A-LEVEL

PHYSICS

7408/1

Paper 1

Mark scheme

June 2018

Version/Stage: 1.1 Final

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this mark scheme are available from aqa.org.uk

Physics - Mark scheme instructions to examiners

1. General

The mark scheme for each question shows:

- the marks available for each part of the question
- the total marks available for the question
- the typical answer or answers which are expected
- extra information to help the Examiner make his or her judgement and help to delineate what is acceptable or not worthy of credit or, in discursive answers, to give an overview of the area in which a mark or marks may be awarded.

The extra information is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.

At the beginning of a part of a question a reminder may be given, for example: where consequential marking needs to be considered in a calculation; or the answer may be on the diagram or at a different place on the script.

In general the right-hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent.

2. Emboldening

2.1 In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following bullet points is a potential mark.
2.2 A bold **and** is used to indicate that both parts of the answer are required to award the mark.
2.3 Alternative answers acceptable for a mark are indicated by the use of **or**. Different terms in the mark scheme are shown by a / ; eg allow smooth / free movement.

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which candidates have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

Each error / contradiction negates each correct response. So, if the number of errors / contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (often prefaced by 'Ignore' in the mark scheme) are not penalised.

3.2 Marking procedure for calculations

Full marks can usually be given for a correct numerical answer without working shown unless the question states 'Show your working'. However, if a correct numerical answer can be evaluated from incorrect physics then working will be required. The mark scheme will indicate both this and the credit (if any) that can be allowed for the incorrect approach.

However, if the answer is incorrect, mark(s) can usually be gained by correct substitution / working and this is shown in the 'extra information' column or by each stage of a longer calculation.

A calculation must be followed through to answer in decimal form. An answer in surd form is never acceptable for the final (evaluation) mark in a calculation and will therefore generally be denied one mark.

3.3 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

3.4 Errors carried forward, consequential marking and arithmetic errors

Allowances for errors carried forward are likely to be restricted to calculation questions and should be shown by the abbreviation ECF or *conseq* in the marking scheme.

An arithmetic error should be penalised for one mark only unless otherwise amplified in the marking scheme. Arithmetic errors may arise from a slip in a calculation or from an incorrect transfer of a numerical value from data given in a question.

3.5 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited (eg fizix) **unless** there is a possible confusion (eg defraction/refraction) with another technical term.

3.6 Brackets

(…..) are used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.7 Ignore / Insufficient / Do <u>not</u> allow

'Ignore' or 'insufficient' is used when the information given is irrelevant to the question or not enough to gain the marking point. Any further correct amplification could gain the marking point.

'Do **not** allow' means that this is a wrong answer which, even if the correct answer is given, will still mean that the mark is not awarded.

3.8 Significant figure penalties

Answers to questions in the practical sections (7407/2 – Section A and 7408/3A) should display an appropriate number of significant figures. For non-practical sections, an A-level paper may contain up to 2 marks (1 mark for AS) that are contingent on the candidate quoting the **final** answer in a calculation to a specified number of significant figures (sf). This will generally be assessed to be the number of sf of the datum with the least number of sf from which the answer is determined. The mark scheme will give the range of sf that are acceptable but this will normally be the sf of the datum (or this sf -1).

An answer in surd form cannot gain the sf mark. An incorrect calculation **following some working** can gain the sf mark. For a question beginning with the command word 'Show that…', the answer should be quoted to **one more** sf than the sf quoted in the question eg 'Show that X is equal to about 2.1 cm' – answer should be quoted to 3 sf. An answer to 1 sf will not normally be acceptable, unless the answer is an integer eg a number of objects. In non-practical sections, the need for a consideration will be indicated in the question by the use of 'Give your answer to an appropriate number of significant figures'.

3.9 Unit penalties

An A-level paper may contain up to 2 marks (1 mark for AS) that are contingent on the candidate quoting the correct unit for the answer to a calculation. The need for a unit to be quoted will be indicated in the question by the use of 'State an appropriate SI unit for your answer'. Unit answers will be expected to appear in the most commonly agreed form for the calculation concerned; strings of fundamental (base) units would not. For example, 1 tesla and 1 Wb m^{-2} would both be acceptable units for magnetic flux density but 1 kg m^2 s^{-2} A^{-1} would not.

3.10 Level of response marking instructions

Level of response mark schemes are broken down into three levels, each of which has a descriptor. The descriptor for the level shows the average performance for the level. There are two marks in each level.

Before you apply the mark scheme to a student's answer read through the answer and annotate it (as instructed) to show the qualities that are being looked for. You can then apply the mark scheme.

Determining a level

Start at the lowest level of the mark scheme and use it as a ladder to see whether the answer meets the descriptor for that level. The descriptor for the level indicates the different qualities that might be seen in the student's answer for that level. If it meets the lowest level then go to the next one and decide if it meets this level, and so on, until you have a match between the level descriptor and the answer. With practice and familiarity you will find that for better answers you will be able to quickly skip through the lower levels of the mark scheme.

When assigning a level you should look at the overall quality of the answer and not look to pick holes in small and specific parts of the answer where the student has not performed quite as well as the rest. If the answer covers different aspects of different levels of the mark scheme you should use a best fit approach for defining the level and then use the variability of the response to help decide the mark within the level. i.e. if the response is predominantly level 2 with a small amount of level 3 material it would be placed in level 2.

The exemplar materials used during standardisation will help you to determine the appropriate level. There will be an answer in the standardising materials which will correspond with each level of the mark scheme. This answer will have been awarded a mark by the Lead Examiner. You can compare the student's answer with the example to determine if it is the same standard, better or worse than the example. You can then use this to allocate a mark for the answer based on the Lead Examiner's mark on the example.

You may well need to read back through the answer as you apply the mark scheme to clarify points and assure yourself that the level and the mark are appropriate.

Indicative content in the mark scheme is provided as a guide for examiners. It is not intended to be exhaustive and you must credit other valid points. Students do not have to cover all of the points mentioned in the indicative content to reach the highest level of the mark scheme

An answer which contains nothing of relevance to the question must be awarded no marks.

Question	Answers	Additional Comments/Guidelines	Mark
01.1	Tangent drawn at $t = 2.0 \pm 1$ s ✓ Mean deceleration from use of tangent using correct coordinates (correct Δv and Δt) and answer in range (-)2.5 to (-)2.9 (m s^{-2}) ✓ Use of $F = ma$ using their a with answer i.e Force =1. 8 x 10^4 x their a from an attempt at a tangent or trying to use *suvat* equation✓	Use of *suvat* loses first 2 marks Guidance- take tangent point to be half-way between where the line clearly leaves the curve Ignore minus sign $=15/5.5 = 2.7(3)$ m s^{-2} Allow if answer rounds to these values answers from best attempts at tangent in range 4.7 to 4.9 x 10^4 N	1 1 1
01.2	Attempt to estimate area under the graph. ✓ Correct square count 21 to 23 10 mm squares (525-575 small squares) **OR** distance per square = 2.5 m or 0.1 m✓ Value in range 50 m to 60 m **and conclusion** that escape lane would be long enough✓	Use of *suvat* equation = 0 For attempt to find area using trapezium rule expect use of 1 s intervals for this mark.	1 1 1

01.3	KE of lorry : to KE of gravel (as it is pushed aside/moved)✓ OR PE of gravel (as it may be ejected upwards)✓ transfer to thermal energy /internal energy/heating of gravel /ground/lorry **OR** work done on the gravel/vehicle increasing internal energy/raising temperature✓	Ignore losses due to friction Not KE of the ground Must refer to what is heated	Max 2 1 1

1.4	Appreciates that KE converted into PE or May be stated or by attempt to use of $mgh = ½ mv^2$ or Calculates initial KE of lorry $\frac{1}{2} 1.8 \times 10^4 \times 17.5^2 = 2.76 \times 10^6$ (J) ✓ Height needed in escape lane $= 2.76 \times 10^6 / (1.8 \times 10^4 \times 9.81) = 15.6$ m or Length of lane required =15.6/sin25 = 37 m (compare with 85 m) or vertical height of ramp = 35.9 m (compare with height needed 15.6 m) or maximum change in PE possible = 85 sin 25 x 9.81 x 1,8 x 10^4= 6.3 x 10^6 (J) (compare with initial KE) ✓ **Comparison and conclusion** that escape lane would be long enough.This must follow from correct working✓ …………………………………………………………………………. Deceleration produced by slope = 9.8(1) sin 25 or 4.15 (4.1 or 4.2) m s^{-2} seen✓ Distance to stop from $v^2 = 2as$ give s = 37 m (compare with 85 m)✓ Or Minimum deceleration needed = 17.5^2/2 x 85 = 1.8 m s^{-2} (compare with 4.15 m s^{-2})	 Allow max 2 if height = 85 tan 25 or length of lane = 15.6/tan 25 i.e allow these incorrect values when drawing conclusion Arriving at 37 m gets first two marks	1 1 1

	Comparison and conclusion that escape lane would be long enough This must follow from correct working✓		

01.5	The straight road of uniform gradient because: The deceleration (condone acceleration) is uniform ✓ with the gravel the initial deceleration is larger/may vary ✓ Travelling through gravel could make the vehicle unstable/bounce erratically(owtte) ✓ Gravel because: On the ramp the lorry would roll backwards after stopping (as it has no brakes)	Do not allow deceleration less when on gravel(It is greater initially) Do not allow answers that (average) force using gravel lane is less than decelerating force on the ramp (due to increased stopping distance or stopping time) Or because stopping time is longer	Max 1
Total			**12**

02.1	Clear indication of correct process two correct values for λv from working plus conclusion (7.35; 7.25; 7.35)✓ three correct values plus conclusion ✓ …………………………………………………………………………… ratio approach $v_1/v_2 = \lambda_2/\lambda_1$ shown for 2 sets of data ✓ shown for two other sets of data + conclusion✓	Condone no or misuse of powers of 10 Allow use of v alue of *h* as the constant to show that v values in table are consistent with the λ values May predict one of the values assuming inverse proportionality and compare with table value (once for 1 mark; twice for 2 marks)	1 1
02.2	$h = \lambda mv$ or substitution of correct data in any form ✓ 6.7(0) x 10^{-34} from first and third data set; 6.6(0) x 10^{-34} from second ✓	May determine average value using mean constant from 2.1 or average 3 calculations in this part.	1 1

02.3	Particle behaviour would only produce a patch/circle of light /small spot of light or Particles would scatter randomly✓ Wave property shown by diffraction/ interference✓ Graphite causes (electron)waves/beam to spread out /electrons to travel in particular directions✓ Bright rings/maximum intensity occurs where waves interfere constructively/ are in phase✓ for a diffraction grating maxima when $\sin\theta = n\lambda/d$ ✓	Marks are essentially for 1. Explaining appearance of screen if particle 2. Identifying explicitly a wave property 3. Explaining what happens when diffraction occurs 4. Explaining cause of bright rings 5. Similar to diffraction grating formula (although not same) NB Not expected: For graphite target maxima occur when $\sin\theta = \lambda/2d$ (*d* =spacing of atomic layers in crystal)	Max 3 1 1 1

02.4	Electrons must provide enough (kinetic) energy 'instantly' to cause the excitation **OR** the atom or energy transfer in 1 to 1 interaction **OR** Electron can provide the energy in discrete amounts **OR** energy cannot be provided over time as it would be in a wave **Any 2 from** Idea of light emission due to excitation and de-excitation of electrons/atoms✓ Idea of collisions by incident electrons moving electrons in atoms between energy levels/shells/orbits✓ Light/photon emitted when atoms de-excite or electrons move to lower energy levels✓	Description of Photoelectric effect = 0 Not allowed: any idea that wave cannot pass on energy, e.g. waves pass through the screen	1 1 1

Total			**10**

03.1	Waves travel to the boundaries and are reflected✓ two waves travelling in opposite directions interfere/superpose✓ Fixed boundaries (cannot move so) are nodes✓ In some positions the waves always cancel /interfere destructively to give zero amplitude/no vibration/nodes) **OR** interfere constructively to produce positions of maximum amplitude/maximum vibration/antinodes ✓	Not bounce off … Not superimpose or interferes with itself creates nodes and antinodes bland =0	Max 3 1 1 1

03.2	Use of $f = \frac{1}{2l}\sqrt{\frac{T}{\mu}}$ ✓ $4.2\ (4.19) \times 10^{-4}$ (kg) ✓	Either rearranges for μ without substitution or substitutes correctly in the formula	1 1

03.3	240 (244) (m s^{-1})		1

03.4	1 rotation of the peg = 22 mm ✓ extra extension = 22 × 75/360 = 4.6 mm (ecf for incorrect circumference)✓ Total extension = 11 + 4.6 (15.6 mm) so tension 35 - 36N ✓ Calculates frequency **for their tension**	Or Reads increase in tension produced by the extra extension (about 10 N) from graph and adds to 25 πd x 75/360 not evaluated =1 Inspect their length and their tension in the substitution T must <u>be greater than</u> the original 25N Condone adding or subtracting <u>extra</u> extension to 0.33 m If 4.0 × 10^{-4} kg used then answer will be in range 448 Hz to 455 Hz If 4.19 x 10^{-4} used 438 to 444 Hz	1 1 1 1

Total			**10**

04.1	Length of resistance wire = 50 × 2 × 3.14 × 4 × 10^{-3} = 1.26 m✓ Substitution of data in resistance formula or $A = \rho L/R$ seen✓ Area of cross section = 2.1(1)× 10^{-9} (m^2) ✓	or 50 × 3.14 × 8 × 10^{-3} ecf for incorrect length from attempt at a calculation	1 1 1

04.2	Maximum possible pd across 0.25 kΩ is 9 V ✓ (Max power dissipated) = 9^2/250 = 0.32 W so resistor is suitable. ✓ OR When resistor dissipates maximum power V^2 = 0.36 x 250 so max V = 9.5 V✓ This is higher than the supply pd so this power dissipation so will not be reached. ✓ OR Power dissipated when output is 5 V = 4^2/250 = 0.064 W✓ Which is below the max power dissipation of 0.36 W✓	9^2/250 = 0.32 W with incorrect conclusion scores 1 Second mark implies the first 9^2/0.36 = 225 Ω alone is not a useful calculation in the context. Still need to explain the effect of using the 250 Ω. First mark is for a valid useful calculation	1 1

04.3	Use of potential divider formula to determine resistance of parallel combination✓ 0.313 kΩ ✓ Use of equation for resistors in parallel ✓ 540 Ω✓ **OR** Current in circuit at room temp = 4/250 = 16 mA✓	Alternative to find resistance of combination Current in circuit at room temp = 4/250 = 16 mA✓ Resistance of combination = 5/16mA = 313 Ω✓ OR $\frac{V_{combination}}{V_{250}} = \frac{R_{combination}}{250}$ $\frac{5}{4} = \frac{R_{combination}}{250}$ $R_{combination}$ = 313 Ω	1 1 1 1

	Current in thermistor = 5/750 = 6.7 mA✓		
	Current in R = 9.3 mA ✓ R = 5/9.3 = 540 Ω✓ 2sf answer ✓ (only allowed with some relevant working leading to a resistor value)		1

04.4	Resistance of <u>thermistor</u> decreases✓ <u>Output pd decreases since</u> resistance of the parallel combination /circuit decreases OR lower proportion of pd across the parallel combination (or higher proportion across 250Ω) OR higher current so greater pd across the 0.25 k resistor. ✓	Accept correct consequences for R increasing with temperature for 1 mark.	1 1
Total			**12**

05.1	Radius of orbit = 5 tan 28.5 + 1 = 3.71 m ✓ Speed = 2 × 3.14 × 3.71/5.2 = 4.49 () ✓	For second mark only allow Use of sin 28.5 gives orbit radius 3.39 m and speed = 4.1 $m\ s^{-1}$ Or Forgets to add 1 giving radius 2.71 and speed 3.27 $m\ s^{-1}$	1 1

05.2	Centripetal force = 85 × 4.49^2/3.71 = 460 N ✓ Centripetal force = T sin 28.5✓ T = 950 - 970 N✓ **OR** Weight = 85 x 9.8(1) 0r 834 N seen✓ Weight = T cos 28.5 ✓ T = 950 (949) (N) ✓ **OR** Centripetal force = 85 x 4.5^2/3.71 = 464 N✓ Weight = 834 N✓ $T = \sqrt{464^2 + 834^2}$ = 950 - 970 N✓ Allow ecf for incorrect weight or centripetal force	470 N if using 4.5 m s^{-1} leads to 1000 N **Allow the following as ecf:** forgetting to add the 1 m (using r = 2.71 m) leads to centripetal force = 630 N T = 1300 N) Using r =3.39 m as ecf from 5.1 which leads to Centripetal force = 510 N giving T = 1070 N **Allow the following as ecf:** forgetting to add the 1 m (using r = 2.71 m) leads to centripetal force = 630 N, T = 1050 N using r =3.39 m leads to Centripetal force = 510 N giving T = 980N	1 1 1

05.3	Vertical (compressive) force **on the pole** increases✓ Increases mass <u>increases weight</u> and hence tension in the rope(for the same angle) ✓ <u>Centripetal Force</u> on the acrobats/masses would be different/not equal Or would be greater <u>on the more massive acrobat</u>(travelling at the same speed/same angle to vertical) ✓ Unbalanced (horizontal) forces/resultant force exists (on the pole) ✓ **or** Unbalanced moments acting (on pole)/resultant torque acting (on pole)✓ Causing the pole to sway/bend/move/ or tilt/topple the platform <u>toward more massive acrobat</u>✓		Max 3 1 1 1

Total			**8**

06.	(Total) kinetic energy ✓		1
06.2	Attempt to apply conservation of momentum ✓ 16 000 × 2.8 – 12 000 × 3.1 = 28 000 v ✓ v = 0.27(1) (m s^{-1}) ✓	NB This is a 'show that' so all stages must be seen Must see substitution Correct equation (watch signs) gets first and second marks	1 1 1
06.3	Impulse = 16 000(2.8 – 0.271) or 12 000(3.1 + 0.271) = 4.0(5) × 10^4 ✓ N s or kg m s^{-1} ✓	If 0.3 m s^{-1} used then impulse will be 4.0 × 10^4 or 4.08(4.1) × 10^4	1 1
06.4	Trucks move in opposite directions/rebound ✓ velocity of **B** is greater than that of **A** because total momentum is to the right OR **B** has lower mass ✓ or Momentum of **B** after collision is same as that of **A** before the collision (and vice versa)		1 1
Total			**8**

	Keys to Objective Test Questions (each correct answer is worth 1 mark)												
Q	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**
A	B	B	C	C	A	B	B	A	C	D	B	D	D
Q	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	
A	D	D	C	C	D	C	B	D	C	D	A	D	