Nagy, Tibor

Keep this exam CLOSED until advised by the instructor.

50 minute long closed book exam.

Fill out the bubble sheet: last name, first initial, student number (PID). Leave the section, code, form and signature areas empty.

Three two-sided handwritten 8.5 by 11 help sheets are allowed.

When done, hand in your test and your bubble sheet.

Thank you and good luck!

Possibly useful constants:

- \( g = 9.81 \text{ m/s}^2 \)
- \( G = 6.67 \times 10^{-11} \text{ Nm}^2/\text{kg}^2 \)
- \( \rho_{\text{water}} = 1000 \text{ kg/m}^3 = 1 \text{ kg/l} = 1 \text{ g/cm}^3 \)
- 1 atm = 101.3 kPa
- \( N_A = 6.02 \times 10^{23} \text{ /mol} \)
- \( R = 8.31 \text{ J/(molK)} \)
- \( k_B = 1.38 \times 10^{-23} \text{ J/K} \)
- 0 °C = 273.15 K

1 pt Are you sitting in the seat assigned?

1 \(\bigcirc\) Yes, I am.
4 pt Planet-X has a mass of $4.32 \times 10^{24}$ kg and a radius of 5060 km. What is the Escape Speed i.e. the minimum speed required for a satellite in order to break free permanently from the planet? (in km/s)

2. A $\circ$ 4.87  B $\circ$ 5.70  C $\circ$ 6.66  
   D $\circ$ 7.80  E $\circ$ 9.12  F $\circ$ $1.07 \times 10^1$
   G $\circ$ $1.25 \times 10^1$  H $\circ$ $1.46 \times 10^1$

3 pt What would be the height of the Mercury column on the surface of the Moon? The Moon has no atmosphere, and the gravitational field is six times weaker on the Moon than here on Earth.

3. A $\circ$ 0 mm. 
   B $\circ$ 127 mm, six times shorter. 
   C $\circ$ 760 mm, same as on Earth. 
   D $\circ$ 4560 mm, six times higher.

4 pt What would be the height of the Mercury column inside a Moon-base where an Earth-like air atmosphere is maintained for comfortable living? (The Toricelli barometer has sufficient amount of Mercury, and the glass tube can be extended, if necessary.)

4. A $\circ$ 0 mm. 
   B $\circ$ 4560 mm, six times higher. 
   C $\circ$ 127 mm, six times shorter. 
   D $\circ$ 760 mm, same as on Earth.
An object weighs 87.9 N in air. When it is suspended from a force scale and completely immersed in water the scale reads 18.4 N. Determine the density of the object. (in kg/m$^3$)

5. A $6.48 \times 10^2$  B $8.09 \times 10^2$  C $1.01 \times 10^3$
   D $1.26 \times 10^3$  E $1.58 \times 10^3$  F $1.98 \times 10^3$
   G $2.47 \times 10^3$  H $3.09 \times 10^3$

8 pt The figure illustrates the flow of an ideal fluid through a pipe of circular cross section, with diameters of 1 cm and 2 cm and with different elevations. $p_x$ is the pressure in the pipe, and $v_x$ is the speed of the fluid at locations $x = q, r, s, t, u$.

\[ v_q \text{ is .... } 2v_r \]
6. A Greater than  B Less than  C Equal to

\[ p_q \text{ is .... } p_u \]
7. A Greater than  B Less than  C Equal to

\[ p_r \text{ is .... } p_t \]
8. A Greater than  B Less than  C Equal to

\[ v_q \text{ is .... } v_s \]
9. A Greater than  B Less than  C Equal to
What is the sound level of a sound with an intensity of \( I = 1.00 \times 10^{-6} \text{ W/m}^2 \)? Give your answer in dB units.

\[ \text{A} \quad 37.46 \quad \text{B} \quad 43.83 \quad \text{C} \quad 51.28 \]
\[ \text{D} \quad 60.00 \quad \text{E} \quad 70.20 \quad \text{F} \quad 82.13 \]
\[ \text{G} \quad 96.10 \quad \text{H} \quad 112.43 \]

Now the intensity of this sound is increased to a value of 34.0 times of its original intensity. What is the new increased sound level? Give your answer in dB units.

\[ \text{A} \quad 24.70 \quad \text{B} \quad 35.82 \quad \text{C} \quad 51.94 \]
\[ \text{D} \quad 75.31 \quad \text{E} \quad 109.21 \quad \text{F} \quad 158.35 \]
\[ \text{G} \quad 229.61 \quad \text{H} \quad 332.93 \]

A truck horn emits a sound with a frequency of 200 Hz. The truck is moving on a straight road with a constant speed. If a person standing on the side of the road hears the horn at a frequency of 225 Hz, then what is the speed of the truck? Use 340 m/s for the speed of the sound.

\[ (\text{in m/s}) \]

\[ \text{A} \quad 3.78 \times 10^1 \quad \text{B} \quad 4.27 \times 10^1 \quad \text{C} \quad 4.82 \times 10^1 \]
\[ \text{D} \quad 5.45 \times 10^1 \quad \text{E} \quad 6.16 \times 10^1 \quad \text{F} \quad 6.96 \times 10^1 \]
\[ \text{G} \quad 7.87 \times 10^1 \quad \text{H} \quad 8.89 \times 10^1 \]

An organ pipe is 1.70 m long and it is open at one end and closed at the other end. What are the frequencies of the lowest three harmonics produced by this pipe? The speed of sound is 340 m/s. Only one answer is correct.

\[ \text{A} \quad 200 \text{ Hz}, 300 \text{ Hz}, 400 \text{ Hz} \]
\[ \text{B} \quad 50 \text{ Hz}, 100 \text{ Hz}, 150 \text{ Hz} \]
\[ \text{C} \quad 100 \text{ Hz}, 300 \text{ Hz}, 500 \text{ Hz} \]
\[ \text{D} \quad 50 \text{ Hz}, 100 \text{ Hz}, 200 \text{ Hz} \]
\[ \text{E} \quad 100 \text{ Hz}, 200 \text{ Hz}, 300 \text{ Hz} \]
\[ \text{F} \quad 200 \text{ Hz}, 600 \text{ Hz}, 1000 \text{ Hz} \]
\[ \text{G} \quad 50 \text{ Hz}, 150 \text{ Hz}, 250 \text{ Hz} \]
\[ \text{H} \quad 200 \text{ Hz}, 400 \text{ Hz}, 600 \text{ Hz} \]
4 pt The height of the Eiffel tower is 321 m during the Summer when the temperature is 25.3 °C. What is the magnitude of the change in the height of the tower, when the temperature cools down to -12.0 °C during the Winter? The coefficient of linear expansion of the tower’s material is 1.18 × 10^{-5} 1/C°.

14. A 1.06 × 10^1
   B 1.41 × 10^1
   C 1.88 × 10^1
   D 2.50 × 10^1
   E 3.32 × 10^1
   F 4.42 × 10^1
   G 5.88 × 10^1
   H 7.82 × 10^1

3 pt What is the pressure of 1.07 moles of Nitrogen gas in a 4.71 liter container, if the temperature of the gas is 40.2 °C?

15. A 1.32
    B 1.92
    C 2.78
    D 4.03
    E 5.84
    F 8.47
    G 12.28
    H 17.80

4 pt A 24.5 l gas bottle contains 9.87 × 10^{23} Radon molecules at a temperature of 312 K. What is the thermal energy of the gas? (You might need to know Boltzmann’s constant: k_B = 1.38 × 10^{-23} J/K.)

16. A 6.38 × 10^3
    B 9.25 × 10^3
    C 1.34 × 10^4
    D 1.94 × 10^4
    E 2.82 × 10^4
    F 4.09 × 10^4
    G 5.93 × 10^4
    H 8.59 × 10^4

3 pt The diameter of the Hydrogen atom is almost exactly one angstrom which is 10^{-10} meter. How many Hydrogen atoms do we need to place next to each-other side by side to form a one millimeter long chain?

17. A one hundred
    B one thousand
    C one million
    D ten million
    E hundred million
    F one billion
    G one trillion
    H 6×10^{23}