LAST NAME: **STUDENT #:**

FIRST LETTER OF LAST NAME: **FIRST NAME:**

Phys. 101 Section 203 Mid-term exam.
Thurs. Feb. 23, 2006. Hebb Theatre 9:40 am – 10:30 am
Instructor : J. E. Eldridge

ANSWER BOTH QUESTIONS.   PART MARKS ARE SHOWN IN THE MARGIN.

Question	#1	#2	TOTAL
Mark			

Part marks

Question 1.   How many cubic metres of helium are required to lift a balloon with a 400-kg payload to a height of 8000 m ?   (Take $\rho_{He} = 0.180$ kg/m^3.)   Assume that the balloon maintains a constant volume and that the density of air decreases with the altitude z according to the expression $\rho_{air} = \rho_0 \exp(- z / 8000)$ where z is in m and $\rho_0 = 1.25$ kg/m^3 is the density at sea level.

$$\text{Buoyancy mass}, \ m_B \ = \ \rho_{air} \, V \ \text{where} \ V = \text{volume of balloon.} \quad (1)$$

$$\rho_{air} = 1.25 \exp\left(-\frac{8000}{8000}\right) = 1.25 \, e^{-1} = 0.460 \ kg/m^3$$

$$\text{Mass to be supported} = \rho_{He} \, V + 400 \, kg$$
$$= 0.18 \, V + 400 \qquad (2)$$

$$\text{Equating (1) and (2)}$$
$$0.46 \, V = 0.18 \, V + 400$$
$$V = \frac{400}{0.46 - 0.18} = \frac{400}{0.28} = \underline{\underline{1428.6 \, m^3}}$$

$$\left[V = \frac{400}{\rho_{air} - \rho_{He}} \right]$$

Question 2   MULTIPLE CHOICE (Circle the one correct answer.   Each of the five questions is worth 10 marks)

1. Water is pumped through a neighbourhood.   It moves under pressure at a speed of 1.25 m/s through a 6.0 cm radius pipe at the bottom of a hill.   What is the speed in m/s when it reaches the top of the 9.0 m hill where the pipe narrows to 3.0 cm radius ?

   a) 2.5   b) 0.31   c) 0.62   d) 13.3   e) 5.0

2. Continuing question 1. above, if the gauge pressure at the bottom of the hill is 4.00 atmospheres, what will it be, in kPa, at the top of the hill?   (Please ignore the velocity term in Bernoulli's equation).   (1.0 atmos. = 101.3 kPa).

   a) 405   b) 406   c) 204   d) 308   e) 317

3. A transverse wave is represented by the function $d = 2.3 \sin (1.9x - 25t)$, where d, x and t are in cm, m and seconds respectively.   How much time is required for the phase of the wave to change by 90°?

   a) 31.4 msec   b) 62.8 msec   c) 251 msec   d) 3.6 sec   e) 0.57 sec

4. A mass is connected to one end of a horizontal spring.   The other end of the spring is fixed.   The mass is pulled to the right (+ x) and released at t = 0.   The period is 2.0 sec. and the maximum velocity is 0.4 m/s.   Find the amplitude in m.

   a) 0.127   b) 1.26   c) 1.0   d) 2.0   e) 2.50   f) 0.40

5. If the damping constant, b, in a damped forced harmonic oscillator is doubled, the amplitude at resonance is

   a) doubled   b) the same   c) halved   d) quadrupled   e) reduced to ¼ of its first value