For Examiner's Use

3 **(a)** Define *electric potential* at a point.

....

....

.... [2]

(b) Two point charges A and B are separated by a distance of 20 nm in a vacuum, as illustrated in Fig. 3.1.

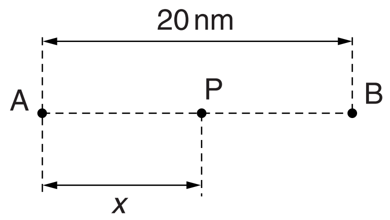

Fig. 3.1

A point P is a distance x from A along the line AB.
The variation with distance x of the electric potential V_A due to charge A alone is shown in Fig. 3.2.

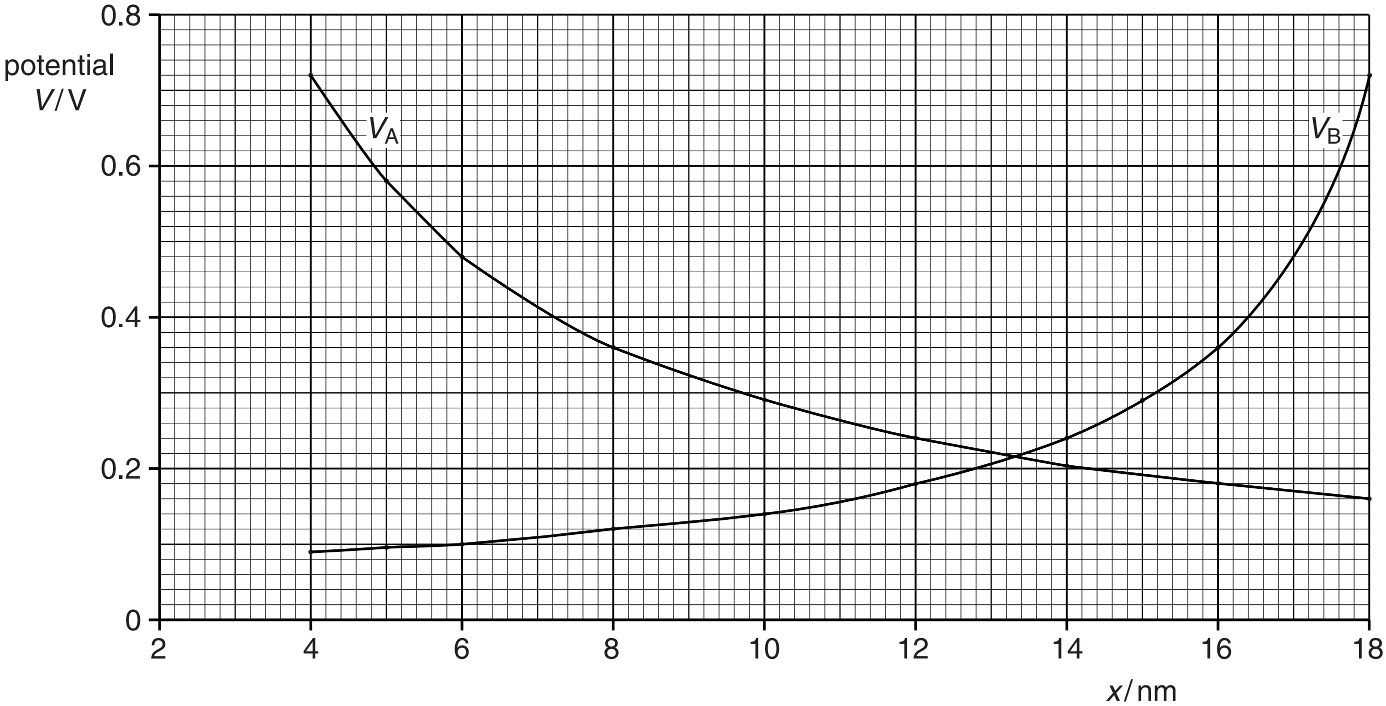

Fig. 3.2

The variation with distance x of the electric potential V_B due to charge B alone is also shown in Fig. 3.2.

(i) State and explain whether the charges A and B are of the same, or opposite, sign.

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....

....

.... [2]

(ii) By reference to Fig. 3.2, state how the combined electric potential due to both charges may be determined.

....

.... [1]

(iii) Without any calculation, use Fig. 3.2 to estimate the distance x at which the combined electric potential of the two charges is a minimum.

x = ... nm [1]

(iv) The point P is a distance $x = 10\,\text{nm}$ from A.
An α-particle has kinetic energy E_K when at infinity.

Use Fig. 3.2 to determine the minimum value of E_K such that the α-particle may travel from infinity to point P.

E_K = ... J [3]