Mark Scheme (Results)

January 2014

IAL Physics (WPH04/01)

Unit 4: Physics on the Move

Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications come from Pearson, the world's leading learning company. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information, please visit our website at www.edexcel.com.

Our website subject pages hold useful resources, support material and live feeds from our subject advisors giving you access to a portal of information. If you have any subject specific questions about this specification that require the help of a subject specialist, you may find our Ask The Expert email service helpful.

www.edexcel.com/contactus

Pearson: helping people progress, everywhere
Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk

January 2014
Publications Code IA037839

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)	<u>Horizontal force of hinge on table top</u> 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. '<u>resonance</u>'

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] 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

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	B	**1**
2	A	**1**
3	C	**1**
4	C	**1**
5	B	**1**
6	B	**1**
7	C	**1**
8	B	**1**
9	D	**1**
10	C	**1**

Question Number	Answer		Mark
***11**	**(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate)** Curvature at Q greater than at P, therefore slower at Q **Or** radius at Q smaller than at P, therefore slower at Q (accept less momentum or <u>kinetic</u> energy for slower) Particle travels P → Q **Or (**left) to right Force is: upwards/ towards A / towards centre of curvature **Or** current is Q → P **Or** current to the left Particles have negative charge (consistent with their direction) (Candidates who say charge is +ve can score MP4 if they say the direction is Q → P)	**(1)** **(1)** **(1)** **(1)**	**4**
	Total for Question 11		**4**

Question Number	Answer		Mark
***12**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) Reference to electric field **Any three from** particles accelerate when in the gaps **Or** particles gain energy when in the gaps p.d. / polarity / supply reverses while particles are in the tube p.d./ polarity / supply switches at constant time interval **Or** p.d./supply has a constant frequency (Drift) tubes get longer so particles are in tubes for the same time	 **(1)** **(1)** **(1)** **(1)** **(1)**	 **4**
	Total for Question 12		**4**

Question Number	Answer		Mark
13(a)	B_v = 4.0 × 10^{-5} T <u>Example of calculation</u> B_v = 4.4× 10^{-5} T × cos 25º B_v = 3.99 × 10^{-5} T	**(1)**	**1**
13(b)(i)	Conductor/wing moving at an angle to magnetic field **Or** the vertical component is at right angles to the wing) Hence force on electrons (in conductor) is at right angles to both direction of motion and magnetic field **Or** Reference to cutting / change of (magnetic) flux So an e.m.f. is induced	 **(1)** **(1)** **(1)** **(1)**	**2**
13(b)(ii)	X on the right hand wing when looking at the diagram	**(1)**	**1**
13(b)(iii)	The build-up of charge creates an electric field This creates a force in the opposite direction to the magnetic force (A statement that the rate of change of flux is constant so that the e.m.f. is constant scores 1 mark)	**(1)** **(1)**	**2**
13(b)(iv)	(Magnetic) field will be parallel to the wings **Or** motion of plane at right angles to (magnetic) field **Or** reference to $F=BIl\sin\theta$ with $\sin\theta = 0$ So no force acts (in the direction of the wings) on the (free) electrons **Or** wings not cutting flux, so no e.m.f. across wing tips.	 **(1)** **(1)**	**2**
	Total for Question 13		**8**

Question Number	Answer		Mark
14(a)(i)	*R* cos 62º = mg **Or** *R* sin 28º = mg *R* = 1670 (N) <u>Example of calculation</u>	**(1)** **(1)**	**2**
14(a)(ii)	Use of force component **and** acceleration = force/mass a = 18.4 m s^{-2} (show that value gives 18.8 m s^{-2}) <u>Example of calculation</u> a = 1670 N cos 28º / 80 kg a =18.4 m s^{-2}	**(1)** **(1)**	**2**
14(a)(iii)	Use of $a = v^2/r$ (do not credit if g is used) v = 9.6 m s^{-1} ecf answer to (a)(ii) (show that value gives 9.7 m s^{-1}) <u>example of calculation</u> v = √(18.4 m s^{-2} × 5.0 m) v = 9.6 m s^{-1}	**(1)** **(1)**	**2**
14(b)	Use of speed = distance /time v = 13 m s^{-1} <u>example of calculation</u> v = 24 × 2π × 5.0 m / 60 s v = 12.56 m s^{-1}	**(1)** **(1)**	**2**
14(c)	Child's mass/weight is less (than adult) The smaller the mass, the smaller the force the rider experiences (since they experience the same acceleration) **Or** the push of the pad is less **Or** Centre of mass of child is lower (than adult) Distance to centre is smaller so force is less	**(1)** **(1)** **(1)** **(1)**	**2**
	Total for Question 14		**10**

Question Number	Answer		Mark
15(a)(i)	t = 0, capacitor uncharged therefore 12V across R **Or** at t = 0, the capacitor begins to charge [accept 'when the switch is closed' for t = 0] (capacitor and resistor in series so) V_R decreases as V_C increases **Or** $V_R + V_C$ = constant **Or** as charge on capacitor increases, current decreases so V_R decreases. **Or** numerical justification of exponential decrease	 **(1)** **(1)**	**2**
15(a)(ii)	Exponentially increasing graph with decreasing gradient Max value 10.4 – 11.2 V at t = 50 s	**(1)** **(1)**	**2**
15(b)(i)	Indicates that t 37% of initial V_R **Or** 1/e of initial V_R read time off graph **Or** Uses graph to find time for p.d.to half Equates this to 0.69RC where RC equals the time constant **Or** draw a tangent at t = 0 value is where tangent cuts x-axis. **Or** draws a tangent at any time value is difference between where tangent cuts x-axis and time where tangent was drawn. **Or** plot a graph of ln V against t Time constant is gradient of graph **Or** take a pair of values from graph and sub into exponential equation calculate RC which is time constant	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**2**
15(b)(ii)	Use of $V = IR$ R = 48 kΩ Use of t and their value of R to find C in $t = RC$ C = 520 μF (consistent with their values) **Or** Use $C=It/V$ with V =12 V and t = 25s C = 520 μF Use of t and their value of C to find R **Or** use of $V = IR$ to find R R = 48 kΩ <u>Example of calculation</u> $R = 12\text{ V} / 0.25 \times 10^{-3}\text{ A} = 48\text{ k}\Omega$ $t = 48 \times 10^{3}\ \Omega \times C$ $C = 25\text{ s} / 48 \times 10^{3}\ \Omega$ C = 520 μF	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**4**
	Total for Question 15		**10**

Question Number	Answer		Mark
16(a)(i)	Correct equation to show conservation of momentum Correctly works through to show $v = 0$ <u>Example of calculation</u> Momentum before = Momentum after (20 000 kg × 4.5 m s^{-1}) + (60 000 × 1.5 m s^{-1}) = (60 000 kg × 3.0 m s^{-1}) + (20 000 kg × v) 180 000 kg m s^{-1} = 180 000 kg m s^{-1} + 20 000 kg × v	**(1)** **(1)**	**2**
16(a)(ii)	Horizontal line at v = 4.5 m s^{-1} **and** **Either** negative gradient line for a collision time the same as for the heavier truck. **Or** negative gradient line passing through midpoint of collision	**(1)**	**1**
16(a)(iii)	Use of $F = \Delta(mv) / \Delta t$ for either truck F = 900 000 N <u>Example of calculation</u> For the heavier truck F = [(60 000 kg × 3.0 m s^{-1}) - (60 000 × 1.5 m s^{-1})] / 0.1 s F = (-) 900 000N	**(1)** **(1)**	**2**
16(b)(i)	Kinetic energy is conserved	**(1)**	**1**
16(b)(ii)	Recognises need to use $E_k = mv^2/2$ Calculation of E_k halfway at 0.050 s after collision begins [if graphs cross at a different point both velocities must be used] Calculation of E_k after collision = 270 000 J <u>Example of calculation</u> E_k halfway = (20 000 kg × (2.25 m s^{-1})^2)/2 + (60 000 kg × (2.25 m s^{-1})^2)/2 = 203 000 J E_k after = (60 000 kg × (3.0 m s^{-1})^2)/2 + 0 = 270 000 J	**(1)** **(1)** **(1)**	**3**
16(b)(iii)	Elastic (potential) energy is stored in the buffers/ springs ['lost' as elastic energy is not sufficient]	**(1)**	**1**
	Total for Question 16		**10**

Question Number	Answer		Mark
17(a)(i)	$v_v = 7.5 \times 10^6$ m s^{-1} Example of calculation $v_v = 8.0 \times 10^6$ m s^{-1} × cos 20º $v_v = 7.5 \times 10^6$ m s^{-1}	**(1)**	**1**
17(a)(ii)	$v_h = 2.7 \times 10^6$ m s^{-1} (apply ue only once in (i) and (ii)) Example of calculation $v_h = 8.0 \times 10^6$ m s^{-1} × cos 70º $v_h = 2.7 \times 10^6$ m s^{-1}	**(1)**	**1**
17(a)(iii)	Circular motion in the vertical plane/direction No force is horizontal direction **Or** uniform motion in horizontal direction **Or** constant velocity in horizontal direction (For these marks, candidates must refer to vertical/perpendicular and horizontal/parallel)	**(1)** **(1)**	**2**
17(b)(i)	See $BQr = mv$ Use of perpendicular component of velocity from (a)(i) $r = 2.8 \times 10^{-3}$ (m) Example of calculation $r = mv^2/Bev = mv/Be$ $r = (9.11 \times 10^{-31}$ kg × 7.5×10^6 m s^{-1})/ (0.015 T × 1.6×10^{-19} C) $r = 2.8 \times 10^{-3}$ m	**(1)** **(1)** **(1)**	**3**
17(b)(ii)	Use of $T = 2\pi r/v$ ecf r from (b)(i) $T = 2.3 \times 10^{-9}$ s (show that gives 2.5×10^{-9} s) [use of 8.0×10^6 m s^{-1} is incorrect and can score 1 for 'use of'] Example of calculation $T = (2\pi \times 2.8 \times 10^{-3}$ m) / 7.5×10^6 m s^{-1} $T = 2.3 \times 10^{-9}$ s	**(1)** **(1)**	**2**
17(b)(iii)	Use of distance = speed × time **with** v_h from (a)(ii) and T from (b)(ii) Distance = 6.2×10^{-3} m (use of 2.5×10^{-9} s gives 6.8×10^{-3}) Example of calculation Distance = 2.7×10^6 m s^{-1} × 2.3×10^{-9} s Distance = 6.2×10^{-3} m	**(1)** **(1)**	**2**
17(c)	The circles would have a smaller radius Distance between adjacent loops would increase	**(1)** **(1)**	**2**
	Total for Question 17		**13**

Question Number	Answer		Mark
18(a)(i)	Charge of Ω is negative /−(1) due to conservation of charge (accept demonstration by equation) Ω baryon because 3 quarks (are needed for strangeness of −3) **Or** to conserve Baryon number since proton has B = 1	**(1)** **(1)**	**2**
18(a)(ii)	Marks awarded for the kaon particles and proton K^- : $s\bar{u}$ p : uud K^+ : $u\bar{s}$ K^0 : $d\bar{s}$ The quarks for each particle can be in any order	**(1)** **(1)** **(1)** **(1)**	**4**
18(b)(i)	Finds mass of (stationary) particles Subtracts 2× rest mass proton Divides by 2 to give E_k = 1320 (MeV) (for MP1 &2 ignore units and further calculations involving c^2) <u>Example of calculation</u> mass of new particles = 938+(14 × 140)+494+1115 = 4507 MeV/c^2 E_k required = 4507 MeV Before collision, E_{total} = $E_k + E_{mass}$ E_k = 4507 **-** (2×938) = 2631 MeV E_k for each proton = 1315.5 MeV	**(1)** **(1)** **(1)**	**3**
18(b)(ii)	Evidence that (conservation of) momentum is being considered (if one particle is moving) total momentum before collision is not zero **Or** (for the interaction to occur, initial) momentum must/should be zero **Or** not all of the (kinetic) energy can be used to create particles / mass (only award MP2 if it is related to conservation of momentum) (if the candidate states that momentum is not conserved, allow MP1 only)	**(1)** **(1)**	**2**
	Total for Question 18		**11**

Pearson Education Limited. Registered company number 872828
with its registered office at Edinburgh Gate, Harlow, Essex CM20 2JE