster alpha has more ionisation (more energy loss per unit length) alpha has more mass / more momentum for the same kinetic energy alpha has greater interactions as it penetrates further into the atom beta deflected away by other atoms so do not get close	**2**
9(b)(i)	any time with p.d. > 0	**1**
9(b)(ii)	**any three from:** no electric field within tube / constant potential in tube so no acceleration of protons in tube the voltage / field reverses (from negative to positive) when the protons are in the tubes (when it reaches the next gap) the next tube is negative tube length increases (along accelerator path) to make alternating pd match position of accelerating protons	**3**
9(b)(iii)	(*T* =) 80 ns **and** (*f* =) 1.25×10^{7} (Hz)	**1**
	f_{range} $3 \times 10^{7} - 1.5 \times 10^{5}$ **or** (λ =) 24 m can be so classified 1.5×10^{5} (Hz) < 1.25×10^{7} (Hz) <3.0×10^{7} (Hz) **or** 10 (m) < 24 (m) < 2000 (m)	**1**
9(c)(i)	**any two from** *v* is perpendicular to *B* *F* is perpendicular to *B* and to *v* (both are constant) *F* perpendicular to *v* results in circular motion (in the plane of the dee)	**2**

Question	Answer	Marks
9(c)(ii)	$\frac{mv^2}{r} = Bqv$	**1**
	evidence of rearrangement leading to $r = \frac{mv}{Bq}$	**1**
9(c)(iii)	**Either** v_{max} occurs when r = 0.14 m	**1**
	v_{max} = (0.14 × 1.60 × 10^{-19} × 1.1) / 1.67 × 10^{-27}) **or** 1.475 × 10^7 (m s^{-1})	**1**
	(E_{max} = ½ mv_{max}^2 = 0.5 × 1.67 × 10^{-27} kg × (1.475 × 10^7 m s^{-1})^2 = 1.818 × 10^{-13} (J) = (1.818 × 10^{-13} (J)) / (1.60 × 10^{-19} (J) × 10^6) =) 1.14 MeV – claim valid	**1**
	Or At energy 1 MeV radius should be less than when r = 0.14 m	**(1)**
	E = ½mv² → $v = \sqrt{\frac{2\times1\times1.6\times10^{-19}}{1.67\times10^{-27}}}$ = 1.38 x10^7	**(1)**
	$r = mv / Bq = \frac{1.67\times10^{-27}\times1.38\times10^{7}}{1.1\times1.6\times10^{-19}}$ = 1.33 < 0.14 – claim valid	**(1)**
9(c)(iv)	(proton gains 50 keV twice per orbit and so number of orbits is: 1 × 10^6 eV / (2 × 50 × 10^3 eV) =) 10	**1**
9(c)(v)	(mean orbital radius = ½ × r of dee =) 0.07 m	**1**
	(distance = 10 × 2πr = 20π × 0.07 =) 4.40 m ;	**1**
9(d)(i)	charges move up and down (alternately) **or** alternating electric field	**1**
	velocity of charges changes **or** (alternating) field causes (an alternating) force on charges	**1**
9(d)(ii)	(centripetal) acceleration **or** changing direction and changing velocity ;	**1**