AS Level
Further Maths

Bronze Set A, Paper FM1 (Edexcel version)

Question	Solution	Partial Marks	Guidance
1 (a)	$\frac{1}{2}m(20)^2 = mg(-40) + \frac{1}{2}mV^2$ $\Rightarrow V^2 = 20^2 + 2g(40) = 1184$ $\Rightarrow V = 34.409...$ so $V = 34$ m/s to 2 sf	M1 A1 A1 **[3]**	Uses energy conservation to form a dimensionally correct equation with the correct number of terms A correct equation Correct value of V to 2 or 3 significant figures Use of vertical free-fall kinematics formula is 0/3 XP
1 (b)	$10 \times 40 = \frac{1}{2}(7)(20)^2 + 7g(40) - \frac{1}{2}(7)W^2$ $\Rightarrow \frac{1}{2}(7)W^2 = 3744$ $\Rightarrow W = 32.706...$ so $W = 33$ m/s to 2 sf	M1 A1 A1 **[3]**	Their work done = initial energy – final energy Correct equation Correct value of W
1 (c)	Rotational energy can be ignored	B1 **[1]**	Idea that rotational energy can be ignored Allow 'rotational effects' in place of 'rotational energy'
1 (d)	Make the air resistance variable (dependent on speed)	B1 **[1]**	Correct refinement
2 (a)	2.5 m/s	B1 **[1]**	Correct initial speed oe
2 (b)	COLM gives $4(2.5) = 4(2) + 3v$ $\Rightarrow v = \frac{2}{3}$, so speed of B after collision is $\frac{2}{3}$ m/s	M1 A1 A1 **[3]**	Uses COLM to form an equation. Allow a sign error Forms correct equation Correct speed of B

2 (c)	$\frac{2}{3}(3) = 3(1) + 3v$ $\Rightarrow v = -\frac{1}{3}$, so speed of B after collision is $\frac{1}{3}$ m/s and B moves to the left	M1 A1 A1 A1ft **[4]**	Uses COLM to form an equation. Allow a sign error Forms correct equation Correct **speed** of B after collision (A0 if a minus sign given) Correct direction of B ft their value of v and their positive direction Award the ft carefully – not all candidates will necessarily choose right as their positive direction
2 (d)	A is moving to the right and B moves to the left after its collision with C, so yes, B will collide again with A	B1* B1(dep*) **[2]**	Explains that A and B are moving towards each other after B collides with C Concludes 'yes'
3 (a)	Force = Resistance (since no acceleration) = 20 N So power = force × speed = 20(5) = 100 W	B1 M1 A1 ft **[3]**	Correct force seen or implied Uses power = force × speed Correct power ft their 100
3 (b)	$F - (23+m)g\sin\alpha - 20 = 0 \Rightarrow F = \frac{(23+m)g}{13} + 20$ $P = Fv \Rightarrow \frac{190}{3} = \frac{(23+m)g}{13} + 20$ $\Rightarrow m = 58.972...$, so mass of the sledge is 59 kg to 2 sf	M1* A1 A1 M1(dep*) A1 **[5]**	Resolves parallel to the plane. Allow sin/cos confusion Correct resolution in terms of 'm' (allow in terms of $\sin\alpha$) Correct force seen in terms of 'm' (value of $\sin\alpha$ must be substituted) Uses power = force × speed to form a correct equation in m ft their F Correct mass of the sledge to 2 or 3 sf
4 (a)	Let x and y respectively be the speeds of A and B after collision COLM gives $mu = -mx + 3my \Rightarrow u = -x + 3y$ NLR gives $e = \frac{y-(-x)}{u} \Rightarrow ue = y + x$ Solving the equations gives $x = \frac{u}{4}(3e-1)$ and $y = \frac{u}{4}(1+e)$ and	M1* A1 M1* A1 M1(dep*) A1 oe A1 oe **[7]**	Attempts to use COLM to form one equation (allow sign errors) Correct equation Attempts to use Newton's law of restitution (allow sign errors) Correct equation Solves their two equations simultaneously for the speeds Correct speed of A and B (one mark for each one correct) Must state speed of A = … and speed of B = … or use a letter they have defined (on a diagram is OK)

4 (b)	Rebound speed of B is $\frac{7u}{40}(1+e)$ Require $\frac{7u}{40}(1+e) > \frac{u}{4}(3e-1) \Rightarrow e < \frac{17}{23}$ Also require $\frac{u}{4}(3e-1) > 0 \Rightarrow e > \frac{1}{3}$ hence result **AG**	B1ft M1 A1 B1 **[4]**	Correct rebound speed of B ft their y Sets their rebound speed of B > their speed of A after the collision Obtains the upper bound through correct workings Obtains the lower bound through correct workings
4 (c)	Initial KE = $\frac{1}{2}mu^2$ KE after collision = $\frac{1}{2}m\left(\frac{u}{4}(3e-1)\right)^2 + \frac{1}{2}(3m)\left(\frac{u}{4}(1+e)\right)^2$ $= \frac{1}{32}mu^2 + \frac{25}{96}mu^2 = \frac{7}{24}mu^2$ So KE lost = $\frac{1}{2}mu^2 - \frac{7}{24}mu^2 = \frac{5}{24}mu^2$	M1 A1 A1 **[3]**	Attempts to find KE after the collision using their speeds and the value of e Correct KE after the collision Correct KE lost. Final answer