5(a)		
	CLM: $2mu = 2mv_P + mv_Q$	M1A1
	NEL: $eu = -v_P + v_Q$	M1A1
	(v_Q =) $\frac{2(1+e)u}{3}$ *	A1*
		(5)
5(b)	e.g. $v_P = \frac{2(1+e)u}{3} - eu \quad \left(= \frac{u}{3}(2-e)\right)$	B1
	KE After = $\frac{1}{2} \times 2m\left(\frac{u}{3}(2-e)\right)^2 + \frac{1}{2}m\left(\frac{2(1+e)u}{3}\right)^2$	M1A1
	KE Loss = $\frac{1}{2} \times 2mu^2 -$ their KE after	DM1
	$= \frac{1}{3}(1-e^2)mu^2$ so $k = \frac{1}{3}$	A1
		(5)
5(c)	$\frac{8mu}{9} = m \times \frac{2(1+e)u}{3}$ **OR** $-\frac{8mu}{9} = 2m\left(\frac{u}{3}(2-e) - u\right)$	M1
	$e = \frac{1}{3}$	A1
		(2)
5(d)	$\frac{2(1+e)uf}{3}$ seen or implied, e does not need to be substituted.	B1
	$\frac{2\left(1+"\frac{1}{3}"\right)uf}{3}$ = their speed of P, with their value of e used to give an equation in f **only**.	M1
	$f = \frac{5}{8}$ or 0.625	A1
		(3)
		(15)
	Notes for question 5	
5(a)	**N.B.** Mark CLM equation first.	
	M1 for a CLM equation, dimensionally correct with correct no. of terms, condone sign errors, consistent extra g's or cancelled m's	
	A1 for a correct equation	
	M1 for a NEL equation, with e on the correct side, condone sign errors	
	A1 for a correct equation, consistent with the CLM equation.	
	A1* for given answer correctly obtained, with at least one line of intermediate working. **N.B.** Allow any fully factorised equivalent form.	
5(b)	B1 for a correct unsimplified expression in e and u for v_P seen or	

	implied.	
	M1 for correct unsimplified expression, using **their** v_P and the **given** v_Q for KE after (must be adding the KE's)	
	A1 for a correct unsimplified expression for the KE After	
	DM1 for $\left(\frac{1}{2}\times 2mu^2 - \text{ their KE after}\right)$ using their v_P and the **given** v_Q, condone Final KE – Initial KE.	
	A1 Accept 0.33 or better. **N.B.** Must be from correct working.	
5(c)	M1 for a **correct** impulse-momentum equation for either Q or P i.e. do NOT condone sign errors.	
	A1 Accept 0.33 or better.	
5(d)	B1 cao	
	M1 for equating their speeds of P and Q, with their e substituted, to give an equation **in *f* only**, allow slip when substituting in their e value, provided the method is clear. **N.B**. Must be using a value of e where $0 < e \leq 1$	
	A1 Accept 0.63	