Comment on 'Symmetry of the adiabatic condition in the piston problem'

2013 Eur. J. Phys. 34 L35

(http://iopscience.iop.org/0143-0807/34/1/L35)

IOP PUBLISHING EUROPEAN JOURNAL OF PHYSICS

Eur. J. Phys. **34** (2013) L35–L36 doi:10.1088/0143-0807/34/1/L35

COMMENT

Comment on 'Symmetry of the adiabatic condition in the piston problem'

Vasco Guerra and Rodrigo de Abreu

Departamento de Física, Instituto Superior Técnico, Universidade Técnica de Lisboa, 1049-001 Lisboa, Portugal

E-mail: vguerra@ist.utl.pt

Received 31 May 2012, in final form 21 September 2012
Published 10 December 2012
Online at stacks.iop.org/EJP/34/L35

We make some observations regarding a recent paper by Anacleto and Ferreira (2011 Symmetry of the adiabatic condition in the piston problem *Eur. J. Phys.* **32** 1625).

In a recent paper [1], Anacleto and Ferreira returned to analysis of the adiabatic piston problem, which Anacleto and co-workers have addressed in numerous publications (see [1, 2] and references therein). The same problem was analysed recently by other authors [3–5], in the case of [3] with relevance for the present discussion. Unfortunately, [1] does not acknowledge the fact that some of its results are inconsistent with their earlier work and were actually first derived in [3], from which two examples are given below.

The first example relates to the solution to the adiabatic piston problem, contained in equation (5) of [1], for both the cases of a diathermic and an 'adiabatic' piston, as previously explained and derived in [3] (equations (6) and (8) from [3]). A very important fact in the treatment of the adiabatic piston problem is that we cannot make the association

$$dU_i = -P_i\, dV_i \tag{1}$$

(discussion of equation (7) from [1]). This is a key result, which is at the core of the conclusions from our former work [3, 4] (see equations (9) and (14) from [3] and respective discussions). Indeed, one of the main results from [3] is the demonstration of the inadequacy of using equation (1) with generality. What is more, we establish the correct solution to the adiabatic piston problem precisely by showing that (1) *cannot* be used and by taking into account the correct expression. However, Anacleto and Ferreira give our paper as an example of a work where the adiabatic condition is considered to be expressed by equation (1). A more relevant reference here would be [2], where the adiabatic condition was indeed expressed by (1).

Another important result from [3] is that the condition $dQ = 0$ cannot be imposed, even if the piston is 'adiabatic' (discussion below equation (11) in [3]). One outcome from [3] is that if we insist on using the standard formalism of thermodynamics and utilize a quantity dQ, it may lose its intuitive energetic meaning. In the present case, we would have to formally consider the energy transfers resulting from the 'jiggling insulating piston' as heat transfers, so that d$Q \neq 0$. This conclusion is also irreconcilable with [2] and imported to [1] without the appropriate reference (discussion below (17) in [1]).

Further insight into these questions can be found in [6].

References

[1] Anacleto J and Ferreira J M 2011 Symmetry of the adiabatic condition in the piston problem *Eur. J. Phys.* **32** 1625

[2] Anacleto J and Anacleto J A C 2008 Thermodynamical interactions: subtleties of heat and work concepts *Eur. J. Phys.* **29** 555

[3] de Abreu R and Guerra V 2011 Comment on 'A close examination of the motion of an adiabatic piston,' by Eric A Gislason (*Am. J. Phys.* **78** (10), 995–1001 (2010)) *Am. J. Phys.* **79** 684–5

[4] de Abreu R 2002 The first principle of thermodynamics and the non-separability of the quantities 'work' and 'heat': the adiabatic piston controversy arXiv:cond-mat/0205566

[5] Gislason E A 2010 A close examination of the motion of an adiabatic piston *Am. J. Phys.* **78** 995–1001

[6] de Abreu R and Guerra V 2012 Introducing thermodynamics through energy and entropy *Am. J. Phys.* **80** 627–37