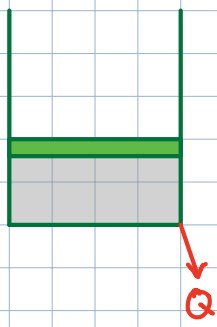


Piston – cylinder (N_2)

$p_1 = 1\,MPa$, $T_1 = 427°C$ (isobaric process)

$\downarrow$

$T_2 = 27°C$

Q Determine the heat transfer (kJ/kg)

$$\Delta E_{sys} = Q - W = \Delta U + \Delta KE + \Delta PE$$

$$Q - (W_b) = \Delta U$$

$$Q = \Delta U + W_b$$
$$= \Delta H$$

$\delta q = du + pdV$ ← $u + pv = h$

$= dh - udp$

$\delta q = dh = C_p dT$

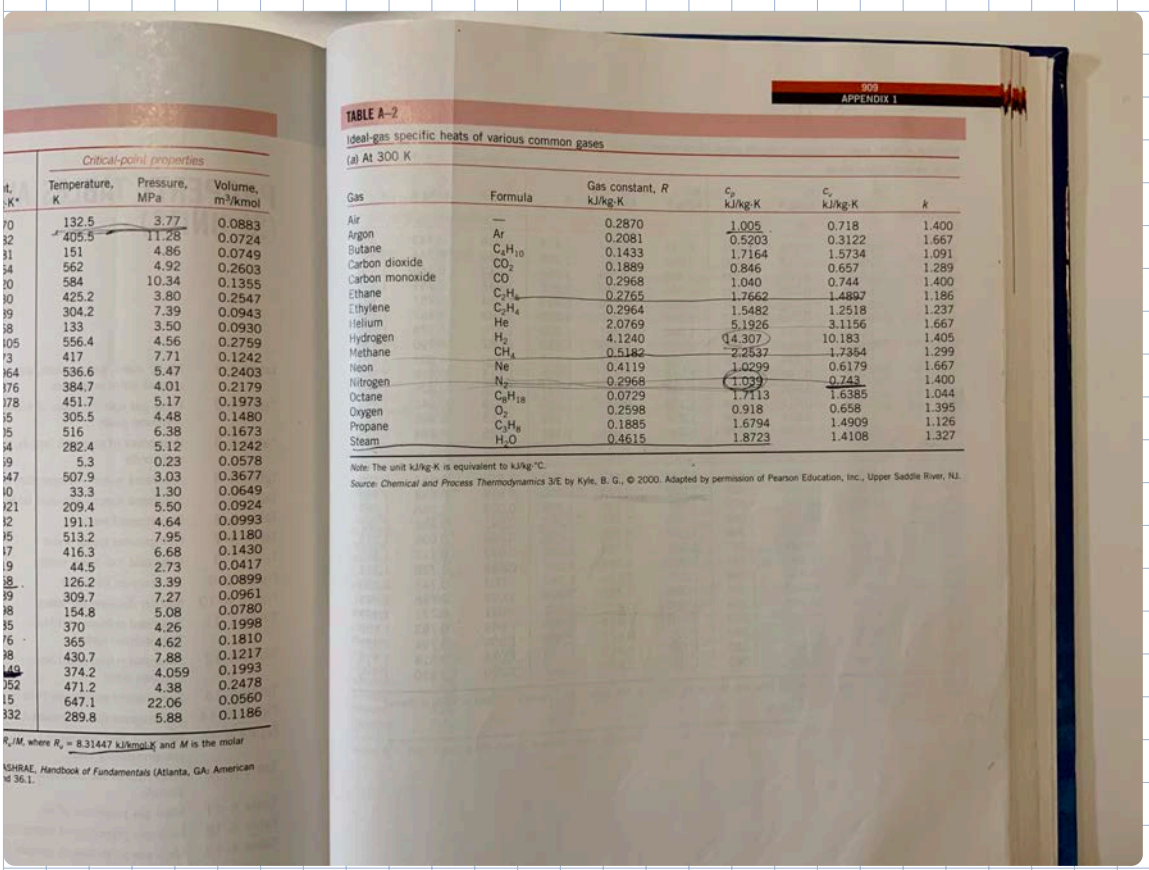
$q = \Delta h = C_p (T_2 - T_1)$

N_2 : Table > A-2 → $C_p = 1.039\ kJ/kg \cdot K$

$q = C_p (T_2 - T_1) = (1.039\ kJ/kg \cdot K) \cdot (27 - 427)\ K$

$= -415.6\ kJ/kg$

Ans.



Critical-point properties

Temperature, K	Pressure, MPa	Volume, m^3/kmol
132.5	3.77	0.0883
405.5	11.28	0.0724
151	4.86	0.0749
562	4.92	0.2603
584	10.34	0.1355
425.2	3.80	0.2547
304.2	7.39	0.0943
133	3.50	0.0930
556.4	4.56	0.2759
417	7.71	0.1242
536.6	5.47	0.2403
384.7	4.01	0.2179
451.7	5.17	0.1973
305.5	4.48	0.1480
516	6.38	0.1673
282.4	5.12	0.1242
5.3	0.23	0.0578
507.9	3.03	0.3677
33.3	1.30	0.0649
209.4	5.50	0.0924
191.1	4.64	0.0993
513.2	7.95	0.1180
416.3	6.68	0.1430
44.5	2.73	0.0417
126.2	3.39	0.0899
309.7	7.27	0.0961
154.8	5.08	0.0780
370	4.26	0.1998
365	4.62	0.1810
430.7	7.88	0.1217
374.2	4.059	0.1993
471.2	4.38	0.2478
647.1	22.06	0.0560
289.8	5.88	0.1186

R_u/M, where $R_u = 8.31447$ kJ/kmol·K and M is the molar

ASHRAE, *Handbook of Fundamentals* (Atlanta, GA: American
ed 36.1.

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APPENDIX 1

TABLE A–2

Ideal-gas specific heats of various common gases

(a) At 300 K

Gas	Formula	Gas constant, R kJ/kg·K	c_p kJ/kg·K	c_v kJ/kg·K	k
Air	—	0.2870	1.005	0.718	1.400
Argon	Ar	0.2081	0.5203	0.3122	1.667
Butane	C_4H_{10}	0.1433	1.7164	1.5734	1.091
Carbon dioxide	CO_2	0.1889	0.846	0.657	1.289
Carbon monoxide	CO	0.2968	1.040	0.744	1.400
Ethane	C_2H_6	0.2765	1.7662	1.4897	1.186
Ethylene	C_2H_4	0.2964	1.5482	1.2518	1.237
Helium	He	2.0769	5.1926	3.1156	1.667
Hydrogen	H_2	4.1240	14.307	10.183	1.405
Methane	CH_4	0.5182	2.2537	1.7354	1.299
Neon	Ne	0.4119	1.0299	0.6179	1.667
Nitrogen	N_2	0.2968	1.039	0.743	1.400
Octane	C_8H_{18}	0.0729	1.7113	1.6385	1.044
Oxygen	O_2	0.2598	0.918	0.658	1.395
Propane	C_3H_8	0.1885	1.6794	1.4909	1.126
Steam	H_2O	0.4615	1.8723	1.4108	1.327

Note: The unit kJ/kg·K is equivalent to kJ/kg·°C.

Source: *Chemical and Process Thermodynamics* 3/E by Kyle, B. G., © 2000. Adapted by permission of Pearson Education, Inc., Upper Saddle River, NJ.