Mark Scheme (Results)

June 2017

Pearson Edexcel
GCE Advanced Subsidiary in Physics (6PH04)
Paper 01 Physics on the Move

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Quality of Written Communication

Questions which involve the writing of continuous prose will expect candidates to:

- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities.
Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

Mark scheme notes

Underlying principle

The mark scheme will clearly indicate the concept that is being rewarded, backed up by examples. It is not a set of model answers.

For example:

(iii) Horizontal force of hinge on table top

66.3 (N) or 66 (N) **and** correct indication of direction [no ue] [Some examples of direction: acting from right (to left) / to the left / West / opposite direction to horizontal. May show direction by arrow. Do not accept a minus sign in front of number as direction.]	✓	**1**

This has a clear statement of the principle for awarding the mark, supported by some examples illustrating acceptable boundaries.

1. Mark scheme format

1.1 You will not see 'wtte' (words to that effect). Alternative correct wording should be credited in every answer unless the ms has specified specific words that must be present. Such words will be indicated by underlining e.g. 'resonance'

1.2 Bold lower case will be used for emphasis.

1.3 Round brackets ( ) indicate words that are not essential e.g. "(hence) distance is increased".

1.4 Square brackets [ ] indicate advice to examiners or examples e.g. [Do not accept gravity] [ecf].

2. Unit error penalties

2.1 A separate mark is not usually given for a unit but a missing or incorrect unit will normally mean that the final calculation mark will not be awarded.

2.2 Incorrect use of case e.g. 'Watt' or 'w' will **not** be penalised.

2.3 There will be no unit penalty applied in 'show that' questions or in any other question where the units to be used have been given, for example in a spreadsheet.

2.4 The same missing or incorrect unit will not be penalised more than once within one question (one clip in epen).

2.5 Occasionally, it may be decided not to penalise a missing or incorrect unit e.g. the candidate may be calculating the gradient of a graph, resulting in a unit that is not one that should be known and is complex.

2.6 The mark scheme will indicate if no unit error penalty is to be applied by means of [no ue].

3. Significant figures

3.1 Use of an inappropriate number of significant figures in the theory papers will normally only be penalised in 'show that' questions where use of too few significant figures has resulted in the candidate not demonstrating the validity of the given answer.

3.2 The use of g = 10 m s^{-2} or 10 N kg^{-1} instead of 9.81 m s^{-2} or 9.81 N kg^{-1} will be penalised by one mark (but not more than once per clip). Accept 9.8 m s^{-2} or 9.8 N kg^{-1}

4. Calculations

4.1 Bald (i.e. no working shown) correct answers score full marks unless in a 'show that' question.

4.2 If a 'show that' question is worth 2 marks then both marks will be available for a reverse working; if it is worth 3 marks then only 2 will be available.

4.3 **use** of the formula means that the candidate demonstrates substitution of physically correct values, although there may be conversion errors e.g. power of 10 error.

4.4 **recall** of the correct formula will be awarded when the formula is seen or implied by substitution.

4.5 The mark scheme will show a correctly worked answer for illustration only.

4.6 Example of mark scheme for a calculation:

<u>'Show that' calculation of weight</u>

Use of L × W × H ✓

Substitution into density equation with a volume and density ✓

Correct answer [49.4 (N)] to at least 3 sig fig. [No ue] ✓
[If 5040 g rounded to 5000 g or 5 kg, do not give 3rd mark; if conversion to kg is omitted and then answer fudged, do not give 3rd mark]
[Bald answer scores 0, reverse calculation 2/3] **3**

Example of answer:

$80 \text{ cm} \times 50 \text{ cm} \times 1.8 \text{ cm} = 7200 \text{ cm}^3$

$7200 \text{ cm}^3 \times 0.70 \text{ g cm}^{-3} = 5040 \text{ g}$

$5040 \times 10^{-3} \text{ kg} \times 9.81 \text{ N/kg}$

$= 49.4 \text{ N}$

5. Quality of Written Communication

5.1 Indicated by QoWC in mark scheme. QWC – Work must be clear and organised in a logical manner using technical wording where appropriate.

5.2 Usually it is part of a max mark, the final mark not being awarded unless the QoWC condition has been satisfied.

6. Graphs

6.1 A mark given for axes requires both axes to be labelled with quantities and units, and drawn the correct way round.

6.2 Sometimes a separate mark will be given for units or for each axis if the units are complex. This will be indicated on the mark scheme.

6.3 A mark given for choosing a scale requires that the chosen scale allows all points to be plotted, spreads plotted points over more than half of each axis and is not an awkward scale e.g. multiples of 3, 7 etc.

6.4 Points should be plotted to within 1 mm.

- Check the two points furthest from the best line. If both OK award mark.
- If either is 2 mm out do not award mark.
- If both are 1 mm out do not award mark.
- If either is 1 mm out then check another two and award mark if both of these OK, otherwise no mark.

6.5 For a line mark there must be a thin continuous line which is the best-fit line for the candidate's results.

Question Number	Answer	Mark
1	**D – work done**	**1**
	Incorrect Answers: A – centripetal force is not a scalar quantity B – electric field strength is not a scalar quantity C – magnetic flux density is not a scalar quantity	
2	**D – thermionic emission**	**1**
	Incorrect Answers: A – involves electrons moving to higher energy levels in atoms B – involves electrons gaining enough energy to leave atoms C – involves electrons being emitted when energy from photons is absorbed	
3	**D –** **Mass of particle**: increased; **Decay time of particle**: increased	**1**
	Incorrect Answers: A – Mass should be increased, Decay time should be increased B – Mass should be increased C –Decay time should be increased	
4	**B - 2π ÷ 0.60**	**1**
	Incorrect Answers: Correct method: 2π ÷ period A – uses 2π × period C – uses 2π × radius ÷ period D – uses 2π × radius × period	
5	**A – 13 N**	**1**
	Incorrect Answers: Correct method: $F = 0.30 \text{ kg} \times (4.2 \text{ m s}^{-1})^2 \div 0.40 \text{ m}$ B – uses $0.30 \text{ kg} \times (4.2 \text{ m s}^{-1})^2 \div 0.80 \text{ m}$ C – uses $0.30 \text{ kg} \times (4.2 \text{ m s}^{-1}) \div 0.40 \text{ m}$ D – uses $0.30 \text{ kg} \times (4.2 \text{ m s}^{-1})^2 \times 0.40 \text{ m}$	
6	**B – allow the creation of new particles**	**1**
	Incorrect Answers: A – annihilation does not require high energies C – diffraction is not involved in such collisions D – relativistic effects do not need to be avoided	
7	**C – F**	**1**

	Incorrect Answers: Correct method: × 22 for charge change and ÷ 22 for separation change A – uses × 22 for charge change and × 2 for separation change B – only uses × 22 for charge change D – only uses ÷ 22 for separation change	
8	**C – The new particles have opposite charge**	**1**
	Incorrect Answers: A – without knowing the charges, the direction of the field cannot be deduced B – the particles cannot be deduced from the information given, other oppositely charged particles could produce the same tracks without a scale D – without knowing the direction of the field, the charges cannot be deduced	
9	**C - The particles are losing energy**	**1**
	Incorrect Answers: A – An oscillating field would not produce this track as the force would be switching direction periodically B – The particles would require an increase in magnitude of velocity to gain mass and the force from this field is perpendicular to their velocity D – An increasing speed would produce spirals of increasing radius	
10	**D – 5.1 × 102**	**1**
	Incorrect Answers: Correct method: mass in keV/c2 = mass in kg × c2 ÷ 1000 eV A – mass in kg × c2 ÷ 1000 B – mass in kg × c ÷ 1000 eV C – mass in kg × 109 ÷ eV	

Question Number	Answer		Mark
11 (a)	Baryons are made of 3 quarks (or 3 anti-quarks)(do not accept a specific example) Mesons are made of a quark and an anti-quark	**(1)** **(1)**	**2**
11 (b)	For baryons, one example e.g. 2/3(e) + 2/3(e) + −1/3(e) = 1 For mesons, one example e.g. 2/3(e) + 1/3(e) = 0	**(1)** **(1)**	**2**
	Total for question 11		**4**

Question Number	Answer		Mark
12 (a)	Use of $r = p / Bq$ **Or** Use of $F=mv^2/r$ **and** $F = Bqv$ Use of $p = mv$ $v = 2.8 \times 10^7$ (m s^{-1}) <u>Example of calculation</u> $v = 3.2\text{ T} \times 1.6 \times 10^{-19}\text{ C} \times 0.091\text{ m} / 1.67 \times 10^{-27}\text{ kg}$ $v = 2.8 \times 10^7\text{ m s}^{-1}$	**(1)** **(1)** **(1)**	**3**
12 (b)	Use of $F = Bqv$ (ecf v from (a)) **Or** Use of $F=mv^2/r$ $F = 1.4 \times 10^{-11}$ N (show that value gives 1.5×10^{-11} N) <u>Example of calculation</u> $F = 3.2\text{ T} \times 1.6 \times 10^{-19}\text{ C} \times 2.8 \times 10^7\text{ m s}^{-1}$ $F = 1.4 \times 10^{-11}$ N	**(1)** **(1)**	**2**
	Total for question 12		**5**

Question Number	Answer	Mark
13 (a)	Use of $V = V_0\,e^{-t/RC}$ **(1)** R = 510 kΩ **(1)** <u>Example of calculation</u> $2\text{ V} = 12\text{ V}\,e^{-20\text{ s}/R\times22\times10^{\wedge}-6\text{ F}}$ $\ln(1/6) = -20\text{ s} / R\times22\times10^{-6}\text{ F}$ R = 510 kΩ	**2**
13 (b)	Use of $C = Q/V$ and $W = ½\,QV$ **Or** see $W = ½\,CV^2$ **(1)** $W = 1.6\times10^{-3}$ J **(1)** <u>Example of calculation</u> $W = ½\,QV$ and $C = Q/V$ so $W = ½\,V^2C$ $= ½\,(12\text{ V})^2\times22\times10^{-6}\text{ F}$ $= 1.6\times10^{-3}$ J	**2**
	Total for question 13	**4**

Question Number	Answer	Mark
14	Use of $E_k = p^2 / 2m$ **(1)** Use of $\lambda = h/p$ **(1)** $\lambda = 1.82\times10^{-10}$ m **(1)** The wavelength is very similar to the interatomic spacing **(1)** so significant electron diffraction will take place **(1)** <u>Example of calculation</u> $p = \sqrt{(2\times9.11\times10^{-31}\text{ kg}\times7.3\times10^{-18}\text{ J})}$ $p = 3.65\times10^{-24}\text{ kg m s}^{-1}$ $\lambda = 6.63\times10^{-34}\text{ Js} / 3.65\times10^{-24}\text{ kg m s}^{-1}$ $\lambda = 1.82\times10^{-10}$ m	**5**
	Total for question 14	**5**

Question Number	Answer		Mark
15 (a)	Use of $F = BIl$ B = 0.0098 T <u>Example of calculation</u> F = 1.4772 N – 1.4776 N = −0.0004 N −0.0004 N = B × 0.82 A × 0.050 m B = 0.00976 T	**(1)** **(1)**	**2**
15(b)	(The force on the balance decreases so the force on the magnets and holder is upwards), so the force on the wire is downwards. Using Fleming’s Left Hand Rule, the field is from Y to X. (conditional on MP1)	**(1)** **(1)**	**2**
15 (c)	Method Explanation e.g. increase current used absolute uncertainties are fixed, so increasing the value of current, and therefore force, decreases the percentage uncertainty	**(1)** **(1)**	**2**
	Total for question 15		**6**

Question Number	Answer		Mark
16 (a)	Electric field shows the direction of the force on a positive charge A positive charge at P is repelled from the top plate and attracted to the bottom plate **Or** a positive charge at P will experience a downwards force component due to each of the charges The components parallel to the plate to the left are all balanced by components parallel to the sheet to the right The field at P is perpendicular to plates from + to −	**(1)** **(1)** **(1)** **(1)**	**4**
16 (b)	Use of $E = V/d$ Use of $F = Eq$ $F = 1.8 \times 10^{-18}$ N <u>Example of calculation</u> $E = 0.4$ V / 0.035 m $= 11.4$ V m^{-1} $F = Eq = 11.4$ V m$^{-1} \times 1.6 \times 10^{-19}$ C $F = 1.8 \times 10^{-18}$ N	**(1)** **(1)** **(1)**	**3**
	Total for question 16		**7**

Question Number	Answer		Mark
*17	**(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate)**		
	proton is accelerated by the electric field	**(1)**	
	The alternating p.d. means that as a proton emerges from one tube the next one is negative	**(1)**	
	length of drift tubes increases because proton travels further during that half period of the cycle as its speed is greater **Or** size of gap between drift tubes increases because proton travels further during that half period of the cycle as its speed is greater	**(1)**	
	p.d. must switch at constant frequency so time in each drift tube is the same **Or** p.d. must switch at constant frequency so time between each pair of drift tubes is the same	**(1)**	**4**
	Total for question 17		**4**

Question Number	Answer	Mark
*18 (a)	**(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate**) Lines of magnetic flux cut through coils of wire **Or** this causes a change in flux linkage for the coil **(1)** There is an induced e.m.f. (across coil) **(1)** There is a current in the coil, lighting the green LED **(1)** When the direction (of magnet) is reversed, the current/e.m.f. is in the opposite direction so red LED lights **(1)** When the magnet is completely inside the coil there is no change in flux linkage, so no emf **Or** when the magnet is moving completely inside the coil the emf induced by the north pole is the exact opposite of the emf induced by the south pole **(1)**	**5**
18 (b)	The size of the induced emf is proportional to the rate of change of flux **(1)** A current will only flow in the LED when a certain p.d. is applied, so the rate of change of flux must be increased by using more coils **(1)**	**2**
18 (c)	Statement of Lenz's law in terms of induced e.m.f. or current **(1)** The (induced) current in the coil produces a magnetic field to oppose motion **(1)** . so there is a force on the magnet in the opposite direction to its motion **(1)** As work = force × distance, work is done as the magnet moves **(1)**	**4**
	Total for question 18	**11**

Question Number	Answer		Mark
19 (a)	to ensure sufficient alpha particles reach the foil/microscope because alpha particles would collide with air molecules	**(1)** **(1)**	**2**
19 (b)	**Observation 1** because the atom is mostly empty space most alpha particles did not get near enough to any matter to be affected **Or** most of the alpha particles went straight through **Observation 2** because the charge is concentrated in the centre most alpha particles did not get near enough to a sufficiently large charge to be affected **Observation 3** the nucleus must be massive in order to cause this deflection because the mass of the atom is concentrated a very small space relative to the size of the atom	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**6**
19 (c)	Top: 226, 4 Bottom: 88, 2	**(1)** **(1)**	**2**
19 (d)	Use of $E_k = ½\,mv^2$ Use of $W = QV$ $V = 2.33 \times 10^6$ V = 2.33 MV Example of calculation Use of $E_k = ½\,mv^2 = ½ \times 4.0 \times 1.66 \times 10^{-27}$ kg $\times (1.50 \times 10^7$ m s$^{-1})^2$ $= 7.47 \times 10^{-13}$ J Use of $V = 7.47 \times 10^{-13}$ J $\div (2 \times 1.6 \times 10^{-19}$ C) $= 2.33 \times 10^6$ V = 2.33 MV	**(1)** **(1)** **(1)**	**3**
	Total for question 19		**13**

Question Number	Answer		Mark
20(a) (i)	Force = change in momentum / time = gradient of momentum-time graph	**(1)**	**1**
20 (a)(ii)	Uses gradient to determine force F = 0.045 N – 0.060 N <u>Example of calculation</u> gradient = 0.008 / 0.14 = 0.057 N	**(1)** **(1)**	**2**
20(a)(iii)	Interval between frames = 1 s/30 = 0.033 s Maximum momentum could be reached at any point between the photographed frames	**(1)** **(1)**	**2**
20(b)	Uses 0.80 m s^{-1} as speed of sphere A Use of $F = (mv - mu) / t$ Average force = 0.026 N <u>Example of calculation</u> F = 0.017 kg × 0.80 m s^{-1} / 0.53 s F = 0.026 N	**(1)** **(1)** **(1)**	**3**
20(c)	Use of $E_k = \frac{1}{2} mv^2$ E_k = 0.0054(J) for 1 spheres **and** 0.0027 (J) for 2 spheres (Kinetic energy not equal,) so not elastic	**(1)** **(1)** **(1)**	**3**
	Total for question 20		**11**

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