

- 7 When some substances are in the solidstate, they exist as positively-charged and negatively-charged ions arranged in a cubiclattice, as illustrated in Fig. 7.1.

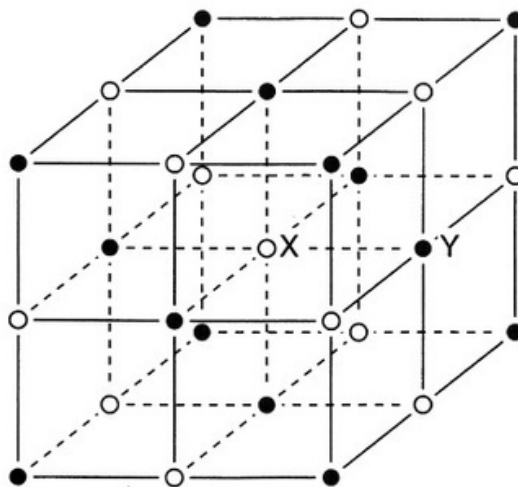


Fig. 7.1

A starting point for the understanding of lattice energies is to consider the potential energy E_p between two ions X and Y.

Fig. 7.2 shows the variation with the distance r between X and Y of E_p .

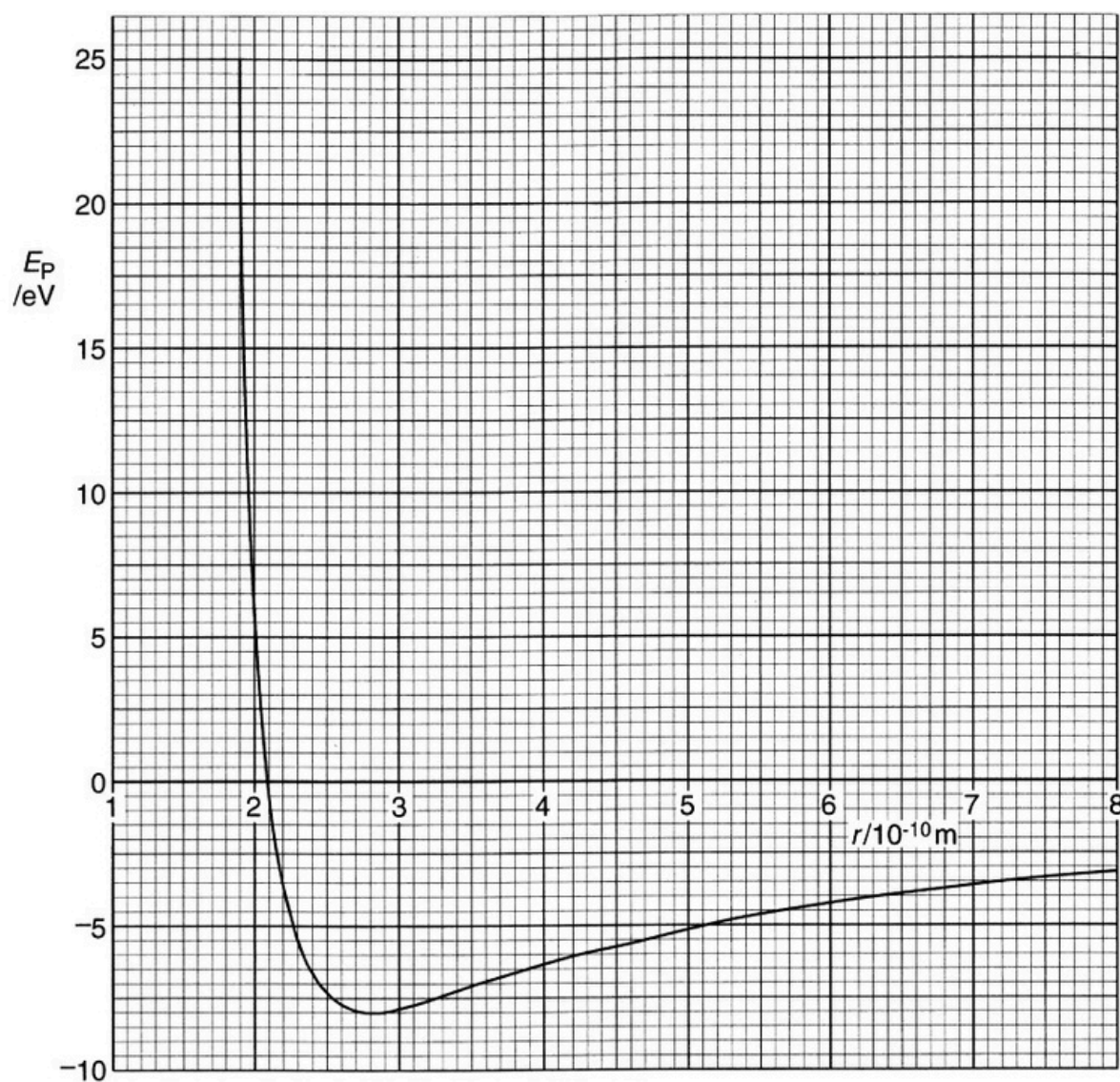


Fig.7.2

- (a) (i) The gradient G of the graph varies with the distance r . Show that, starting from the definition of *work done*, for any value of r the magnitude of the force F between X and Y is given by the expression

$$F = G.$$

.....

.....

.....

..... [2]

- (ii) Suggest how Fig. 7.2 indicates that, for some values of r , the force between X and Y is attractive and, for other distances, the force is repulsive.

.....

 [2]

- (iii) Use Fig. 7.2 and the expression in (i) to determine the magnitude of the force, in newton, for values of the distance r equal to

1. 2.8×10^{-10} m,

force =N [1]

2. 5.0×10^{-10} m.

force =N [3]

- (b) The variation with distance r of the potential energy E_p may be represented by the expression

$$E_p = -\frac{A}{r} + \frac{B}{r^8}$$

where A and B are constants.

By reference to Fig. 7.2, state two features of the force represented by the term $\frac{B}{r^8}$ in this expression.

1.

 2.
 [2]

(c) Fig. 7.3 shows part of Fig. 7.2, drawn on a larger scale.

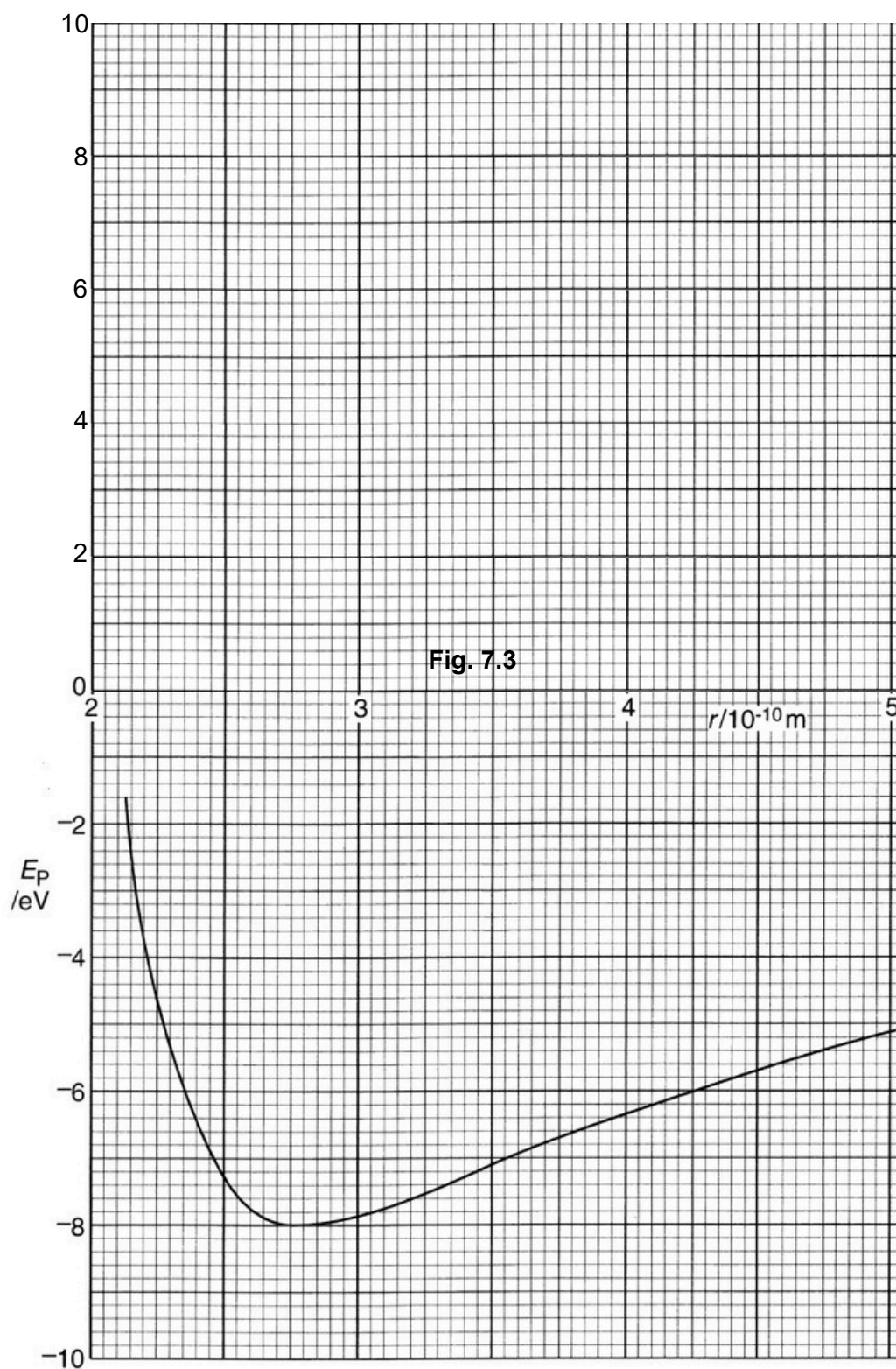


Fig. 7.3

Thermal energy of the ions causes them to vibrate.
The ions have a total energy of -6.0 eV.

(i) On Fig. 7.3,

1. draw the variation with the distance r of the total energy of the ions. Label the line T. [1]

2. draw the variation with the distance r of the kinetic energy of the ions. Label [2] the line K.

(ii) Use Fig. 7.3 to determine, for these ions, the values of r between which they vibrate.

minimum value of $r = \dots\dots\dots$ m

maximum value of $r = \dots\dots\dots$ m [2]

(iii) State and explain whether the oscillations of the ions are simple harmonic.

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..... [2]

(d) By reference to Fig. 7.3, suggest why the dimensions of the whole lattice increase as it is heated.

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.....
.....
..... [3]

[Total: 20]