GCSE MARKING SCHEME

JANUARY 2016

SCIENCE – Physics 2
4473/01/02

INTRODUCTION

This marking scheme was used by WJEC for the 2016 examination. It was finalised after detailed discussion at examiners' conferences by all the examiners involved in the assessment. The conference was held shortly after the paper was taken so that reference could be made to the full range of candidates' responses, with photocopied scripts forming the basis of discussion. The aim of the conference was to ensure that the marking scheme was interpreted and applied in the same way by all examiners.

It is hoped that this information will be of assistance to centres but it is recognised at the same time that, without the benefit of participation in the examiners' conference, teachers may have different views on certain matters of detail or interpretation.

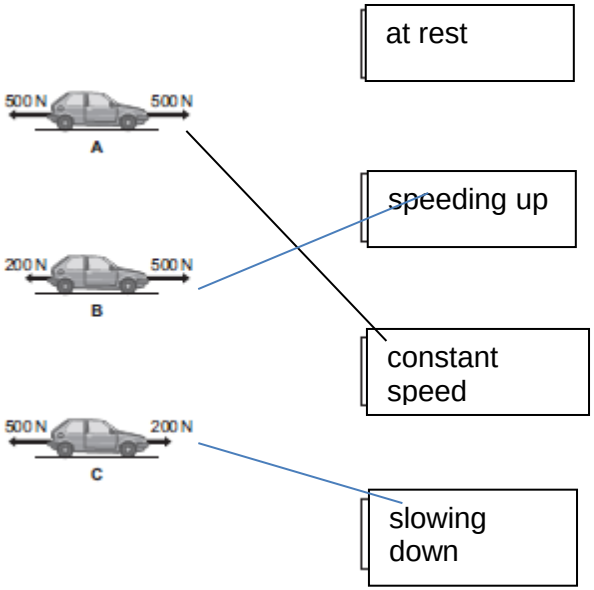
WJEC regrets that it cannot enter into any discussion or correspondence about this marking scheme.

Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
1		*(a)*		i	1	3			
				ii	3	92, 90, 92			
		(b)		i	1	moderator	graphite water		
				ii	1	control <u>rods</u>	boron <u>rods</u>		rods
		Total			**6**				

Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
2		*(a)*			1	18 000 [N]			
		(b)	i		2	1 000 × 6 (1) substitution 6 000 [J] (1)			
			ii		1	No work is done / 0 [J]	1 000 × 0 = 0 [J]		0 × 6 = 0 [J]
			iii		1	Potential [energy] / gravitational potential [energy]			Gravity PE / GPE gravitational
		Total			**5**				

Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
3		*(a)*	i		2	$\frac{5}{2.5}$ (1) = 2 [Ω] (1)			2.5 ÷ 5 = 2 [Ω]
			ii		2	5 × 2.5 (1) = 12.5 [W] (1)			
			iii		1	2.5 [A]			5 – 2.5 = 2.5 [A]
		(b)			3	Increase, stay the same, decrease.			
		(c)			1	Same voltage / switch separately / others stay on if one 'blows'	Converse about series	Lower risk of lamps going out Reference to brightness	
		Total			**9**				

Question Number		Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT								
4		*(a)*			1	Braking distance	Breaking distance		
		(b)	i		2	Thinking distance increases with speed (1) in proportion / uniformly / steadily (1)	As speed doubles thinking distance doubles (2) Speed increases with thinking distance (1)		Linear Constantly
			ii		1	Less steep straight line through origin ± 1 small square division			Any curves at all
		(c)	i		1	C			
			ii		1	A			
		Total			**6**				

Question Number		Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT								
5		*(a)*			3				2 lines originating from 1 car
		(b)			3	resultant force = 2 500 – 1 000 = 1 500 [N] (1) $a = \frac{F}{m} = \frac{1\ 500}{1\ 200}$ subs (1) **ecf on 1 500** 1.25 [m/s^2] answer (1)	$\frac{3\ 500}{1\ 200}$ = 2.92 [m/s^2] award 2 marks $\frac{2\ 500}{1\ 200}$ = 2.08 [m/s^2] award 2 marks		An ecf for any force other than 3 500 unless it is clearly shown that it is their resultant force
		(c)	i		1	N.B. the answer **must be half** of the answer in (b) [0.625 m/s^2]	0.63		0.62 or 0.6
			ii		1	It increases			
			iii		2	Drag **or** it equals driving force / forces are balanced / no ΣF (1) so a becomes zero / reaches a constant speed (1) **The 2nd mark can only be awarded if it is linked to the 1st mark.**	Forces are the same Terminal velocity		Any reference to weight don't award 1st mark Reaches a maximum speed for the 2nd mark
		Total			**10**				

Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
6	**1**	*(a)*	i		1	100			$\frac{1}{6}$ or $\frac{100}{600}$
			ii		1	It is random	Decay is not regular / radioactive decay is random	A 1 in 6 chance	It is unpredictable / happens by chance / [throwing of] a dice is random
		(b)	i		1	70			
			ii		3	All points plotted within ± ½ small square division (2) -1 mark for each incorrect plot to a maximum of 2 marks Smooth curve of best fit ±1 small square division on each point between (2,420) and (7,170) (1)			Thick, wobbly, disjointed, wispy curves
			iii		2	[Horizontal and] <u>vertical</u> lines drawn on graph (1) Half-life taken from the intercept of their graph (around 4.0) (1)	Don't demand horizontal lines to be drawn when they are on the major grid lines. Allow answer close to 4 where no construction lines are drawn for the 2nd mark only Allow answer rounded to a whole number		Constructions and outcome that doesn't match the half-life
		(c)	i		1	Imbalance between protons and neutrons	Unstable <u>nucleus</u>		It is unstable. Unstable atom. Unstable nucleus with references to electrons. Too many neutrons. Unbalanced nucleus.

	ii		1	Helium nucleus / 2 protons + 2 neutrons			helium helium atom helium ion $^{4}_{2}\mathrm{He}$
	iii		2	Alpha particles have low penetrating power (1) so, cannot get through plastic or air to reach people (1) **The 2nd mark can only be awarded if it is linked to the 1st mark.**	Alpha is highly ionising for the 1st mark Alpha can't travel far through air = 2 marks	Cannot get through the skin, paper	
Total			**12**				

Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
7	**2**	*(a)*			2	20 ± 0 [s] **or** 35 ± 2 [s] (1 for either value) = 55 ± 2 [s] (1) Answer alone gets both marks	[120] – 65 ± 2 [s] (1) = 55 ± 2 [s] (1) **Or** 20 + 15 + 20 (1) = 55 ± 2 [s] (1)		
		(b)			6	**Indicative content:** In the first 10 s, the train travels at constant velocity at 10 m/s. It then decelerates uniformly to rest in 20 s. Its deceleration is 0.5 m/s^2. Having remained at rest for the next 30 s, it accelerates non-uniformly to a velocity of 15 m/s in the last 60 s. The acceleration increases between 60 and 90 s and then decreases again between 90 s and 120 s. The mean acceleration is 0.25 m/s^2. **5 – 6 marks** The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar. **3 – 4 marks** The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar.	Accept "speed" instead of "velocity" in answer		

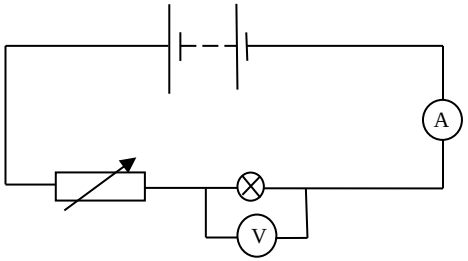
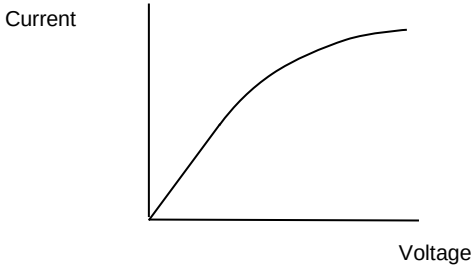
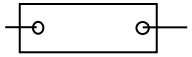
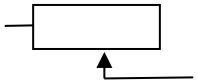
Question Number		Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT								
						1 – 2 marks The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit.			
		(c)	i		1	[Distance] = 10 × 10 = 100 [m]			
			ii		3	Mean speed $= \frac{(100+100)(1-\quad)\,\textbf{ecf}}{60(1)}$ 3.33 [m/s] (1)	3 or 3.3 Time = -60		3.0 or 3.30
		(d)			2	**HIGHER TIER only** Distance = 60 × 15 (1) ÷ 2 = 450 [m] (1 - answer)	No workings shown: 900 [m] = 1 mark Separate added area calculations that total 450 [m] = 2 marks 7.5 × 60 **or** 30 × 15 =1 mark		
		Total **FT** **HT**			**12** **14**				

Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
	3	*(a)*			2	56, 3			
		(b)			2	92 gives the number of protons / is the proton number (1) 235 gives the number of protons and neutrons / is the nucleon number / it has 143 neutrons (1) N.B. Reference to electrons loses 1 mark		92 is the atomic number. 235 is the mass number	
		(c)			1	[Boron steel / cadmium] control rods are dropped <u>completely</u> [into the reactor] **Or** Control rods can be lowered to absorb <u>all</u> the neutrons	Ball bearings or boron steel dust is dropped [into the reactor]		Any reference to moderator
		Total			**5**				

Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
	4	*(a)*	i		3	KE = mgh (written or implied) (1) $h = \frac{2\,940}{(60 \times 10)}$ (1-manip or sub) h = 4.9 [m] (1-ans)	mgh = 2 940 for the first mark. $h = \frac{2\,940}{600}$ for the first 2 marks Answer of 49 or 490 = 1 mark		
			ii		3	Some energy has been lost [to air resistance] / heat is produced (1) So the diver would have had more than 2 940 J of PE when on the diving board (1) So the diving board would have been higher than 4.9 [m] (**ecf**) (1) **Alternative:** The acceleration would have been smaller (1) So the acceleration would have been over a greater distance (1) So the diving board would have been higher than 4.9 [m] (**ecf**) (1) **To award full marks the first two statements must be linked.**			
		(b)	i		3	½mv^2 = 7.5 (1) $v^2 = \frac{(2 \times 7.5)}{60}$ (1-manip and sub) v = 0.5 [m/s] (1)	$v^2 = \frac{15}{60}$ or 0.25 for the first 2 marks		

Question Number								
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
		(b)	ii		3	Work = force × distance moved (written or implied) (1) $F = \frac{7.5}{2}$ (1-manip or sub) F = 3.75 [N] (1) **Alternative 1:** Mean speed = 0.25 [m/s] **ecf** Then time = $\frac{2}{0.25}$ = 8 [s] (1) Δp = 60 × 0.5 **ecf** = 30 (1) Force = $\frac{\Delta p}{t} = \frac{30\ \textbf{ecf}}{8\ \textbf{ecf}}$ = 3.75 [N] (1) **Alternative 2:** Mean speed = 0.25 [m/s] **ecf** Then time = $\frac{2}{0.25}$ = 8 [s] (1) $a = \frac{(v-u)}{t} = \frac{0.5\ \textbf{ecf}}{8\ \textbf{ecf}}$ = [-]0.0625 [m/s^2] (1) using $F = ma$ F = 60 × [-]0.0625 F = [-]3.75 [N](1)	$F \times d$ =7.5 for the first mark $F = \frac{7.5}{2}$ for the first 2 marks		
		Total			**12**				

Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
	5	*(a)*	i		2	Use of any pair of matching coordinates in the equation (1) e.g. 1.2 = $m \times 1.5$ m= 0.8 [kg] (1 – ans)	Any mathematical function of a matching pair award the 1st mark		
			ii	I	1	acceleration = $\frac{2.0}{0.8\ \textbf{ecf}}$ = 2.50 [m/s^2]			
				II	4	$a = \frac{(v-u)}{t}$ 2.5(**ecf**) $\frac{(v-0)}{0.6}$ v = 2.5 × 0.6 (1 – sub or manip) v = 1.5 [m/s] (1 – ans) momentum = 0.8 **(ecf)** × 1.5 (**ecf**) (1 – sub) = 1.2 [kg m/s] (1 – ans) **Alternative:** $\Delta p = F \times t = 2 \times 0.6 = 1.2$ [kg m/s] (4)	Accept error carried forward on mass from (b)(i) and from acceleration taken from graph.		
				III	2	The momentum / it does not change (1) as there is no [resultant] force acting on the trolley (1) **The 2nd mark can only be awarded if it is linked to the 1st mark.**	momentum / it <u>decreases</u> (1) due to air resistance (1)		It changes as the slider slows down for the 1st mark
		(b)			2	Straight line drawn from origin ± ½ small square division and below the one given (1) **And** through point (1.2, 0.5) ± ½ small square division (1)			
		Total			**11**				

Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
	6				6	**Indicative content:**  Resistance (in Ohms) is calculated each time by dividing the voltage (read from the voltmeter in volts) by the current (from the ammeter in amps). The results would show that as the voltage is increased, the resistance stays constant for low voltages and then increases as the voltage gets bigger and bigger. (The graph is initially straight and then curves showing a decreasing gradient.)  **5 – 6 marks** The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar.	For power supply accept with or without box:  For variable resistor accept: 		Squares for ammeter, voltmeter or lamp $R = V \div C$

Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
						3 – 4 marks The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar. **1 – 2 marks** The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit.			
Total			**6**						