A particle of mass $m$ moves in 1 dimension under the influence of only conservative forces. The potential energy of the particle may be written as:

$$U(x) = \frac{1}{2} kx^2 - \frac{1}{4} \alpha x^4$$

where $k$ and $\alpha$ are given positive constants.

Calculate what would be the acceleration of the particle when it is at $x = \frac{1}{2} \sqrt{k/\alpha}$.

**Answer:**

(a) $a = -\frac{kx}{m}$

(b) $a = kx - \alpha x^3$

(c) $a = -\frac{1}{8} \frac{k^3}{m\alpha}$

(d) $a = -\frac{3}{8m} \sqrt{\frac{k^3}{\alpha}}$

(e) $a = \frac{1}{4} \sqrt{\frac{k^3}{\alpha}}$

(f) $a = \left( \frac{1}{6} kx^3 - \frac{1}{20} \alpha x^5 \right) \frac{1}{m}$

(g) $a = \frac{k^3}{2\alpha} - \frac{k^4}{4\alpha^2}$

(h) $a = \frac{1}{2m} \sqrt{\frac{k}{\alpha}} (kx - \alpha x^3)$

(i) $a = 42$

(j) More than one of the above.