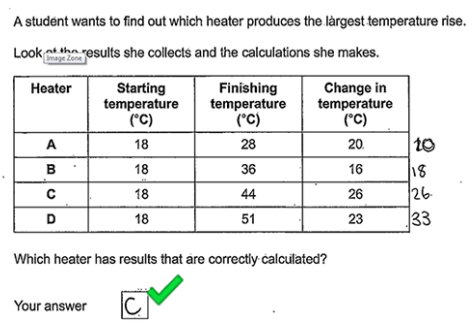
Mark scheme – Physics on the Move (F)

Question			Answer/Indicative content	Marks	Guidance
1			**C** ✓	1 (AO1.2)	
			Total	**1**	
2			**B**	**1 (AO 1.1)**	**Examiner's Comments** This question assessed P8.1a which includes the abilities to recall typical speeds of other transportation systems. Many candidates chose 2500 m/s (equivalent to 9000km/h), rather than 250 m/s, equivalent to 900 km/h (or about 560 mph). Candidates should have an idea of typical speeds of wind, sound as well as walking, running, cycling and other transportation systems such as trains.
			Total	**1**	
3			**C** ✓	**1 (AO 2.2)**	**Examiner's Comments** Higher ability candidates added an extra column to the table to calculate the change in temperature. These candidates were also more likely to write down their workings, even for multiple choice questions. See exemplar 1 **Exemplar 1**  6 A student wants to find out which heater produces the largest temperature rise. Look at the results she collects and the calculations she makes. Heater / Starting temperature (°C) / Finishing temperature (°C) / Change in temperature (°C) A 18 28 20 10 B 18 36 16 18 C 18 44 26 26 D 18 51 23 33 Which heater has results that are correctly calculated? Your answer C
			Total	**1**	
4			**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 12 (m/s) award 2 marks** Rearrange formula - 4 × 3 ✓	**2** **(AO 2.1)**	**Examiner's Comments** Higher ability candidates wrote out in a recognisable form that *change in velocity = acceleration × time = 3 × 4 = 12 (m/s)*. A

			12 (m/s) ✓	**(AO 2.1)**	common misconception was to divide the acceleration by time taken (i.e. 3 × 4 = 0.75). Candidates should be encouraged to put the numbers into the given equation which will help them to identify if they will need to rearrange the formula.
			Total	**2**	
5	a		Mass / inertia of child is lower ✓ Less force is needed (for the same deceleration)✓	**2 (AO 2.1) (AO 1.1)**	**ALLOW** weight of child is lower/child is smaller **Examiner's Comments** Many candidates suggested that the narrower belts were needed because of child car seats are smaller.
	b	i	Reduces pressure / spreads the force / AW ✓	**1 (AO 1.1)**	**Examiner's Comments** Many candidates found it difficult to use appropriate technical language in their answers to this question (for example, force and pressure). Many candidates wrote vague responses such as 'it would cover more of the body' without explaining why this was important. Higher ability candidates used specific technical language such as 'reducing the pressure' or 'spreading the force'. **AfL** The parts of a question form a story that develops a central theme. In part (a) looks at the pressure the car applies to the road, part (b) looks at the pressure that the force resulting from breaking applies to passengers, and part (c) applies this knowledge to the specific context of child safety seats. Where candidates follow these story lines, it helps them to improve the quality of their answers. However in (i) and (c) most candidates did not make the connection after they were asked to calculate pressure in (a).
		ii	Absorb energy (in a crash) ✓	**1 (AO 1.1)**	**ALLOW** higher level answers: eg. Reduces force / acceleration E.g. Increases time / distance to stop **Examiner's Comments** Higher ability candidates realised that the material was stretchy to absorb energy in a

					crash. Other responses referred to more generalised reasons such as allowing seatbelts 'to fit around different sized people.' Some candidates described the seat belt material as 'having a little give' or 'movement' without explicitly explain how this would increase time, reducing the rate of deceleration and thus the force exerted on the passenger.
			Total	**4**	
6			**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 0.75 (s) award 3 marks** Recall: (Reaction) time = (Thinking) distance ÷ Speed ✓ 6÷8 **or** 12÷16 **or** 24÷32 ✓ = 0.75 (s) ✓	**3** **(AO 1.2)** **(AO 2.1)** **(AO 2.1)**	**IGNORE** correct substitutions if **NOT** rearranged **Examiner's Comments** 10% of candidates recalled the speed equation and rearrange it as *reaction time* = *thinking distance* ÷ *speed*. The majority of the candidates were unable to interpret the data from the table and very few realised that the reaction time depended on the thinking distance before calculating the answer.
			Total	**3**	
7		i	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 2.8 (kW) award 4 marks** (P =) $I^2 \times R$ ✓ 11 × 11 × 23 or 112 × 23 or 121 × 23 ✓ = 2783 ✓ Conversion to kW = 2.8 (kW) ✓	**4** **(AO 1.2)** **(AO 2.1)** **(AO 2.1)** **(AO 2.1)**	**ALLOW** 2.78 kW or 2.783 kW ✓✓✓✓ **ALLOW** equation in any form **ALLOW** ecf candidates answer to 3rd marking point converted to kW **Examiner's Comments** Q23 is an overlap question with J249/04 and candidates found it very challenging with

					only a small number of the most able candidates being credited with any marks. From the stem of the question candidates knew that their answer needed to be between 1.0 kW and 3.0 kW. There were compensatory marks available where candidates wrote down the equation they were using and the different stages of their calculations. The most common workings shown were 11 × 23 or 23 ÷ 11, rather than 112 × 23 = 2.78kW. .
		ii	Wind speed varies / AW ✓	**1 (AO 2.1)**	**ALLOW** it depends on the strength of the wind / how windy it is / AW **IGNORE** there might not be any wind / wind changes direction / AW **Examiner's Comments** Many candidates realised that the wind speed would vary, but most responses were vague statements about the 'weather'.
		iii	(Idea of) not always enough wind / demand may exceed supply / AW ✓	**1 (AO 2.1)**	**ALLOW** (it) may not generate enough power / energy / AW **Examiner's Comments** Two thirds of the candidates reasoned that there may not be enough wind of the required speed or that a 3.0 kW wind turbine would not be sufficient to power a household. **AfL** It is very important to show candidates how to focus their answers on the question that they are being asked. For example, this question was about whether 'just one wind turbine' could be a reliable source of power a house. However, many candidates answered a question about the impact of a domestic electrical supply failure, which would apply to any source of power to a house.
			Total	**6**	
8			**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 800 (kg) award 3 marks** Recall: force = mass × acceleration ✓	**3** **(AO 1.2)**	

			4000 ÷ 5 ✓ 800 (kg) ✓	**(AO 2.1)** **(AO 2.1)**	**ALLOW** 0.8 for two marks **Examiner's Comments** Some candidates divided their calculated answer by 1000 so that there answer was actually in tonnes rather than kilograms. Because the equation uses force in N and acceleration in m/s^2 the computed mass will be kilograms. Other candidates divided 4000 by 5^2 perhaps thinking that 5 m/s^2 implied it needed to be squared.
			Total	**3**	
9	a	i	16 (m) ✓	1 (AO 3.1a)	**Examiner's Comments** This question was generally answered well.
		ii	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 0.67 (s) award 3 marks** Rearrangement to give Time = distance / speed ✓ Time = 16 / 24 ✓ Time = 0.67 (s) (2 decimal places) ✓	1 (AO 1.2) (AO 2.1) (AO 2.1)	**ALLOW ECF** from **(b)(i)** **ALLOW** 0.6 or 0.7 or 0.66(6…) (s) for 2 marks **ALLOW** one mark for any calculated answer to 2dp **Examiner's Comments** Higher ability candidates rearranged the equation, substituted the numbers and wrote the answer as 0.66667 before rounding the answer to 0.67. A number of candidates wrote their answer exactly from the calculator as 0.66̇ which was not acceptable for two decimal places.
	b		**Maximum 2 marks from:** Higher speed increases braking distance ✓ **BUT** Double speed quadruples braking distance / braking distance is (directly) proportional to the speed squared AW ✓✓ **Maximum 2 marks from:** (Idea that) higher speed (car has) more KE ✓ **BUT** Double speed quadruples KE / KE is (directly) proportional to the speed squared / AW ✓	3 (AO 2.1) (AO 3.1a x2) (AO 2.1) (AO 3.1a x2)	**ALLOW** numerical values from graph, e.g. at 10 (m/s), bd = 7.5 (m) but at 20 (m/s) bd = 30 (m). **ALLOW** numerical values from graph, e.g. at 10 (m/s), bd = 7.5 (m) but at 20 (m/s) bd = 4×7.5 (= 30m) for 2 marks **Examiner's Comments** Many answers to this question were vague. This question again required candidates to indicate the direction of the change in speed, e.g. as the speed increases. A small minority of candidates realised that both the kinetic energy and the braking distance increased

					with increasing speed. Very few used their graph to show that as the speed doubled the braking distance and kinetic energy quadrupled.
	c	i	(Driver under influence of) alcohol / drugs / tired / (named) distraction / ill / old-age / intoxication / high(er) speed ✓	1 (AO 1.1)	**IGNORE** just age **ALLOW** increase in driver's reaction time **Examiner's Comments** Many candidates correctly answered this question. The common factors were alcohol, drugs and tiredness. Some candidates did not score the mark for factors related to braking distances. Other candidates did not give an appropriate direction for the change, e.g. 'speed' was not credited but 'increasing speed' was credited.
		ii	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 26 (m) award 2 marks** (Stopping distance =) braking (distance) + thinking (distance) OR 16 OR 10 ✓ (sd =) 26 (m) ✓	2 (AO 2×2.2)	**Examiner's Comments** The majority of the candidates gained one mark for correctly reading off either the thinking distance or the braking distance. Many candidates did not read the question carefully to realise it was the stopping distance that was required. Higher ability candidates clearly showed both the values from the graph and the addition.
			Total	**10**	
10	a	i	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 3.25/3.3 (m/s^2) award 2 marks** 13 ÷ 4 ✓ = 3.3 (m/s^2) ✓	2 (AO2 × 2.1)	**ALLOW** 3.25 (m/s^2)
		ii	**Any two from:** Yes / No (no mark) (agree with driver) stopping distance is shorter ✓ Less likely to hit obstacles / safer ✓ Attempt to quantify, e.g. 4 s / 0.4 s = 10 ✓ **OR** (disagree with driver) (*F* = *ma* / so) the force (acting on the people in the car) is 10x greater ✓	2 (AO2.1) (AO2 ×3.1b) (AO2.1)	1

			This can lead to injury / 10× more dangerous ✓ Other factors involved (so cannot quantify) ✓	(AO2 ×3.1b)	
		iii	Seat belt / airbag / crumple zone ✓	1 (AO1.1)	
	b	i	(9 + 14) = 23 (m) ✓	1 (AO2.2)	
		ii	Stopping distance at 50 mph = 53 m ✓ Stopping distance is greater than 40 m / Car hits the barrier ✓	2 (AO3.1a) (AO3.2a)	**ALLOW** 52-54m
		iii	Factor: larger mass (of car) ✓ Reason: Braking distance is increased ✓ because deceleration is less / larger KE to dissipate ✓ **OR** Factor: Poor quality brakes / tyres ✓ Reason: Braking distance is increased ✓ Less friction / smaller deceleration ✓ **OR** Factor: Icy / wet / slippery road ✓ Reason: Braking distance is increased ✓ Less friction / smaller deceleration ✓ **OR** Factor: Going uphill ✓ Reason: Braking distance is decreased ✓ Weight of car increases deceleration ✓ **OR** Factor: Going downhill ✓ Reason: Braking distance is decreased ✓ Weight of car decreases deceleration ✓	3 (AO1.1) (AO2 × 2.1) (AO1.1) (AO2 × 2.1) (AO1.1) (AO2 × 2.1) (AO1.1) (AO2 × 2.1) (AO1.1) (AO2 × 2.1)	**DO NOT ALLOW** distance for braking/thinking distance **DO NOT ALLOW** stopping distance
	c	i	**Any two from:** First student drops the ruler and second student catches as quick as possible ✓ Measure the distance on the ruler where it was caught ✓ Use look-up table/equation to find time to travel this distance ✓	2 (AO2 × 1.2)	1
		ii	**Any one from:** To check the precision or repeatability of the readings ✓ to find the uncertainty in the measurement	1 (AO3.3a)	

			✓ to find an average or mean ✓		
		iii	Student B's reaction times will be longer / increases ✓	1 (AO3.2a)	**ALLOW** B will be slower
			Total	**18**	