Unit 10 - Week 9

Week 9 assignment 1

The due date for submitting this assignment has passed. **Due on 2017-10-02, 23:59 IST.**

Submitted assignment

Answer the following questions, More than one option can be correct.

1) The heat transfer and pressure drop in micro channels compared to macro channel for same Reynolds number *1 point*

- Heat transfer decreases; Pressure drop increases;
- Heat transfer decreases; Pressure drop decreases;
- Heat transfer increases ; Pressure drop decreases;
- Heat transfer increases; Pressure drop increases;

No, the answer is incorrect.
Score: 0

Accepted Answers:
Heat transfer increases ; Pressure drop decreases;

2) Navier stokes equation is not applicable in the following regimes (Kn refers to Knudsen number) *1 point*

- 0.1<Kn<10
- Kn>10
- 1e-3<Kn<0.1
- Kn<1e-3

No, the answer is incorrect.
Score: 0

Accepted Answers:
0.1<Kn<10
Kn>10

3) Choose the correct statements *1 point*

- Knudsen number is an important parameter to define regimes in microchannel
- No slip condition can be applied across all the Knudsen number range.
- The gas flow in microchannel can be laminar and compressible.
- High Reynolds number is essential for the compressible regimes in microchannel.

No, the answer is incorrect.
Score: 0

Accepted Answers:
Knudsen number is an important parameter to define regimes in microchannel
The gas flow in microchannel can be laminar and compressible.

4) A microchannel with constant rectangular cross-section is subjected to a pressure-driven flow of argon. The inlet and the outlet pressures are P_i= 0.2 MPa and P_o= 25 kPa, respectively. The *1 point*

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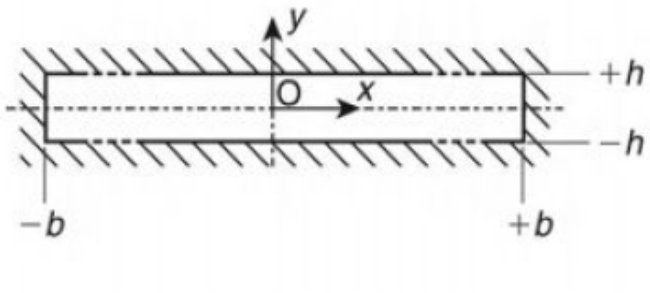
geometry is given in Figure 1, with a width (2b = 20 μm), a depth (2h = 1 μm), and a length (l = 5 mm).

Assume a uniform temperature T = 300 K, and an accommodation coefficient σ = 0.9 associated with Maxwell first-order slip boundary condition. The mean free path for the molecules at inlet and outlet are 34.8nm and 278nm respectively.



Calculate the outlet Knudsen number (Hint: Calculate based on microchannel depth).

- 0.139
- 0.278
- 0.576
- 0.0139

No, the answer is incorrect.
Score: 0

Accepted Answers:
0.278

5) Based on data in problem 4; calculate the mass flow rate (Kg/S) through the microchannel assuming Maxwell first-order slip boundary condition. (Consider viscosity =2.588x10 -5 Pa S, R=2.08x10 2) ***1 point***

- 2.5e-12
- 3.6e10
- 6.636e-12
- 3.6e-12

No, the answer is incorrect.
Score: 0

Accepted Answers:
6.636e-12

6) Based on data in problem 4; Calculate the mass flow rate increase (in %) due to slip at the wall. ***1 point***

- 90.6
- 50.6
- 80.6
- 33.6

No, the answer is incorrect.
Score: 0

Accepted Answers:
90.6

7) Match the following Knudsen number regime and the best model to analyze the problem ***1 point***

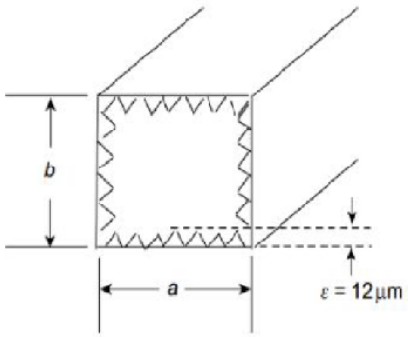
a. Kn=0 i)Navier stokes equation with Slip
b. Kn<1e -3 ii)Euler equation
c. 1e-3 <Kn<0.1 iii)DSMC or lattice Boltzmann
d. Kn>10 iv)Burnett equations with slip

- a-iv,b-iii,c-ii,d-i
- a-ii,b-iii,c-i,d-iv
- a-ii,b-i,c-iv,d-iii
- a-i,b-ii,c-iii,d-iv

No, the answer is incorrect.
Score: 0

Accepted Answers:
a-ii,b-i,c-iv,d-iii

8) A microchannel is etched in silicon. The microchannel surface is intentionally etched to provide an average roughness of 12 μm. The microchannel dimensions measured from the root of the roughness elements are: width = 200 μm, height = 200 μm, length = 10 mm. Water flows through the microchannels at a temperature of 300 K. The mass flow rate is 90e-6 kg/s. (Properties of saturated water at 300 K: viscosity = 0.855 e-3 N s/m2, density = 997 kg/m3, Specific heat = 4179 J/kg K, conductivity = 0.613 W/m K) ***1 point***



Calculate the constricted hydraulic diameter (in μm) .

- 176
- 156
- 126
- 112

No, the answer is incorrect.
Score: 0

Accepted Answers:
176

9) Based on the data in Problem 8; Calculate the constricted Reynolds number. ***1 point***

- 598
- 1500
- 400
- 398

No, the answer is incorrect.
Score: 0

Accepted Answers:
598

10) Based on the data in Problem 8; Calculate the hydrodynamic entry length (in mm). ***1 point***

- 6.78
- 1.26
- 5.26
- 3.42

No, the answer is incorrect.
Score: 0

Accepted Answers:
5.26

11) Based on the data in Problem 8; Calculate the Poisuelle number based on Shaw and London correlation. ***1 point***

- 13.23

- 11.23
- 14.23
- 12.23

No, the answer is incorrect.
Score: 0

Accepted Answers:
14.23

12) Based on the data in Problem 8; Calculate the HagenBach factor for channel length. ***1 point***

- 1.53
- 7.33
- 2.63
- 3.33

No, the answer is incorrect.
Score: 0

Accepted Answers:
1.53

13) Based on the data in Problem 8; Calculate the core frictional pressure drop (in Pa). ***1 point***

- 29356
- 39462
- 43246
- 44648

No, the answer is incorrect.
Score: 0

Accepted Answers:
29356

14) Which of the following losses are important for calculating the pressure drop in a microchannel system ***1 point***

- losses in the bend, entrance and exit losses, developing region effects, and core frictional losses
- developing region effects, and core frictional losses
- losses in the bend, entrance and exit losses, developing region effects
- core frictional losses

No, the answer is incorrect.
Score: 0

Accepted Answers:
losses in the bend, entrance and exit losses, developing region effects, and core frictional losses

15) The Average maximum profile peak height (R_{pm}) is 6 μm and the Floor distance to mean line (F_p) is 2 μm. A channel similar to Fig of problem 8 is with width 200 μm with an average roughness of 12 μm. Calculate the transition Reynolds number. ***1 point***

- 1796.45
- 1456.25
- 2647.36
- 6766.32

No, the answer is incorrect.
Score: 0

Accepted Answers:
1456.25

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