The answers should be entered carefully on a computer readable sheet using an HB pencil. When the exam time is over, you hand over only the computer sheet and keep this questionnaire for yourself.

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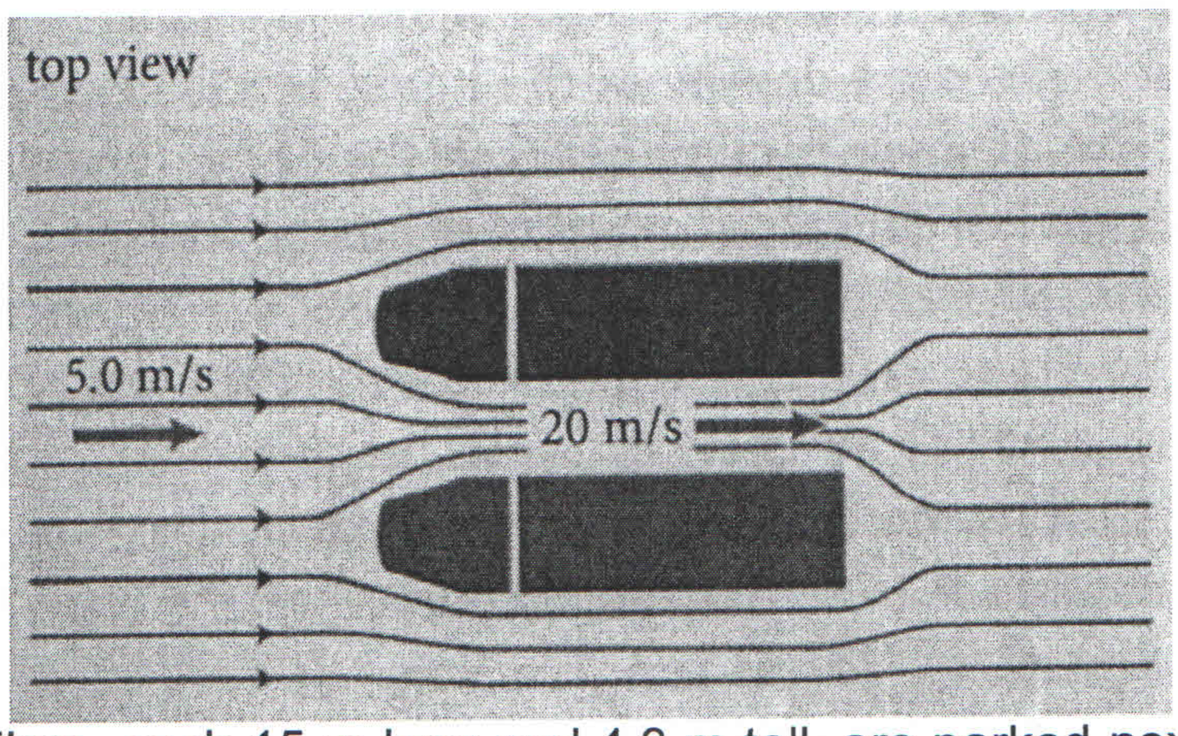
1. You have constructed a raft that is 2.00 m long, 2.00 m wide, and 0.100 m thick. If the mass of the raft is 38.5 kg and your mass is 70.2 kg, how many 75.3-kg friends can cross a river with you during one trip?

A) 1
B) 2
C) 3
D) 4
E) 5

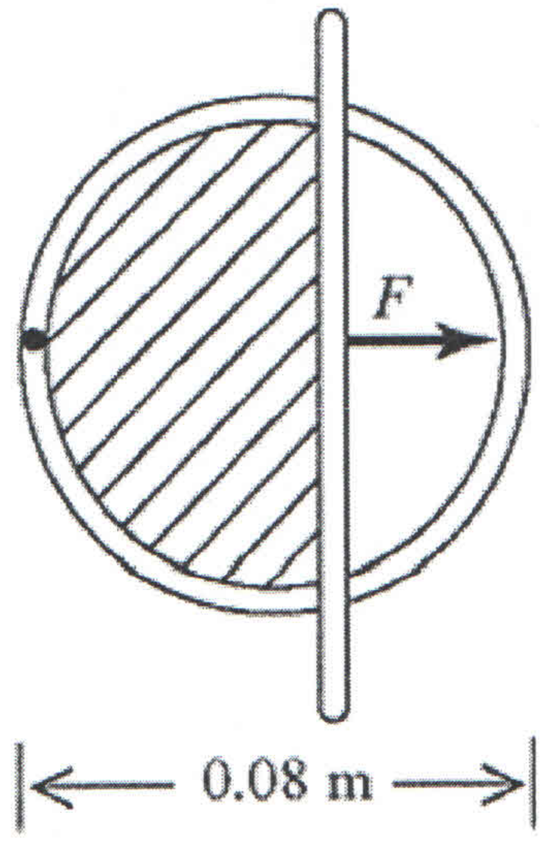
2.



Two tractor trailers, each 15 m long and 4.3 m tall, are parked next to each other as shown in the figure above. A light wind that is blowing at 5.0 m/s in the parking lot but at 20 m/s between the trailers causes the air pressure between them to drop. What is the magnitude of the force exerted by the air on each trailer? (Use 1.2 kg/m^3 for the air density).

A) 1.1×10^4 N
B) 1.2×10^4 N
C) 1.3×10^4 N
D) 1.4×10^4 N
E) 1.5×10^4 N

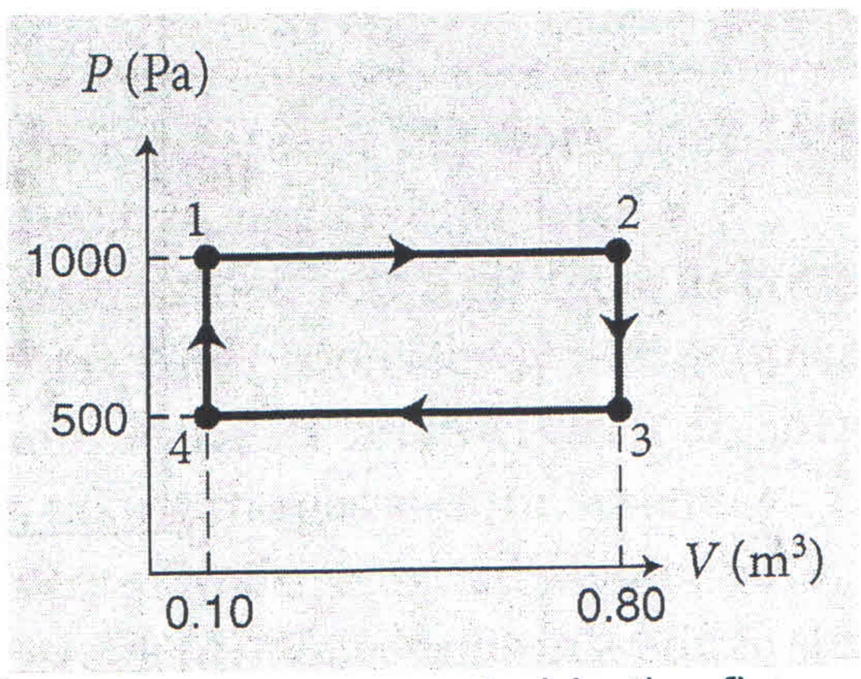
3.



A circular wire, 0.08 m in diameter, with a slider wire on it, is in a horizontal plane. A liquid film is formed, bounded by the wires, on the left side of the slider, as shown. The surface tension of the liquid is 84 mN/m. An applied force *F*, perpendicular to the slider, maintains the film in equilibrium. Ignore the sag in the film. In the figure above, when the equilibrium force *F* is 9.4 mN, the distance of the slider from the center of the circle is closest to

A) 27 mm.
B) 29 mm.
C) 31 mm.
D) 33 mm.
E) 34 mm.

4.



An ideal gas undergoes the process represented in the figure above, where the gas is in state 1 when the process begins and again in state 1 at the finish. Determine the work done by the gas for the process.

A) 700 J
B) 800 J
C) 350 J
D) 400 J
E) 200 J

5. A glass marble 1.000 cm in diameter is to be dropped through a hole in a steel plate. At room temperature the hole diameter is 0.997 cm. The coefficient of linear expansion of steel is $12 \times 10^{-6}\ K^{-1}$. By how much must the plate's temperature be raised so the marble will fit through the hole?

A) 251 K
B) 523 K
C) 125 K
D) 112 K
E) 103 K

6. You put 300 g of water at 20°C into a 500-W microwave oven and accidentally set the time for 20 min instead of 2.0 min. The water specific heat and heat of vaporization are, respectively, 4190 J/(kg·K) and 2256 kJ/kg. How much water is left at the end of 20 min?

A) 98 g
B) 92 g
C) 87 g
D) 84 g
E) 79 g

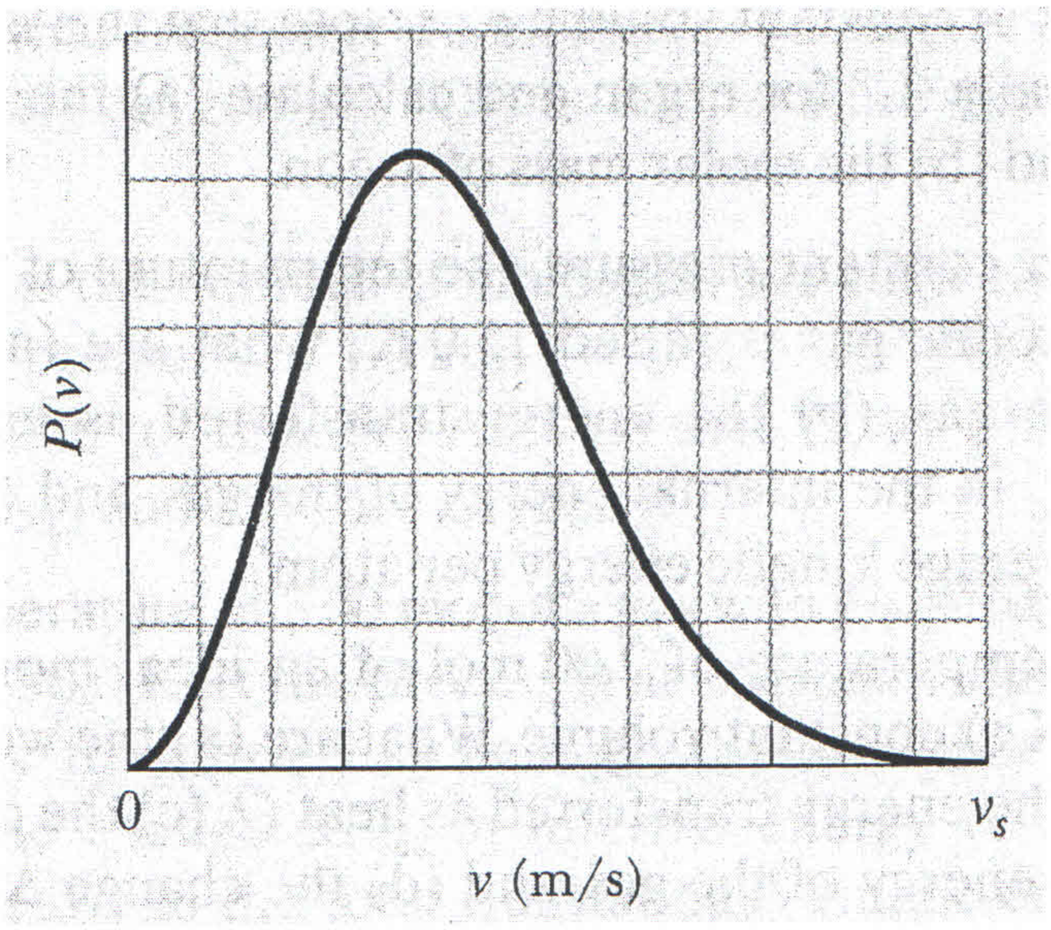
7. At temperature *T*, a balloon is partially inflated with an ideal gas to a volume of 1.0 L. The balloon is then put in a low-pressure container at the same temperature *T* and its volume is increased to 2.0 L. If 26 J of work was done by the gas to accomplish this expansion, what is the final pressure inside the balloon in the low-pressure container?

A) 3.8×10^4 Pa
B) 1.9×10^4 Pa
C) 1.5×10^4 Pa
D) 1.3×10^4 Pa
E) 1.1×10^4 Pa

8. A 250-g sample of water at 80°C is mixed with 250 g of water at 10°C. The specific heat of water is 4190 J/(kg·K). Find the entropy change for the system.

A) +17.4 J/K
B) −17.4 J/K
C) +12.8 J/K
D) −12.8 J/K
E) +20.6 J/K

9.



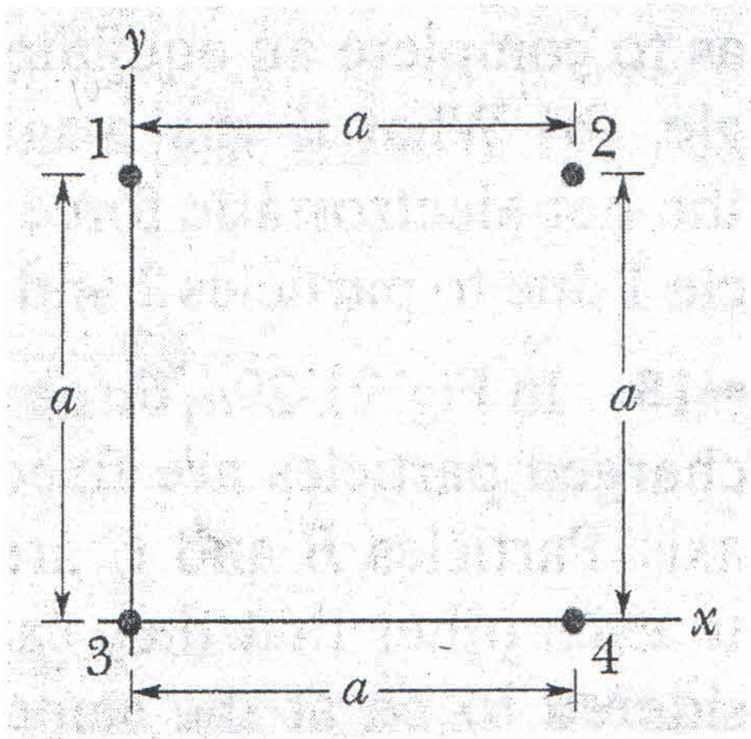
The figure above gives the probability distribution for nitrogen gas (N_2). The scale of the horizontal axis is set by v_s = 1200 m/s. What is the gas temperature?

A) 4.9×10^2 K
B) 2.7×10^2 K
C) 1.9×10^2 K
D) 5.3×10^3 K
E) 4.1×10^3 K

10. A 500-W Carnot engine operates between constant-temperature reservoirs at 100°C and 60.0°C. What is the rate at which energy is taken in by the engine as heat?

A) 4.66 kJ/s
B) 4.37 kJ/s
C) 4.12 kJ/s
D) 3.87 kJ/s
E) 3.76 kJ/s

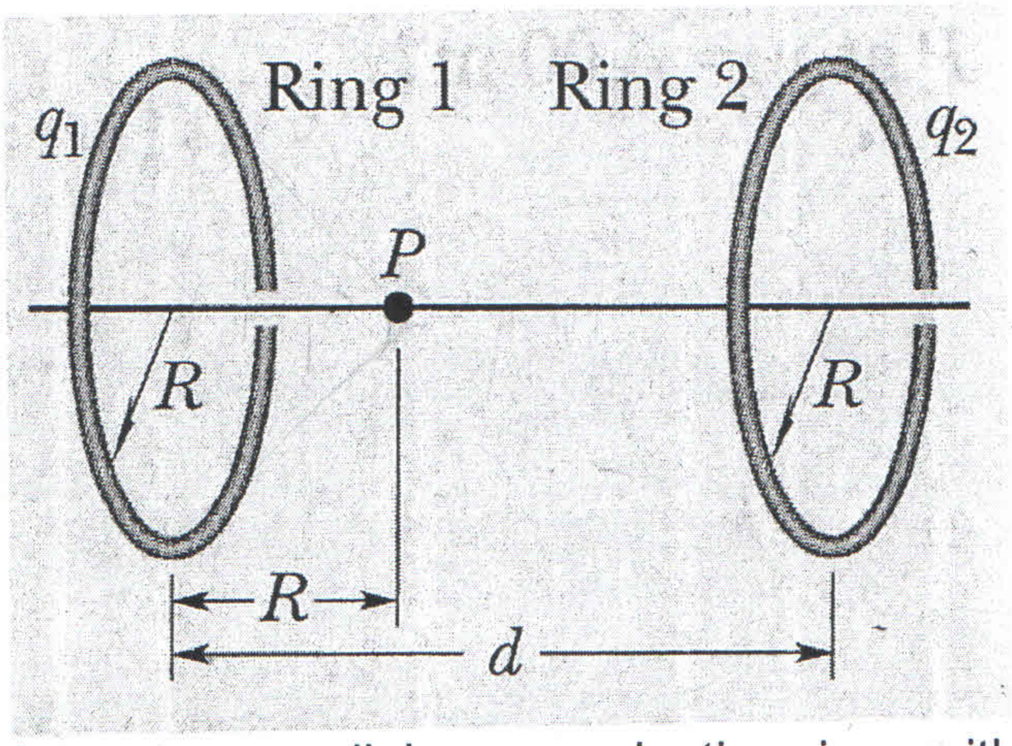
11.



In the figure above, four particles form a square. The particles have charges $q_1 = -q_2 = 100$ nC and $q_3 = -q_4 = 200$ nC, and distance $a = 5.0$ cm. The x component of the net electrostatic force on particle 3 is

A) 0.11 N.
B) 0.13 N.
C) 0.15 N.
D) 0.17 N.
E) 0.19 N.

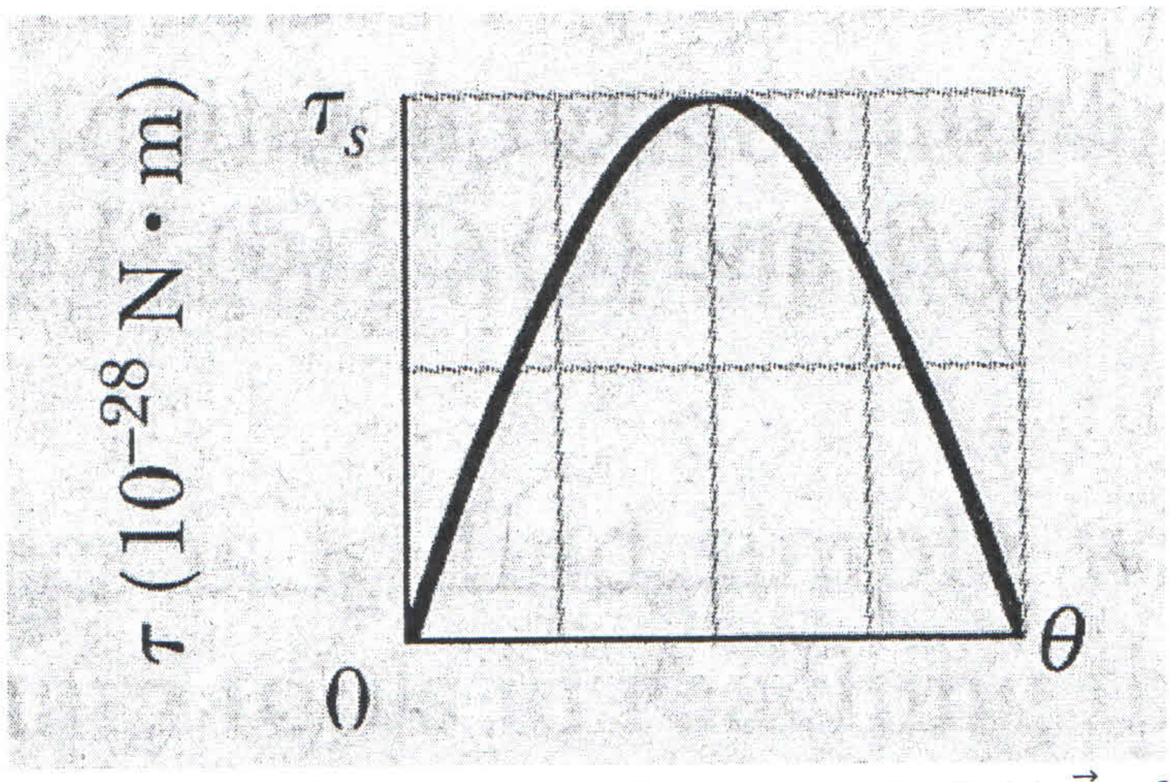
12.



The figure above shows two parallel non-conducting rings with their central axes along a common line. Ring 1 has uniform charge q_1 and radius R; ring 2 has uniform charge q_2 and the same radius R. The rings are separated by distance $d = 3.00R$. The net electric field at point P on the common line, a distance R from ring 1, is zero. What is the ratio q_1/q_2?

A) 0.421
B) 0.447
C) 0.473
D) 0.486
E) 0.506

13.



A certain electric dipole is placed in a uniform electric field $\vec{E}$ of magnitude 40 N/C. The figure above gives the magnitude τ of the torque on the dipole versus the angle θ between the field $\vec{E}$ and the dipole moment $\vec{p}$. The vertical axis scale is set by $\tau_s = 100 \times 10^{-28}$ N·m. What is the magnitude of $\vec{p}$?

A) 1.7×10^{-28} C·m
B) 2.5×10^{-28} C·m
C) 2.9×10^{-28} C·m
D) 3.6×10^{-28} C·m
E) 4.4×10^{-28} C·m

14. An electron is accelerated eastward at 1.80×10^{9} m/s^2 by an electric field. Determine the field magnitude and direction.

A) 0.0174 N/C, westward
B) 0.0174 N/C, eastward
C) 0.0102 N/C, westward
D) 0.0197 N/C, westward
E) 0.0197 N/C, eastward