COMPONENT 1 – MOTION, ENERGY AND MATTER

MARK SCHEME

GENERAL INSTRUCTIONS

Recording of marks

Examiners must mark in red ink.

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

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)*		Height from bench to ruler same at each end / accept use of spirit level / set square	1			1		1
	(b)		Arrow drawn through middle of the ruler labelled W	1			1		1
	(c)		When a system is in equilibrium (1) $\sum$ anticlockwise moments about a point = $\sum$ clockwise moments about the same point / resultant moment = 0 (1)	1 1			2		
	(d)	(i)	Weight of 250 g mass = 2.45 [N] (1) Application of the principle of moments e.g. $2.8 \times 0.8 = (0.6 \times 2.45) + (W \times 0.4)$ (1) Weight = 1.92[5] [N] (1)		1 1 1		3	3	3
		(ii)	$1.92[5] + 2.45 = 2.8 + T$ $T = 1.57[5]$ [N]		1		1	1	1
		(iii)	Resistance increases with length (or increases with decrease in cross-sectional area) (1) Extension is directly proportional to the force and therefore change of resistance (1)		1	1	2		2
			Question 1 total	**4**	**5**	**1**	**10**	**4**	**8**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
2	*(a)*	(i)	$ut + ½ (v – u)t$ / area of trapezium i.e. $½ (u + v)t$ (1) Displacement [in time t] (1)	1	1		2	2	
		(ii)	Use of light gates (1) Measure time for a fixed distance (1)	1 1			2		2
	(b)	(i)	**Height of cliff:** Use of $x = ut + ½ at^2$ (1) $ut = 0$ **and** $a = 9.8$ [m s^{-2}] (1) $x = 122.5$ [m] (1) **Vertical velocity:** Use of $v = u + at$ (1) $v = 49$ [m s^{-1}] (1) **Initial horizontal velocity:** $u = 2$ [m s^{-1}]	1 1 	 1 1 1 1		6	4	
		(ii)	Straight diagonal line (1) Starting at (0,0) finishing at (5,49) (1) Horizontal line starting at (0,2) (1)		1 1 1		3	3	
	(c)		Increase time of flight (1) Reduce final velocity (1)			1 1	2		
			Question 2 total	**5**	**8**	**2**	**15**	**9**	**2**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
3	*(a)*	(i)	**Gravity:** Level the air track by using a spirit level for example (1) **Friction:** Floating on air so no contact (1)	1 1			2		2
		(ii)	Use of momentum before = momentum after (1) m = 0.175 [kg] (1)	1	1		2	2	2
		(iii)	Total kinetic energy before = 0.51 [J] (1) Total kinetic energy after = 0.27 [J] (1) Lost as heat (1)		1 1 1		3	2	3
	(b)		$v = \frac{(2.25 \times 0.2)}{0.175}$ = 2.57 [m s^{-1}] (1) KE = ½ × 0.175 × 2.57^2 = 0.58 [J] (1) Too much KE, since 0.58 > 0.51 hence the statement seems to be true (1)			1 1 1	3	2	3
			Question 3 total	**3**	**4**	**3**	**10**	**6**	**10**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
4	*(a)*		Energy cannot be created or destroyed, only converted to other forms	1			1		
	(b)	(i)	$\frac{1}{2} mv^2 = mgh$ shown (1) (no mark for $E_k = E_p$ only) Clear manipulation (1)	1	 1		2	2	
		(ii)	v = 48.5 [m s^{-1}]		1		1	1	
	(c)		Actual v = [48.5 – 20% × 48.5] = 38.8 [m s^{-1}] (1) (**ecf**) Actual E_k = 210 762 [J] (1) **Either** (½ × 280 × (48.5)^2 – 210 762) **or** (280 × 9.8 × 120 – 210 762) (**ecf** on 48.5 or 210 762) [= 118 500 J] (1) =F × 1 400 (1) F = 85 [N] (1) Air resistance / friction between bobsleigh and ice (1)	 1	1 1 1 1 1		6	5	
			Question 4 total	**3**	**7**	**0**	**10**	**8**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
5	*(a)*		**Method** M0 – Diagram of valid set-up. M1 – Add weights. M2 – Measure extension (no need to mention subtracting original length). M3 – Measure thickness of wire with micrometer / digital callipers. M4 – [Equal] weights added **or** (range) and intervals of measurements stated. M5 – Parallax avoided by eye being perpendicular to scale **or** wire close to the ruler. M6 – Thickness measured at various locations. M7 – Extra accuracy in measuring extension e.g. travelling microscope, two wires and Vernier scale etc. **Results** R0 – Plot graph of force-extension or stress-strain. R1 – Calculate the gradient. R2 – Use only the linear region **or** don't use past the elastic limit / limit of proportionality. **Calculations** C0 – Young modulus = gradient of the force-extension graph $\times \left(\frac{l}{A}\right)$ **or** gradient of the stress-strain graph. C1 – A point is taken and values put into the relevant formula to calculate Young modulus e.g. $\left(\frac{Fl}{Ax}\right)$.						.

			5-6 marks All of M0 – M3 and 2 from M4 – M7 are present. All of R0 - R2 are present. Both C0 and C1 are present. There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured. **3-4 marks** All of M0 – M3 are present. R0 is present. C1 is present. There is a line of reasoning which is partially coherent, largely relevant, supported by some evidence and with some structure. **1-2 marks** Expect any 2 from M0 – M3. Either R0 or C1 is 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.	6			6	1	6
	(b)	(i)	Clear attempt to find gradient or values of stress/strain from graph (ignore errors in powers of 10) (1) E = 208 GPa (accept 204 – 212 GPa) (1) **UNIT mark**			1 1	2	2	2
		(ii)	Benefit – Young modulus or breaking stress obtained over a greater range (1) Risk – Far greater energy and risk of injury (1)			1 1	2		2
			Question 5 total	**6**	**0**	**4**	**10**	**3**	**10**

Question			Marking details		Marks available				
				AO1	AO2	AO3	Total	Maths	Prac
6	*(a)*	(i)	$A = 4\pi(7.22 \times 10^{8}\ [\text{m}])^2 = [6.55 \times 10^{18}\ [\text{m}^2]]$ (1) $P = 5.67 \times 10^{-8} \times$ area attempt $\times$ $5\,970^4$ (1) [W] $P = 4.72 \times 10^{26}$ [W] **and** suitable comment (allow consistency **ecf on slips)** (1) [One mark to be lost for slips e.g. powers of 10, factors of 2, 4, π] Accept other alternatives e.g. finding P from A and T or finding A from P and T			1 1 1	3	3	
		(ii)	$I = \dfrac{\text{power}}{4\pi(1.8\text{x}10^{17})^2}$ (1) $I = 1.16 \times 10^{-9}$ W m^{-2} **UNIT** mark (1) [penalty of 1 mark for slips of 10^n, 4, π etc no penalty if same slip as in (i)]	1	1		2	2	
		(iii)	$\lambda_{\text{max}} = \dfrac{2.9\text{x}10^{-3}}{5970} = 4.86\text{x}10^{-7}$ [m] (1)		1		1	1	
		(iv)	$n\lambda = d\sin\theta$ used (1) Hence $\sin\theta$ (or θ) depends on the wavelength or $\lambda \times \sin\theta$ or $\lambda \times \theta$ for small angles (1)	1	1		2		2
	(b)		P goes up and T goes down and then A goes up (1) Because $A = \dfrac{P}{\sigma T^4}$ or any convincing explanation (1)		1 1		2	1	
			Question 6 total	**2**	**5**	**3**	**10**	**7**	**2**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
7	*(a)*		Neutrino: weak only (1) [No mark if additional tick(s)] Electron: weak and e-m only (1) u quark: strong, weak, e-m (1)	1 1 1			3		
	(b)	(i)	$\left(-\frac{1}{3}\right)+\left(-\frac{2}{3}\right)=\left(-\frac{1}{3}\right)+\left(-\frac{1}{3}\right)+\left(-\frac{1}{3}\right)$ **or** equivalent		1		1		
		(ii)	u: 0 $\rightarrow$ 1 + (-1) **or** equivalent (1) d: 3 $\rightarrow$ 2 + 1 **or** equivalent (1)		1 1		2		
		(iii)	Not a weak interaction stated and then qualified by: no change of quark flavour (1) no neutrino involvement (1)			2	2		
	(c)	(i)	ddd		1		1		
		(ii)	$u\bar{d}$		1		1		
			Question 7 total	**3**	**5**	**2**	**10**	**0**	**0**

COMPONENT 1: MOTION, ENERGY AND MATTER

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
1	4	5	1	10	4	8
2	5	8	2	15	9	2
3	3	4	3	10	6	10
4	3	7	0	10	8	0
5	6	0	4	10	3	10
6	2	5	3	10	7	2
7	3	5	2	10	0	0
TOTAL	**26**	**34**	**15**	**75**	**37**	**32**