Cambridge Assessment International Education
Cambridge Pre-U Certificate

PHYSICS **9792/02**

Paper 2 Written Paper 2 **May/June 2019**

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.

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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.

Question	Answer	Mark
1(a)	velocity / it has a direction **or** is a vector	**1**
1(b)(i)	$v \sin\theta$ **or** $13.1 \sin 15.0°$	**1**
	3.39 (m s^{-1})	**1**
1(b)(ii)	(s =) $u^2/2g$ **or** ($3.39^2/(2 \times 9.81)$)	**1**
	0.586 (m)	**1**
1(c)	(resultant) force is proportional to the rate of change of momentum	**1**
1(d)(i)	(p =) $\pi D^2 v^2 t\rho/4$ **or** $\pi \times 0.0400^2 \times 13.1^2 \times 1.00 \times 1000/4$ (kg m s^{-1})	**1**
	216 (kg m s^{-1})	**1**
1(d)(ii)	water has momentum / velocity as it enters the nozzle	**1**

Question	Answer	Mark
2(a)(i)	no resultant force	**1**
	no resultant moment/torque	**1**
2(a)(ii)	perpendicular distances = 0.480 (m) **or** $T\sin\theta$ **or** $T\cos\theta$ **or** (2 ×) 47.2 × 0.600	**1**
	(m =) Tx_1/x_2g **or** (W =) Tx_1/x_2 **or** 2 × 47.2 × 0.480 / (0.650 × 9.81) **or** 2 × 47.2 × 0.480 / 0.650 **or** 47.2 × 0.480 / (0.650 × 9.81) **or** 3.55 (kg)	**1**
	7.11 (kg)	**1**
	or	
	0.650 × 9.81 × m = 47.2 × 2 × sin(36.9°) × 0.800	**1**
	9.81 × m = 69.7 (N)	**1**
	7.11 (kg)	**1**
2(b)	(length of a cable =) 1.00 (m)	**1**
	(e =) Tl/EA **or** 47.2 × 1.00 / (1.90 × 10^{11} × 7.50 × 10^{-5})	**1**
	3.31 × 10^{-6} (m)	**1**

Question	Answer	Mark
3(a)	variable potential divider (powering lamp)	**1**
	ammeter, voltmeter and lamp connected correctly	**1**
3(b)(i)	6.00 (Ω) **cao**	**1**
3(b)(ii)	2.35 – 2.65 (Ω)	**1**

Question	Answer	Mark
3(b)(iii)	decreasing resistance / negative gradient	**1**
	decreasing resistance / negative gradient **and** then horizontal section	**1**
3(c)	p.d. across fixed resistor = $2.50I$ **and** this used to give $V = 12.0 - 2.50I$	**1**
3(d)(i)	(0, 12) or (2.0, 7.0) plotted on graph	**1**
	straight line from (0, 12) to (2.0, 7.0)	**1**
3(d)(ii)	3.90 – 4.30 (V)	**1**

Question	Answer	Mark
4(a)	a force is exerted through a distance **or** pressure (increase) reduces volume	**1**
4(b)(i)	(p =) F/A **or** $200/2.00 \times 10^{-3}$ **or** 1.00×10^{N} (Pa)	**1**
	1.00×10^{5} (Pa)	**1**
4(b)(ii)	clear estimate of area under line **or** counting squares clear	**1**
	120 to 160 (J)	**1**
	130 to 150 (J)	**1**
4(b)(iii)	increases	**1**
	molecules collide with <u>moving</u> piston	**1**
	collision with piston increases speed / momentum / velocity	**1**

Question	Answer	Mark
4(c)(i)	(work done on piston by gas) is greater (at every point)	**1**
	(thermal energy from explosion) increases pressure	**1**
	greater force (at every point) **and** same distance **or** greater pressure (at every point) **and** same volume change	**1**
4(c)(ii)	(a device that) uses thermal energy **and** does work	**1**

Question	Answer	Mark
5	any **eight** points from: diffraction minimum point in the range of 0.295 to 0.300 m **or** any diffraction minimum diffraction minimum separation in the range of 0.0600 to 0.0650 m from central maximum $\theta = \sin^{-1}(n\lambda / b)$ **or** $\lambda = b \sin\theta_1$ **or** $\lambda = b \sin\theta_2 / 2$ **or** $\sin\theta_1 \approx 0.0625/5.00$ **or** $\sin\theta_2 \approx 0.0125/5.00$ **or** ($\lambda \approx$) $5.20 \times 10^{-5} \times 0.0625/5.00$ **or** $2 \times 5.20 \times 10^{-5} \times 0.125/5.00$ ($\lambda \approx$) 6.50×10^{-7} m fringe width in range of 0.00615 to 0.00635 m ($a =$) $\lambda D / x$ **or** $6.50 \times 10^{-7} \times 5.00/0.00625$ ($a =$) 5.20×10^{-4} m **or** 0.520 mm red light (deduced from wavelength) **or** ($f =$) 4.62×10^{14} Hz light is monochromatic **or** consists of a single wavelength light (from the two slits) is coherent light acts as a wave / undergoes diffraction light undergoes interference some background light is reaching the sensor distance sensor is initially 0.200 m from near end of trolley **or** trolley / light sensor moves through 0.320 m or **or** central maximum at / double slits / light source opposite to 0.360 m (position)	**8**

Question	Answer	Mark
6(a)	vibrations are aligned/parallel **or** all electric/magnetic vectors/fields are parallel	**1**
	all electric/magnetic vectors/fields are parallel **or** (plane of) oscillations perpendicular to direction of travel/energy travel direction	**1**
6(b)(i)	polarising direction (of filter) is vertical/same as polarisation of the light	**1**
6(b)(ii)	attempt at sinusoidal square curve with two complete cycles **and** all values $\geqslant 0$	**1**
	$\cos^2$ curve with maximum of I_0 at 0, 180° and 360° **and** minimums of zero at 90° and 270°	**1**
6(c)	$0.262(I_0)\cos^2(30.0°)$ **or** $0.850(I_0)\cos^2(60.0°)$	**1**
	$0.409(I_0)$	**1**

Question	Answer	Mark
7(a)(i)	small region of three labelled protons and three labelled neutrons	**1**
	three labelled electrons surrounding clear nucleus in circular orbits	**1**
7(a)(ii)	$(2)\,^4_2(\alpha)$	**1**
	$^8_4(\text{Be})$	**1**
	$^2_1(\text{X})$	**1**
7(b)(i)	the nucleus is <u>much</u> smaller than the atom	**1**
	most α-particles pass nowhere near to any of the nuclei/anything	**1**

Question	Answer	Mark
7(b)(ii)	the nucleus is charged / dense / massive	**1**
	(large) force acts on the α-particle (which is charged)	**1**
7(c)	easily absorbed by air / dead skin / clothing (if outside of body)	**1**
	(substantial) ionisation (in body / tissue / cells)	**1**

Question	Answer	Mark
8(a)	(E =)eV **or** $1.6 \times 10^{-19} \times 182$ **or** $\frac{1}{2}mv^2 = eV$	**1**
	$\frac{1}{2} \times 9.11 \times 10^{-31} \times v^2 = 1.6 \times 10^{-19} \times 182$ **or** $v^2 = 2 \times 1.6 \times 10^{-19} \times 182 / 9.11 \times 10^{-31}$ **or** $v = \sqrt{(2 \times 1.6 \times 10^{-19} \times 182 / 9.11 \times 10^{-31})}$	**1**
	8.00×10^6 (m s^{-1})	**1**
8(b)	electrons are diffracted (by the crystal) **or** produce interference	**1**
	diffraction is wave property **or** destructive interference (is not a particle property)	**1**
	electrons (sometimes) behave as waves **or** have a wave aspect to their nature **or** wave-particle duality mentioned **or** a wave model is needed to explain (some) electron properties	**1**
8(c)	($\lambda = h/p$ =) $6.63 \times 10^{-34} / 1.95 \times 10^{-22}$ **or** 3.40×10^{-12}	**1**
	$b \approx \lambda / \theta$ **or** $b \approx h / p\theta$ **or** $3.40 \times 10^{-12} / 1.25 \times 10^{-7}$ **or** $6.63 \times 10^{-34} / (1.95 \times 10^{-22} \times 1.25 \times 10^{-7})$	**1**
	2.72×10^{-5} (m)	**1**

Question	Answer	Mark
9(a)(i)	${}^{1}_{1}\text{p}$ and ${}^{1}_{0}\text{n}$	**1**
	${}^{0}_{1}\beta$ and ${}^{0}_{0}\nu$	**1**
9(a)(ii)	neutron : baryon **and** hadron	**1**
	beta-plus: lepton only	**1**
	neutrino : lepton only	**1**
9(b)(i)	(it is a) force of repulsion at short-range distances	**1**
9(b)(ii)	electrostatic/Coulomb force becomes significant/acts	**1**
	between protons	**1**
9(b)(iii)	work done by/against the strong force (of attraction) **or** strong-force potential energy gained/lost	**1**
	to/from infinite separation/zero potential energy and from/to X	**1**
9(c)(i)	point on *x*-axis above minimum labelled E	**1**
9(c)(ii)	minimum (total) potential energy between nucleons **or** no resultant force	**1**

Question	Answer	Mark
9(d)(i)	1 is u **and** 3 is W^-	**1**
	2 is d **and** 4 is $\overline{u}$	**1**
9(d)(ii)	exchange particle/force carrier/(gauge) boson	**1**
9(e)(i)	(charge on l.h.s. =) $-\frac{1}{3}$ $-\frac{1}{3}$ $-\frac{1}{3}$	**1**
	(charge on r.h.s. =) $+\frac{2}{3}$ $-\frac{1}{3}$ $-\frac{1}{3}$ $-\frac{2}{3}$ $-\frac{1}{3}$	**1**
	charge is conserved **or** –1 = –1	**1**
9(e)(ii)	–3 **and** –2 seen	**1**
	word *strangeness* seen **and** not conserved (e.g. $-3 \neq -2$)	**1**
9(f)(i)	equating BQv and mv^2/r **and** rearranging to $r = mv/BQ$ **or** $r = p/BQ$ (so $r \propto p$)	**1**
9(f)(ii)	$p_p > p_\pi$ clear from diagram or labelled on diagram	**1**
	vector triangle/parallelogram **and** arrowheads	**1**
	27° marked between vectors labelled p and π	**1**
	angle from 13.5° to 14.5°	**1**