

**UNIVERSITY OF WATERLOO  
DEPARTMENT OF PHYSICS**

**PHYSICS 112 – MIDTERM TEST – WINTER 2009**

**Saturday, FEBRUARY 28, 2009; 3:00 – 5:00 P.M.**

Aids Permitted:     Calculator

IMPORTANT INSTRUCTIONS – READ CAREFULLY TO AVOID PENALTY

1. Mark your answer sheet in dark lead PENCIL only. Avoid erasures by checking answers before marking them. Mark your ID Number and section in the space provided. Also (THIS IS IMPORTANT) fill in the correct ovals for your ID Number and section (e.g. 001). Do not mark “card number” column in the answer field. Your last answer should be in row 12.

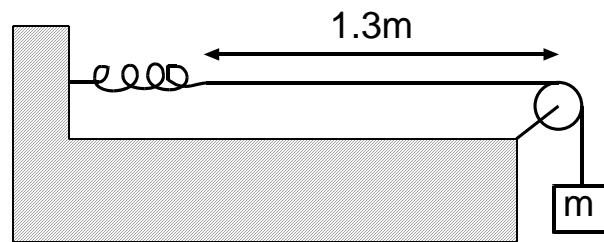
NOTE: KEEP COMPUTER SHEET FACE DOWN WHEN NOT IN USE

2. Print name, etc., in the upper right part of the computer sheet.
3. Use the space available on the test paper for your solutions (under the question, or back of previous page).
4. Check that this has 12 questions. All questions are of equal value, so don't get hung up and miss the easy ones.
5. There is no penalty marking for incorrect answers. Guess if you must! In fact please mark one answer for each question even if you must guess. (This saves a hand search for possible answers which have been marked too lightly.)
6. Ask a proctor to clarify a question if you think that is necessary.
7. Assume any data given are accurate to as many figures as needed. Ignore round off errors.

Good Luck!!!

1. A sound pipe with one closed end oscillates in its 5<sup>th</sup> harmonic at 165 Hz. It is then made to oscillate in its 7<sup>th</sup> harmonic at 231 Hz. Calculate the fundamental frequency. Answer in Hz.
- a) 16.5      b) 33      c) 49.5      d) 66      e) None of these

2. A freely hanging mass of 20kg is attached to a string which passes over a light pulley and is then attached to one end of a spring as shown in the figure. The other end of the spring is attached to the wall. The system shown is at rest in equilibrium. The horizontal portion of the string is 1.3 m long and has a mass of 110 g. Find the speed of a transverse pulse that is sent down the horizontal part of the string. You may ignore the mass of the vertically hanging string. Answer in m/s.



- a) 2342      b) 19.6      c) 187.4      d) 48.1      e) None of these

3. Find the amount of work needed to bring in a  $12\mu\text{C}$  charge from infinity to a point exactly in the middle of two charges,  $q_1=16\mu\text{C}$  and  $q_2=-16\mu\text{C}$ , which are separated by 0.9 m. Answer in J.

a) 7.68      b) -7.68      c) -3.84      d) 3.84      e) None of these

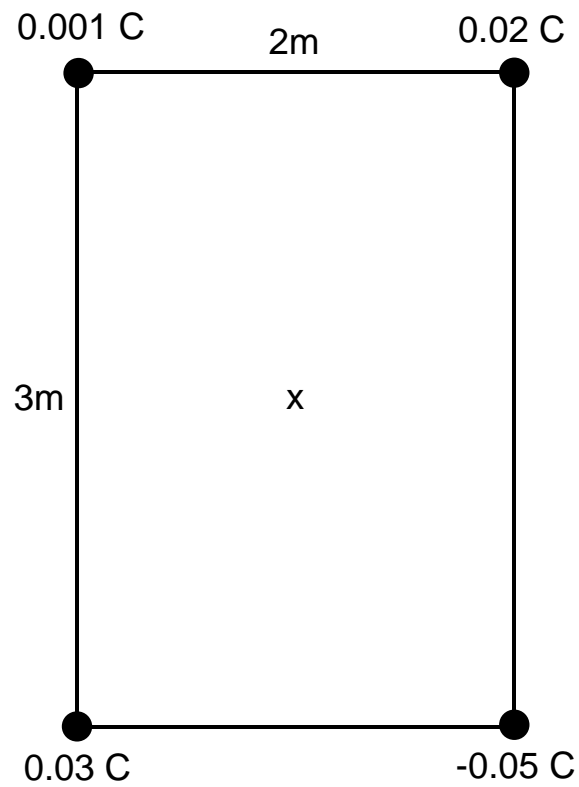
4. Prof Idziak ( $m=120\text{ kg}$ ) volunteers for an endurance test. He is made to stand on a platform ( $m=52\text{ kg}$ ) while holding a  $45\text{ kg}$  steel ball. The platform rests on a frictionless horizontal surface and is attached to a horizontal spring. The system is put into oscillation on the horizontal surface such that the maximum speed is  $7.3\text{ m/s}$ . The spring constant is  $490\text{ N/m}$ . While going through the equilibrium position, Prof Idziak releases the ball and it falls on the ground. Find the new amplitude of the motion. Answer in m.

a) 2.25      b) 3.23      c) 4.32      d) 5.43      e) None of these

5. While taking a walk in the forest you see a bird singing on a tree branch 40 m away, and realize you can just barely hear the bird at that distance. As the bird continues to chirp at the same sound level, you move closer for a better look. How much sound power passes through your ear when you are 5m away? The cross sectional area of your ear canal is  $2.3 \text{ cm}^2$ . Answer in W.
- a)  $1.472 \times 10^{-8}$  b)  $1.472 \times 10^{-10}$  c)  $1.472 \times 10^{-14}$  d)  $1.472 \times 10^{-16}$  e) None of these

6. A point charge ( $Q = +125 \text{ } \mu\text{C}$ ) is fixed onto a frictionless horizontal surface. A second point charge of mass  $m = 120 \text{ g}$  and  $q = +31 \text{ } \mu\text{C}$  is initially held on the same surface a distance of 11 cm away from Q, and then released. Find the speed of the second charge when it is 1.3 m away from the first charge. Answer in m/s
- a) 0            b) 69.5            c) 289            d) 83.2            e) None of these

7. Prof Mansour is sitting in the center of a rectangle, with sides of 2 m and 3 m respectively, surrounded by electrical charges as shown. He is desperately trying to hold a drink in his hand, indicated by the x. If the drink has a charge of 23  $\mu\text{C}$ , what is the total force acting on the drink? Answer in N.



- a) 3310      b) 3061      c) 3542      d) 3783      e) None of these

8. A  $21 \mu\text{C}$  charge is placed 33 cm to the left of a  $-105 \mu\text{C}$  charge. Find the distance from the  $21 \mu\text{C}$  charge that a positive charge needs to be placed so the net electrostatic field it experiences is zero. Answer in m.

a) 0.37      b) 0.165      c) 5.0      d) 0.27      e) None of these

9. A proton moving at a speed of  $2.3 \times 10^6$  m/s enters a region in space where the electric field is uniform. The field points in a direction parallel to the velocity of the proton and in same direction. If the field strength is  $3.4 \times 10^7$  N/C find the speed of the proton after it has travelled 4mm into the field. Answer in m/s.

a)  $1.6 \times 10^8$       b)  $3.2 \times 10^7$       c)  $5.6 \times 10^6$       d)  $7.4 \times 10^6$       e) None of these

10. Two speakers are driven by the same amplifier with a frequency of 680 Hz. The two speakers are 9m apart. An observer, originally at the position of one of the speakers, starts moving away along a line perpendicular to the line connecting the two speakers. What is the distance the observer must travel to move between the locations of the 7<sup>th</sup> and the 8<sup>th</sup> interference minima (destructive interference) that the observer experiences. The speed of sound is 340 m/s. Answer in m.

a) 0.92      b) 1.53      c) 1.88      d) 0.50      e) 0.25

11. 170 uniformly speaking students in classroom produce a sound level of 72 db. What is the sound level after 70 students leave the room? Answer in db.

a) 29.64      b) 68.14      c) 69.70      d) 73.47      e) None of these

12. A mass connected to a horizontal spring executes SHM such that at a certain time the mass is located at  $x = 3/4$  of the amplitude while moving in the positive direction. 1.3 seconds later the mass is moving such that its velocity is  $-1/3$  of the maximum velocity with a negative acceleration. If the mass of the particle is 0.3 g, find the spring constant. Answer in N/m.
- a) 0.25      b)  $2.00 \times 10^{-4}$       c) 0.87      d)  $2.64 \times 10^{-5}$       e) None of these

**112 FORMULA SHEET**Simple Harmonic motion

$$x = A \cos(\omega t) \quad A = \text{amplitude}$$

$$\omega = \sqrt{\frac{k}{m}} \quad \text{mass and spring}$$

Simple pendulum

$$\omega = \sqrt{\frac{g}{\ell}}$$

$$\omega = 2\pi f = 2\pi/T$$

Waves on a string

$$v = \sqrt{\frac{F}{\mu}}, \quad F = \text{Tension}$$

$$v = \lambda f \quad f = \frac{nv}{2L}$$

Sound waves

$$v = \sqrt{\frac{B}{\rho}}$$

$$v = \sqrt{\frac{Y}{\rho}}$$

$$\text{speed of sound} \quad v = 345 \text{ m/s}$$

$$I = \frac{P}{4\pi r^2}$$

$$\beta(\text{db}) = 10 \log \frac{I}{I_o}, \quad I_o = 1.0 \times 10^{-12} \text{ W/m}^2$$

Electrostatics

$$F = k \frac{|q_1 q_2|}{r^2}, \quad k = 8.99 \times 10^9 \text{ Nm}^2 \text{C}^{-2}, \quad k = \frac{1}{4\pi\epsilon_0}$$

$$\vec{F} = q\vec{E}, \quad \Delta V = -\vec{E} \cdot \vec{d} \quad (\text{Uniform Field})$$

$$V_o = k \frac{Q}{r}, \quad m_e = 9.11 \times 10^{-31} \text{ kg}, \quad \Delta U = q\Delta V$$

$$m_p = 1.67 \times 10^{-27} \text{ kg}, \quad e = 1.6 \times 10^{-19} \text{ C}$$