Mark Scheme (SAM)

Pearson Edexcel International Advanced Level in Physics

Unit 4: Physics on the Move

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.

Further notes

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.

Mark scheme format

1. You will not see 'wtte' (words to that effect). Alternative correct wording should be credited in every answer unless the mark scheme has specified specific words that must be present. Such words will be indicated by underlining, e.g. 'resonance'.
2. Bold lower case will be used for emphasis.
3. Round brackets ( ) indicate words that are not essential, e.g. '(hence) distance is increased'.
4. Square brackets [ ] indicate advice to examiners or examples, e.g. [Do not accept gravity] [ecf].

Unit error penalties

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. Incorrect use of case, e.g. 'Watt' or 'w' will **not** be penalised.
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.
4. The same missing or incorrect unit will not be penalised more than once within one question (one clip in e-pen).
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.
6. The mark scheme will indicate if no unit error penalty is to be applied by means of [no ue].

Significant figures

1. Use of an inappropriate number of significant figures (sf) 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.
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}.

Calculations

1. Bald (i.e. no working shown) correct answers score full marks unless in a 'show that' question.
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.
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. **Recall** of the correct formula will be awarded when the formula is seen or implied by substitution.
5. The mark scheme will show a correctly worked answer for illustration only.
6. Example of mark scheme for a calculation:

'Show that' calculation of weight Use of L × W × H Substitution into density equation with a volume and density Correct answer [49.4 (N)] to at least 3 significant figures [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] Example of answer: 80 cm × 50 cm × 1.8 cm = 7200 cm^3 7200 cm^3 × 0.70 g cm^{-3} = 5040 g 5040 × 10^{-3} kg × 9.81 N/kg = 49.4 N	✓ ✓ ✓	**(3)**

Quality of Written Communication

1. Indicated by 'Quality of Written Communication' in the mark scheme. Work must be clear and organised in a logical manner using technical wording where appropriate.
2. Usually it is part of a maximum mark, the final mark not being awarded unless the Quality of Written Communication condition has been satisfied.

Graphs

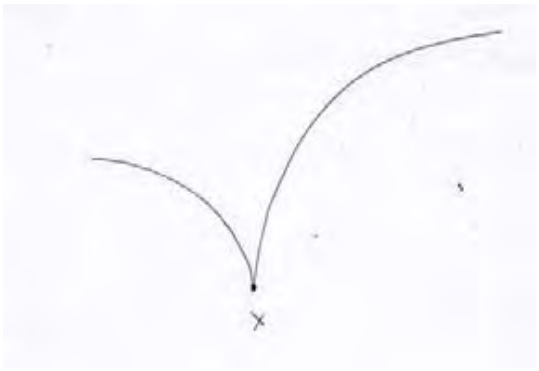
1. A mark given for axes requires both axes to be labelled with quantities and units, and drawn the correct way round.
2. Sometimes a separate mark will be given for units or for each axis if the units are complex. This will be indicated on the mark scheme.
3. A mark given for choosing a scale requires 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.
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.
5. For a line mark there must be a thin continuous line which is the best-fit line for the candidate's results.

Section A

Question Number	Answer	Mark
1	A	**(1)**
2	C	**(1)**
3	A	**(1)**
4	C	**(1)**
5	B	**(1)**
6	C	**(1)**
7	C	**(1)**
8	B	**(1)**
9	C	**(1)**
10	B	**(1)**

Total for Section A = 10 Marks

Section B

Question Number	Answer	Mark
11	**Diagram** Path curves in opposite sense **(1)** With a greater radius of curvature **(1)** [For MP2 drawn line must start at X, upwards at less than 45° to vertical and go above printed line. Look at curvature close to X, do not penalise if later it curves more/less.]  **Explanation: (these marks are independent of the diagram)** (Antihelium) has opposite charge (to proton) **(1)** **Or** reference to proton +ve **and** antihelium -ve See $r = p/BQ$ **(1)** r is doubled **Or** p/Q is doubled [equation may appear near diagram] **(1)**	**(5)**
	Total for Question 11	**(5)**

Question Number	Answer	Mark
12(a)	<table><tr><th>Meson</th><th>Charge/*e*</th><th>Strangeness</th></tr><tr><td>$u\bar{s}$</td><td>+1</td><td>+1</td></tr><tr><td>$d\bar{s}$</td><td>0</td><td>+1</td></tr><tr><td>$s\bar{u}$</td><td>-1</td><td>-1</td></tr><tr><td>$s\bar{d}$</td><td>0</td><td>-1</td></tr></table> **(1)** **(1)** **(1)** **(1)** 1 mark for each correct row. Antiquark can be before quark. (If the + are missing. e or 1.6×10^{-19} appears in charge column apply a 1 mark total penalty.)	**(4)**
12(b)	(Different) masses/lifetimes/stabilities/decay products (accept mass-energy but not energy or weight). **(1)**	**(1)**
	Total for Question 12	**(5)**

Question Number	Answer	Mark
13(a)(i)	Straight through, zero deflection, direction fired in. (Do not accept 'through' or 'directly behind' on its own.) **(1)**	**(1)**
13(a)(ii)	(Atom consists) mainly/mostly of <u>empty space</u> **Or** Volume of atom very much greater than volume of nucleus. (Do not credit if part of a list.) **(1)**	**(1)**
13(b)	Most of the mass is in the nucleus/centre **(1)** [It is not enough to say that the nucleus is dense/concentrated. Looking for idea that nearly all of the atom's mass is in the nucleus.] Nucleus/centre is <u>charged</u> **(1)** [Ignore references to the charge being positive. Just saying the nucleus is positive does not get the mark.]	**(2)**
13(c)(i)	Electrostatic/electromagnetic/electric/coulomb. **(1)**	**(1)**
13(c)(ii)	Arrow starting on the path at closest point to the nucleus. **(1)** Arrow pointing radially away from nucleus **(1)** (correct direction starting on the nucleus scores 2nd mark only).	**(2)**
13(c)(iii)	Deflection starts earlier. **(1)** Final deflection is greater **(1)** (paths should diverge).	**(2)**
	Total for Question 13	**(9)**

Question Number	Answer		Mark
14(a)(i)	Capacitor, resistor, supply and switch all in series (ignore voltmeter). Voltmeter directly across capacitor.	**(1)** **(1)**	**(2)**
14(a)(ii)	Datalogger allows large number of readings to be taken **Or** graph can be plotted directly/automatically **Or** simultaneous reading of t and V can be taken **Or** idea that people can't record quickly enough, (Treat as neutral accuracy, precision misreading or human reaction time.)	**(1)**	**(1)**
14(b)	Use of $C = Q/V$ $Q = 5.0 \times 10^{-4}$ C Example of calculation $Q = 100 \times 10^{-6}$ F $\times$ 5.0 V $Q = 5.0 \times 10^{-4}$ C	**(1)** **(1)**	**(2)**
14(c)(i)	Use of $I = \Delta Q/ \Delta t$ e.c.f their value of C from (b) $I = 0.05$ A (accept recalculation of Q using $V = 4.90$ or 4.95 V) Example of calculation $I = 5.0 \times 10^{-4}$ C / 10×10^{-3} s $I = 0.05$ A	**(1)** **(1)**	**(2)**
14(c)(ii)	tangent drawn at t = 0 $\Delta V/ \Delta t = 2000$ - 3300 V s^{-1} Initial current = 0.22 - 0.28 A (MP2 & 3 can be scored even if no tangent drawn) (No credit for exponential calculation) Example of calculation $\Delta V/ \Delta t = 1.1$ V/ 0.5 ms = 2200 V s^{-1} $I = (\Delta V/ \Delta t) \times C$ $I = 2200$ V $s^{-1} \times 100 \times 10^{-6}$ F $I = 0.22$ A	**(1)** **(1)** **(1)**	**(3)**
14(c)(iii)	Use of $V = IR$ using answer from (ii) correct evaluation of R (5V used with current range in (ii) gives 18 - 23 Ω) Example of calculation 5 V = 0.22 A $\times$ R $R = 23$ Ω	**(1)** **(1)**	**(2)**
	Total for Question 14		**(12)**

Question Number	Answer	Mark
15(a)	At least three vertical lines spread over symmetrically over more than half of the plate length and touching both plates. **(1)** (Ignore edge ones that might curve.) All equispaced and parallel [don't allow gaping to avoid oil drop]. **(1)** Arrow pointing downwards **(1)**	**(3)**
15(b)	Negative/-/-ve **(1)** (Negative and/or positive does not get the mark.)	**(1)**
15(c)	Upward force labelled: Electric (force) **or** Electrostatic (force) **Or** force due to electric field **or** electromagnetic (force) **(1)** [Do not accept repulsive/attractive force. If EQ used, the symbols must be defined.] Downward force labelled: mg, weight, W, gravitational force **(1)** (For both marks the lines must touch the drop and be pointing away from it. Ignore upthrust if drawn but one mark lost for each extra force added.)	**(2)**
15(d)(i)	E = 5100 V/ 2 cm **(1)** Conversion of cm to m **(1)** Use of $QE = mg$ (1.18×10^{-13} kg) **(1)** $Q = 4.6 \times 10^{-19}$ C **(1)** (E = 255 000 (V m^{-1}) scores MP1 & 2. unit conversion missed → $Q = 4.62 \times 10^{-17}$ C scores MP1 & 3 if V is halved → $Q = 9.23 \times 10^{-19}$ C scores MP1 , 2 & 3) <u>Example of calculation</u> $E = V/d$ $F = EQ = mg$ $Q = mg / E = mgd/V$ Q = (1.20×10^{-14} kg × 9.81m s^{-2}× 0.02 m) / (5100 V) Q = 4.62×10^{-19} C	**(4)**
15(d)(ii)	Answer to (d)(i) divided by e **(1)** 3 electrons **or** sensible integer number less than 500 **(1)** (Answers with very large numbers of electrons can get MP1 only.) <u>Example of calculation</u> Number of electrons = 4.62×10^{-19} C / 1.6×10^{-19} C Number = 2.9 i.e. 3 electrons.	**(2)**
	Total for Question 15	**(12)**

Question Number	Answer		Mark
*16(a)	(Quality of Written Communication – work must be clear and organised in a logical manner using technical wording where appropriate.) A clear statement that an alternating/changing current produces an alternating/changing magnetic field/flux. Reference to the iron core becomes magnetised **or** increases magnetic field. the idea that the field produced in the core/wire is linked to the coil (e.m.f. produced) due to EM induction **or** reference to induced e.m.f. **or** Faraday's law in words (do not accept induced current/voltage on its own) [Be careful not to credit the random use of words/phrases like, there is flux linkage, flux cutting takes place or the field lines are cut by the coil. Also watch out for candidates who think there is a current in the coil creating the flux linkage.]	**(1)** **(1)** **(1)** **(1)**	**(4)**
16(b)	(Constant current means) no change of flux (linkage) **or** no changing (magnetic) field **or** flux/field is constant [Do not credit 'flux won't be changing direction' or 'no flux linkage being cut' or alternating.]	**(1)**	**(1)**
16(c)	More than one wire in cable. Cable carries current in both directions **or** Magnetic fields will cancel.	**(1)** **(1)**	**(2)**
16(d)(i)	The larger the current the greater the (magnetic) flux/field (produced) **or** the larger the change in current the larger the change in the (magnetic) flux/field. Gives a greater rate of change of flux **or** bigger change in flux in the same time **or** a greater (induced) e.m.f./voltage/reading.	**(1)** **(1)**	**(2)**
16(d)(ii)	The idea that frequency changes the value of (induced) e.m.f/voltage/reading **or** the idea that the frequency changes the rate of change of (magnetic)flux. An understanding that there are now two factors (current and frequency) altering (induced) e.m.f/voltage/reading.	**(1)** **(1)**	**(2)**
	Total for Question 16		**(11)**

Question Number	Answer	Mark
17(a)	Sum of momenta before (collision) = sum of momenta after (collision) **Or** the total momentum before (a collision) = the total momentum after (a collision) **Or** total momentum remains constant **Or** the momentum of a system remains constant **(1)** Providing no external/unbalanced/resultant force acts **Or** in a closed system. **(1)**	**(2)**
17(b)(i)	Use of equation(s) of motion sufficient to get answer **(1)** Initial speed = 1.1 (m s^{-1}) **(1)** <u>Example of calculation</u> $s = (u + v)t/2$ 0.69 m = (u +0) × 1.3 s /2 u = 1.06 m s^{-1}	**(2)**
17(b)(ii)	Constant acceleration/deceleration **(1)** (accept constant force).	**(1)**
17(b)(iii)	Use of momentum = mv ecf v from (b)(i) **(1)** Calculates momentum after collision using correct mass **(1)** Speed of pellet = 117 or 124 or 129 (m s^{-1}) **(1)** <u>Example of calculation</u> Momentum after = (97.31 + 0.84) g × 1.06 m s^{-1} = 104 g m s^{-1} Momentum before = momentum after Speed of pellet = 104 g m s^{-1} / 0.84 g = 124 m s^{-1}	**(3)**
***17(c)(i)**	(Quality of Written Communication – work must be clear and organised in a logical manner using technical wording where appropriate.) Mention of momentum. **(1)** Pellet (bounces back so) has negative momentum /velocity. **Or** momentum after = momentum of car - momentum of pellet. **(1)** Pellet undergoes a bigger momentum/velocity change **Or** mass of car is less. **(1)**	**(3)**
17(c)(ii)	Reference to greater horizontal momentum/force. **(1)**	**(1)**
17(d)	[The question says that the calculations are correct, the question is about the assumptions made. Do not credit a statement that the GPE is correct. MP1 is for the assumption that the KE after firing is the same as the max GPE. Do not credit energy loss due to air resistance or sound.] Ek → Egrav of pendulum correct Or KE after collision is correct. **(1)** Ek in collision not conserved Or not an elastic collision Or inelastic collision (do not credit just 'KE is lost'). **(1)** Some energy becomes heat. **(1)** Ek (of pellet before collision)is greater than 0.16J **(1)**	**(4)**
	Total for Question 17	**(16)**

Total for Section B = 70 Marks

Total for Paper = 80 Marks