February 12, 2015
(7:00 pm – 9:00 pm)

TERM TEST

PAPER NO.: **A**

PAGE NO.: 1 of 4 (+ formula sheet)

DEPARTMENT & COURSE NO.: PHYS 1070

TIME: 2 hours

EXAMINATION: Physics 2: Waves and Modern Physics

EXAMINERS: G. Gwinner and R. Roshko

All questions are of equal value. Answer all questions. No marks are subtracted for wrong answers.

Record all answers on the computer score sheet provided. **USE PENCIL ONLY!** Black pen will look good but may not be read reliably by the scoring machine. **Mark only <u>one</u> answer for each question!** Select the answer that is closest to yours.

"n.o.t." denotes "none of these" choices.

A formula sheet is provided for your use; you may **not** use your own formula sheet or any other materials or notes. Calculators of any type are allowed, but not devices that store text or that can communicate with other such devices.

Be sure your name and student number are printed on the score sheet and the student number correctly coded in the box at the top right-hand side of the sheet.

This is paper A. Questions are numbered 1 to 20. Mark the correct answers in rows 1-20 of the ***first*** column of the accompanying IBM sheet in pencil. Also write "Paper A" next to your name on the IBM sheet.

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1. In simple harmonic motion, the magnitude of the acceleration is:

   (a) constant
   (b) proportional to the displacement
   (c) inversely proportional to the displacement
   (d) greatest when the velocity is greatest
   (e) never greater than g

2. Two identical undamped oscillators have the same amplitude of oscillation only if:

   (a) they are started with the same displacement x_0
   (b) they are started with the same velocity v_0
   (c) they are started with the same phase
   (d) they are started so the combination $\omega^2 x_0^2 + v_0^2$ is the same
   (e) they are started so the combination $x_0^2 + \omega^2 v_0^2$ is the same

3. A spider of mass 0.36 g sits in the middle of its horizontal web, which sags 3.00 mm under its weight. Around this equilibrium position, the spider begins to oscillate vertically. Estimate the frequency f.

   (a) 3.6 Hz (b) 9.1 Hz (c) 15.6 Hz (d) 65 Hz (e) 102 Hz

4. The position of a particle oscillating in SHM along the x-axis is given by

$$x(t) = (5cm)\cos(4\pi\ t + \frac{\pi}{3})$$

   where x is in centimeters and t is in seconds. What is the first time after t=0 that the particle is at the extreme left end of its motion?

   (a) 0.17 s (b) 0.34 s (c) 0.58 s (d) 0.75 s (e) 1.22 s

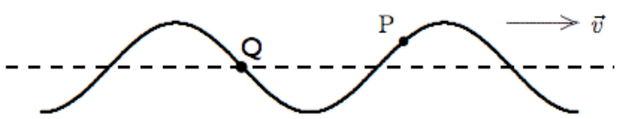
5. A 1.0 kg object on a horizontal, frictionless surface is attached to a spring with constant k = 200 N/m. At t = 0 it is 0.25 m from its equilibrium position and has a speed of 5.0 m/s. What is the maximum speed that the object attains during a cycle of simple harmonic motion?

   (a) 6.1 m/s (b) 8.7 m/s (c) 12 m/s (d) 38 m/s (e) 56 m/s

6. A chair (mass 15 kg) is suspended from the ceiling with a spring. It oscillates in simple harmonic motion with a period T = 0.9 s. When a person sits in the chair (not touching the ground), the oscillation period increases to 2.3 s. What is the mass of that person?

   (a) 53 kg (b) 72 kg (c) 83 kg (d) 98 kg (e) 108 kg

7. A wave traveling to the right on a stretched string is shown in the figure. The direction of the instantaneous velocity of the points P and Q on the string is:



(a) P up and Q down (b) P down and Q zero (c) P down and Q up

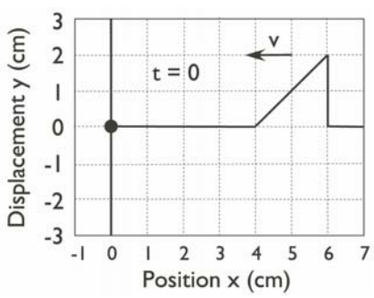
(d) P down and Q down (e) P to the right and Q to the right

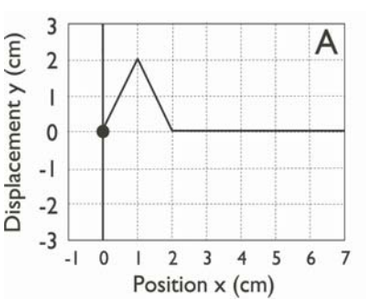
8. Three separate strings are made of the same material. String 1 has length L and tension F, string 2 has length $2L$ and tension $2F$, and string 3 has length $3L$ and tension $3F$. A pulse is started at one end of each string. If the pulses start at the same time, the order in which they reach the ends of their respective strings is:

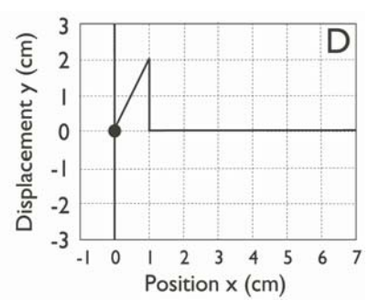
(a) 1, 2, 3 (b) 3, 2, 1 (c) 2, 3, 1

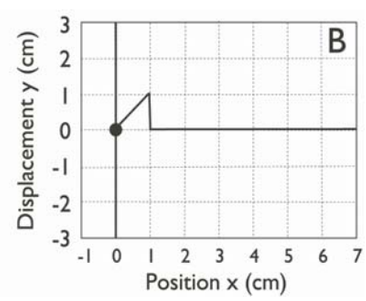
(d) 3, 1, 2 (e) they all take the same time

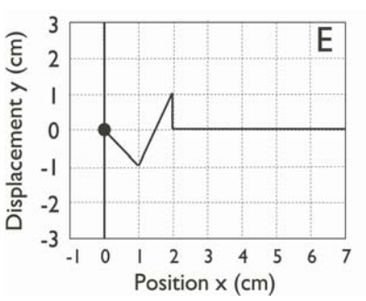
9. The wave pulse shown in the picture travels to the left along a string toward the string's fixed end at $x = 0$ cm as shown at time $t = 0$. The propagation speed of the pulse is 1.0 cm/s. Choose the figure below which most closely depicts the shape of the string at $t = 5$ s.

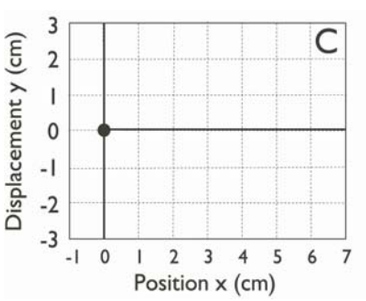








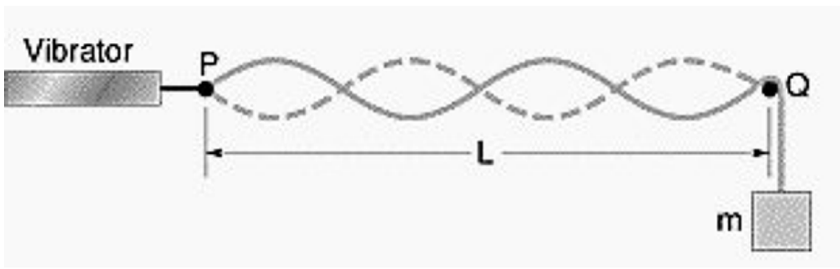




10. Two boats are anchored offshore and are bobbing vertically up and down on a wave at a rate of 6 cycles per minute. When one boat has its maximum positive vertical displacement (relative to a calm sea), the other boat has its maximum negative vertical displacement. If the wave is a harmonic wave propagating at 2.2 m/s, what is the minimum horizontal distance between the boats?

(a) 5 m (b) 11 m (c) 26 m (d) 39 m (e) 42 m

11. A horizontal string under tension is excited in the $n = 4$ standing wave resonance by a mechanical device oscillating at 120 Hz. The length L of the vibrating string is 1.20 m, and its mass is 0.002 kg. What is the value of m, the suspended mass providing the string tension in this case?



(a) 0.22 kg (b) 0.53 kg (c) 0.73 kg (d) 0.88 kg (e) 1.06 kg

12. Two waves travel in the same direction along the same string at the same frequency. Wave #1 has amplitude 5.0 cm and phase constant $\pi/4$; wave #2 has amplitude 5.0 cm and phase constant $5\pi/4$. What is the amplitude of the resultant wave?

(a) 0 cm (b) 10.0 cm (c) 11.2 cm (d) 14.0 cm (e) 5.0 cm

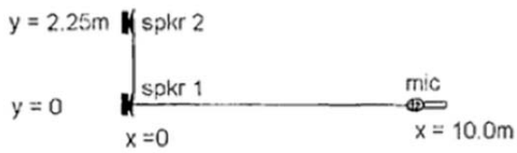
13. A wave travelling on a string under tension is delivering an average power of 2.0 W. A wave of the same frequency and amplitude travelling on a string of twice the linear mass density under the same tension would deliver a power of

(a) 2.8 W (b) 4.0 W (c) 1.4 W (d) 1.0 W (e) 2.0 W

14. Piano strings are strings fixed at both ends and held under tension. In certain ranges of a piano keyboard, more than one string is tuned to the same note to provide extra loudness. For example, the note at 110 Hz has two identical strings at this pitch. If one of these strings slips from its normal tension of 600 N to 540 N, what beat frequency will be heard when the two strings are struck simultaneously (so that each vibrates in the same harmonic)?

(a) 89 Hz (b) 22 Hz (c) 11 Hz (d) 8.3 Hz (e) 5.6 Hz

15. Two speakers, emitting sound waves, in phase, of wavelength 0.25 m, are placed along the y-axis at locations $y = 0$ and $y = 2.25$ m. A microfone is placed on the x-axis at x = 10.0 m. The speaker at y = 2.25 m is slowly shifted along the y-axis to a new position a y' = 4.58 m. Over the course of this shift, how many minima in sound intensity are registered by the microphone?



(a) 1 (b) 2 (c) 3 (d) 4 (e) 5

16. The fundamental frequency of a pipe that has one end closed is 256 Hz. When both ends of the same pipe are opened, the fundamental frequency is

(a) 64.0 Hz (b) 128 Hz (c) 256 Hz (d) 512 Hz (e) 1.02 kHz

17. A piece of metal pipe of length 2.0 m with open ends has a resonance at 850 Hz. One end of the pipe is then sealed with a cap so that its length remains the same. Which of the following frequencies corresponds to the resonance of the sealed pipe which is closest to 850 Hz?

(a) 872 Hz (b) 893 Hz (c) 914 Hz (d) 935 Hz (e) 956 Hz

18. A spherical sound wave is emitted by a point source. Relative to the sound level 1 m from the source, the sound level 5 m from the source is about:

(a) -14 dB (b) +7 dB (c) -7 dB (d) +14 dB (e) 0 dB

19. Two identical tuning forks vibrate at 256 Hz. One of them is then loaded with a drop of wax, after which 6 beats/s are heard. The period of the loaded tuning fork is:

(a) 0.006 s (b) 0.005 s (c) 0.004 s (d) 0.003 s (e) n.o.t.

20. A skydiver carries a tone generator which emits a steady tone of 1800 Hz. She is also equipped with sound receiving equipment sensitive enough to detect sound waves reflected from the ground. While she is falling at constant ("terminal") speed of 55.8 m/s, what frequency of reflected sound wave would she detect with her receiver?

(a) 1292 Hz (b) 1800 Hz (c) 2095 Hz (d) 2153 Hz (e) 2507 Hz