COMPONENT 1 – NEWTONIAN PHYSICS

MARK SCHEME

GENERAL INSTRUCTIONS

The mark scheme should be applied precisely and no departure made from it.

Recording of marks

Examiners must mark in red ink.

One tick must equate to one mark (except for the extended response questions).

Question totals should be written in the box at the end of the question.

Question totals should be entered onto the grid on the front cover and these should be added to give the script total for each candidate.

Marking rules

All work should be seen to have been marked.

Marking schemes will indicate when explicit working is deemed to be a necessary part of a correct answer.

Crossed out responses not replaced should be marked.

Credit will be given for correct and relevant alternative responses which are not recorded in the mark scheme.

Extended response question

A level of response mark scheme is used. Before applying the mark scheme please read through the whole answer from start to finish. Firstly, decide which level descriptor matches best with the candidate's response: remember that you should be considering the overall quality of the response. Then decide which mark to award within the level. Award the higher mark in the level if there is a good match with both the content statements and the communication statement.

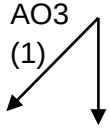
Marking abbreviations

The following may be used in marking schemes or in the marking of scripts to indicate reasons for the marks awarded.

cao = correct answer only
ecf = error carried forward
bod = benefit of doubt

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
1	*(a)*	(i)	The single point within a body at which the entire **weight** of the body may be considered to act	1			1		
		(ii)	Increase θ gradually until the block topples (1) Measure θ with a protractor just before the block topples / measure height and length of slope and calculate (1)	1 1			2		2
	(b)	(i)	$V = 0.6 \times 0.4 \times 0.1$ and $M = \rho \times V$ used correctly (1) Attempt at equating moments (1) ($T\sin\theta$ (1)) $\times$ 1.2 = $9.6 \times 9.81 \times 1.8$ (1) for correct moments $T = 220$ [N] (1)	1 1	 1 1 1		5	4	
		(ii)	$F = 220 \cos 40^{o}$ (**ecf**) (1) $F = 169$ N (1) **UNIT mark**		1 1		2	2	
			Question 1 total	**5**	**5**	**0**	**10**	**6**	**2**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
2	*(a)*	(i)	Correct use of $v^2 = u^2 + 2ax$ (i.e. $0 = 6^2 - 2 \times 9.81 \times x$) (1) $x = 1.8$ [m] (1) Total height = 12.8 [m] (1)	1	 1 1		 3	 3	
		(ii)	$v^2 = 2 \times 9.81 \times 12.8$ (**ecf**) $v = 15.9$ [m s^{-1}] (1) $t_{up} = \left(\frac{0-6}{-9.81}\right) = 0.6$ [s] (1) $t_{down} = \left(\frac{15.9(\text{ecf})-0}{9.81}\right) = 1.6$ [s] (1) Total time = 2.2 [s] (1) **Alternative solution:** t_{up}: $s = ut + ½\ at^2$ $1.8 = 6t - 4.9t^2$ $t = 0.6$ [s] (1) t_{down}: $s = ut + ½\ at^2$ $12.8 = 0t + 4.9t^2$ (1) $t = 1.6$ [s] (1) Total time = 2.2 [s] (1)	1 1	 1 1		 4	 4	

	(b)		AO3 (1) / (1) AO2  Air resistance acts on the ball (1) AO2		1 1	1	3		
			Question 2 total	**3**	**6**	**1**	**10**	**7**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
3	*(a)*	(i)	$0.50 \times 40 = 0.50 \times 30 + 0.16\ v$ [or equivalent] (1) $v = 31.25$ [m s^{-1}] (1)	1	1		2	2	
		(ii)	External forces act upon the system [or by implication] (1) [Specifically] the shaft exerts a force upon the head of the hockey stick (1) [or any other reasonable specific force – accept air resistance]			1 1	2		
	(b)		Using Newton's 2nd law (1) $F = \frac{\Delta \text{momentum}}{\text{time to change}}$ [or by implication] (1) = 2 000 [N] [**ecf**] (1)	1 1	1		3	1	
	(c)	(i)	$(½ \times 0.5 \times 40^2) - (½ \times 0.5 \times 30^2) - (½ \times 0.16 \times 31.25^2) = [100\ \text{J}]$	1			1	1	
		(ii)	Use of $E = mc\Delta T$ (1) $\Delta T = \frac{100}{0.16 \text{x} 850}$ = 0.74 [°C] (1)	1	1		2	1	
			Question 3 total	**5**	**3**	**2**	**10**	**5**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
4	*(a)*		Force × distance moved in direction of force [or equivalent, e.g. component of force in direction of movement × distance moved, **or** $W = Fx\cos\theta$]	1			1		
	(b)	(i)	E_p lost = 70 × 9.81 × 120 sin 20° (1) [or by implication] = 28 000 [J] [28 148] (1) [Use of 10 for g – 1st mark lost]	1	1		2	2	
		(ii)	Use of E_k for either v = 6 m s^{-1} or v = 21 m s^{-1} (1) At A, E_k = ½ × 70 × 6^2 [= 1 260 J] and at B, E_k = ½ × 70 × 21^2 correct values of E_k calculated (1) [=15 435 J] ΔE_k = 14 175 [J] (1) [If (21 – 6)^2 calculated → 1 mark only]	1	1 1		3	2	

	(c)		Use of $W = Fx$ (1) [or by implication] Correct x [120 m] used (1) 28 184 – 14 175 (**ecf** on both) = $F \times 120$ (1) [or by implication] F = 117 [N] (1) **Alternative solution:** $mg\sin\theta$ = 234.9 [N] (1) ma = 118.1 [N] (1) Difference attempted (234.9 – 118.1) **ecf** on both values (1) F = 117 [N] (1) **Alternative solution:** $g\sin\theta$ = 3.36 [m s^{-2}] (1) $a = \frac{v^2 - u^2}{2s}$ = 1.69 [m s^{-2}] (1) Difference attempted (3.36 – 1.69) **ecf** on both values (1) F = answer $\times$ 70 kg = 117 [N] (1) N.B. $\times$ 70 kg may be included in the solution at any point	1 1	1 1		4	3	
			Question 4 total	**5**	**5**	**0**	**10**	**7**	**0**

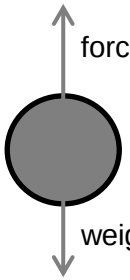
Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
5	*(a)*		All points plotted correctly (to within half a small square) (1) With error bars plotted correctly for temperature (1) Suitable scales on both axes with titles and units (1) Suitable lines of maximum gradient and minimum gradient drawn (1)		1 1 1 1		4	3	4
	(b)	(i) (ii)	Coming into contact with hot water Stir water / take readings at eye level	1 1			2		2
	(c)	(i)	Method for finding the gradient (1) maximum $= \frac{98-30}{100} = 0.68 \pm 0.02$ [°C s^{-1}] **and** minimum $= \frac{94-34}{100} = 0.60 \pm 0.02$ [°C s^{-1}] (1)	1	 1		2	1	2
		(ii)	So mean gradient = 0.64 ± 0.02 [°C s^{-1}] (1) Absolute uncertainty calculated (1) Percentage uncertainty - accept 3 to 8% (1)		1 1 1		3	2	3

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
5	*(c)*	(iii)	Equate $c = \frac{\text{Power}}{m \times \text{gradient}}$ (1) Correct calculation of c = 4 200 [J kg^{-1} °C^{-1}] (1) **ecf** Uncertainty – accept 130 – 340 (1)			1 1 1	3	3	3
	(d)		**Conclusions** C0 – As time increases, temperature increases. C1 – Values of temperature are lower. C2 – Line of graph is not straight. C3 – Gradient is decreasing. C4 – Initial temperature is the same. C5 – Value of specific heat capacity is too low or lower or less than 4 200 [J kg^{-1} °C^{-1}]. C6 – Measured value of specific heat capacity is not constant [because the gradient is not constant]. **Evaluations** E0 – Line should be straight or disagrees with theory. E1 – Results need checking, as they are not what would be expected. E2 – Statement relating to “lost” energy. E3 – Heat is lost or energy is given to the container. E4 – More heat loss occurs at higher temperatures. E5 – Due to a greater temperature difference between water and air / surroundings / outside of container. **5-6 marks** All of C1 – C4 (acceptable for C0 to be omitted) are present. Either C5 or C6 is present.			6	6		6

			E0, E3 and E4 are present (E5 may be present for the best candidates). There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured. **3-4 marks** Expect 2 from C0 – C4. Expect 2 from E0 – E3. There is a line of reasoning which is partially coherent, largely relevant, supported by some evidence and with some structure. **1-2 marks** 1 from C0 – C2 present 1 from E0 – E3 present. There is a basic line of reasoning which is not coherent, largely irrelevant, supported by limited evidence and with very little structure. **0 marks** No attempt made or no response worthy of credit.						
			Question 5 total	**3**	**8**	**9**	**20**	**9**	**20**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
6	*(a)*		A body moves with SHM if its <u>acceleration</u>: is directly proportional to its displacement from a fixed point (1) is always directed towards that fixed point (1)	 1 1			 2		
	(b)		Use of $f = \frac{1}{T}$ (1) $f = \frac{1}{0.4} = 2.5\,\text{Hz}$ (1) **UNIT mark**	1	 1		 2	 1	
	(c)		$\omega = \frac{(2\pi)}{0.4} = 15.7$ [rad s^{-1}]	1			1	1	
	(d)	(i)	$v_{max} = \omega A$ (1) = (15.7)(0.05) = 0.79 [m s^{-1}] (1)	1	1		2	1	
		(ii)	$a_{max} = \omega^2 A$ (1) =(15.7^2)(0.05) = 12.3 [m s^{-2}] (1)	1	1		2	1	
		(iii)	$a = \omega^2 x$ (1) = (15.7^2)(0.02) = 4.93 [m s^{-2}] (1) Downward (1)	1	 1 1		 3	 2	

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
6	*(e)*	(i)	Maximum deceleration [12.3 m s^{-2}] > g (1) Box's downward acceleration can't be greater than g (1) So platform slows down quicker than box (1) $mg = m\omega^2 x$ (1) So $x = \frac{9.81}{15.7^2}$ (1)			1 1 1 1 1	5	2	
		(ii)	Box acts as a moving observer and / or source (1) Wavelength shift due to the Doppler effect (accept red shift or blue shift) (1) $\Delta\lambda \propto v$ **or** $\frac{\Delta\lambda}{\lambda} = \frac{2v}{c}$ **or** $\frac{\Delta\lambda}{\lambda} = \frac{v}{c}$ explained (1)		1 1 1		3		
			Question 6 total	**7**	**8**	**5**	**20**	**8**	**0**

Question		Marking details	Marks available					
			AO1	AO2	AO3	Total	Maths	Prac
7	*(a)*	Weight or gravity identified as one of the forces (1) (diagram acceptable) [Upward] force due to [convection] air current or drag or air resistance (accept answers similar to wind push) is the other force or diagram e.g. (1)  The second force depends on the [cross-sectional] area of the smoke particle (1) Weight depends on [mass and therefore] volume (1) The ration $\frac{\text{Area}}{\text{Volume}}$ increases when size decreases (1)	1 1	 1 1 1		 5		
	(b)	Lopez argument based on the energy released in a nuclear reaction (1) Daxon argument based on the energy released in a chemical reaction (1)		1 1		2		

	(c)	**U-235 points** U1 – Used for nuclear bomb. U2 – Used for nuclear power stations. U3 – In fuel rods. U4 – Detonators for hydrogen bombs / fission bombs. U5 – U-235 fission nucleus. U6 – Induced fission. **Nuclear power** N1 – Dangerous (explosion risk). N2 – Leak risk or nuclear waste. N3 – Low CO_2. N4 - No acid rain. N5 – No climate change. **Nuclear bomb** B1 – Mass extinction. B2 – Deterrent to war. **Depleted uranium** D1 – Spreads radiation. D2 – Better missiles. D3 – Cheap materials. **Conclusions** C1 - Pros and cons discussed for nuclear power (no actual conclusion is necessary). C2 - Pros and cons discussed for nuclear bomb (no actual conclusion is necessary). C3 - Pros and cons discussed for DU (no actual conclusion is necessary). **ALL CONCLUSIONS MUST BE VALID AND JUSTIFIABLE.**						

		5-6 marks At least U1, U2, U3 and U5 present. At least N1, N2 and N3 present. B1 and B2 present. At least D1 present and either D2 or D3. C1, C2 and C3 present. There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured. **3-4 marks** Expect U1 and U2. Expect N1 and N2. Either B1 or B2. Either D1 or D2 or D3. Either C1 or C2 or C3. There is a line of reasoning which is partially coherent, largely relevant, supported by some evidence and with some structure. **1-2 marks** Either U1 or U2. Either N1 or N2 or N3 or N4 or N5. There is a basic line of reasoning which is not coherent, largely irrelevant, supported by limited evidence and with very little structure. **0 marks** No attempt made or no response worthy of credit.			6	6		

	(d)	Mass = $500 \times (10^{-5})^2$ (1) Activity = $12.3 \times 10^6 \times 0.05 = 0.63$ (1) Similar **or** slightly higher **or** 50% higher (1)		1 1 1		3	2	
	(e)	Insoluble more difficult to remove / excrete (1) Therefore stays in the body longer (1) U-235 is removed from the mix to produce DU hence the increased ratio (1) Therefore the claim is correct and answer well-reasoned (1)		1 1	1 1	4		
		Question 7 total	**2**	**10**	**8**	**20**	**2**	**0**

COMPONENT 1: NEWTONIAN PHYSICS

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
1	5	5	0	10	6	2
2	3	6	1	10	7	0
3	5	3	2	10	5	0
4	5	5	0	10	7	0
5	3	8	9	20	9	20
6	7	8	5	20	8	0
7	2	10	8	20	2	0
TOTAL	30	45	25	100	44	22