Question Number	Scheme	Marks
5 (a)	It is not a statistic as it involves unknown [population parameters]	B1
		(1)
(b)	An estimator for μ is unbiased if its expected value is equal to μ	B1
		(1)
(c)	$\mathrm{E}(U_1) = 3\mathrm{E}(X_1) - 2\mathrm{E}(X_2)$ or $\mathrm{E}(U_2) = \frac{1}{4}\left(\mathrm{E}(X_1) + 3\mathrm{E}(X_2)\right)$	M1
	$\mathrm{E}(U_1) = 3\mu - 2\mu = \mu$ (therefore unbiased)	A1cso
	$\mathrm{E}(U_2) = \frac{1}{4}(\mu + 3\mu) = \mu$ (therefore unbiased)	A1cso
		(3)
(d)	$\mathrm{Var}(U_1) = 9\mathrm{Var}(X_1) + 4\mathrm{Var}(X_2)$ or $\mathrm{Var}(U_2) = \frac{1}{16}\mathrm{Var}(X_1) + \frac{9}{16}\mathrm{Var}(X_2)$	M1
	$\left[\mathrm{Var}(U_1) =\right] 13\sigma^2$	A1
	$\left[\mathrm{Var}(U_2) =\right] \frac{5}{8}\sigma^2$	A1
	As $\mathrm{Var}(U_1) > \mathrm{Var}(U_2)$ U_2 is the most efficient estimator for μ	A1
		(4)

	Notes	**Total 9**
(a)	**B1**	for a correct explanation, must include unknown
(b)	**B1**	for a correct explanation that refers to expected *X*. Allow $\mu - \mathrm{E}(X) = 0$, but bias = 0 is B0
(c)	**M1**	for use of $a\mathrm{E}(X_1) + b\mathrm{E}(X_2)$ May be implied by $3\mu - 2\mu$ or $\frac{1}{4}(\mu + 3\mu)$
	A1cso	for a correct solution for $\mathrm{E}(U_1)$ with no incorrect working Condone missing notation. Condone missing subscripts
	A1cso	for a correct solution for $\mathrm{E}(U_2)$ with no incorrect working seen Condone missing notation. Condone missing subscripts
(d)	**M1**	for use of $a^2\mathrm{Var}(X_1) + b^2\mathrm{Var}(X_2)$
	A1	Allow $9\sigma^2 + 4\sigma^2$
	A1	Allow $\frac{1}{16}\sigma^2 + \frac{9}{16}\sigma^2$ or $\frac{5}{8}\sigma^2$ oe
	A1	for U_2 with a correct reason
		NB It is possible to score M1 A0 A0 A1 if $\mathrm{Var}(U_1)$ and $\mathrm{Var}(U_2)$ are correct