**5** **(a)** State the relationship between electric field and electric potential.

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**(b)** Two charged isolated insulating spheres X and Y are near to each other, as shown in Fig. 5.1.



**Fig. 5.1**

P is a point on the line joining the centres of the spheres.

Explain why it is **not** possible for the total electric potential and the resultant electric field to simultaneously be zero at point P.

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**(c)** The magnitudes of the charges on spheres X and Y in Fig. 5.1 are $Q$ and $2Q$ respectively. The spheres may be considered as point charges at their centres.

Point P is a distance $x$ from the centre of sphere X.

The electric potential at point P is zero.

**(i)** Show that the distance $y$ of point P from the centre of sphere Y is equal to $2x$.

[2]

(ii) State an expression, in terms of $Q$, $x$ and the permittivity of free space $\varepsilon_0$, for the electric field strength $E_X$ at P due to sphere X.

$E_X =$ ........................................................ [1]

(iii) Determine an expression, in terms of $Q$, $x$ and $\varepsilon_0$, for the resultant electric field strength $E$ at point P due to the two spheres.

$E =$ ........................................................ [2]

[Total: 10]