February 16, 2012 (7:00 pm – 9:00 pm) MIDTERM TEST

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

DEPARTMENT & COURSE NO.: PHYS 1070 TIME: 2.0 hours

EXAMINATION: Physics 2: Waves and Modern Physics EXAMINERS: P.G. Blunden and G. Gwinner

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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.

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. **Cell phones must be turned off.**

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 bubble sheet in pencil. Also write "Paper A" next to your name on the bubble sheet.

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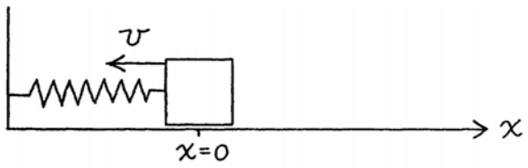
1. An oscillator undergoes simple harmonic motion with angular frequency $\omega = 90\ s^{-1}$. At time $t = 0$ we measure the displacement $x_0 = 2.00$ cm and the velocity $v_0 = 3.00$ m/s. What is the amplitude x_m?

   (a) 15.2 cm (b) 3.9 cm (c) 7.8 cm (d) 1.3 cm (e) 0.8 cm

2. A massive object at the end of a horizontal spring is performing simple harmonic oscillations described by $x(t) = x_m \cos(\omega t+\varphi)$. The diagram below shows the behaviour of the oscillator at $t = 0$. What is the phase angle φ?



   (a) $\pi/2$ (b) 0 (c) π (d) $3\pi/2$ (e) $\pi/4$

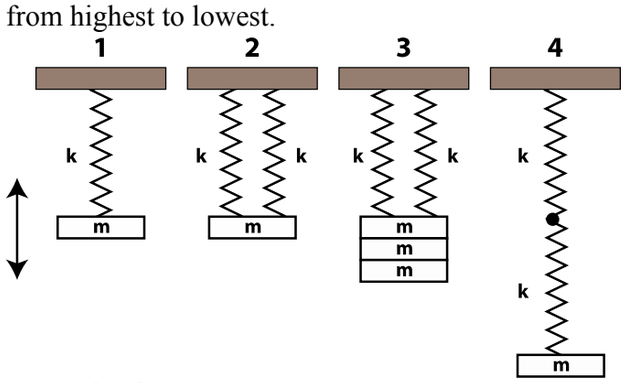
3. A box undergoes vertical simple harmonic motion with amplitude $x_m = 50$ mm. What is the maximum frequency f for a rock inside the box to stay in permanent contact with the floor of the box?

   (a) 4.4 Hz (b) 0.45 Hz (c) 13.8 Hz (d) 2.2 Hz (e) 7.2 Hz

4. A pendulum of length $L = 0.50$ m is used as the time standard in a mechanical clock. It is found that after 12 hours, the clock lags by 30 minutes. To what length must the pendulum be adjusted in order to show the correct time?

   (a) 0.459 m (b) 0.522 m (c) 0.511 m (d) 0.479 m (e) 0.490 m

5. Rank the simple harmonic oscillators shown in the figure by their oscillation frequencies, from highest to lowest.



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

6. A block of mass m is attached to a spring and undergoes simple harmonic motion with amplitude x_m and total energy E. This block is now replaced with a new block of mass $m' = 3\ m$, on the same spring, and set into simple harmonic motion with amplitude $x'_m = 2\ x_m$. The total energy of the oscillator is now:

(a) 4/3 E (b) 2 E (c) 4 E (d) 9 E (e) 13 E

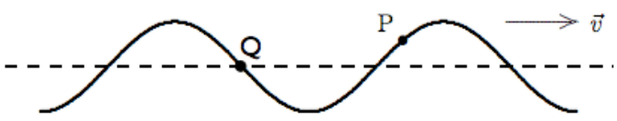
7. At time $t = 0$, a wave pulse is described by the function

$$y = \frac{9.0}{5.0 + x^2}$$

with x and y in cm. The wave pulse is moving in the positive x direction with a speed of 3.0 cm/s. At time $t = 0.3$ s and location $x = 2.0$ cm, the displacement, y, is:

(a) 0 cm (b) 0.67 cm (c) 1.0 cm (d) 1.45 cm (e) 9.0 cm

8. 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 not moving
(c) P down and Q up
(d) P down and Q down
(e) P to the right and Q to the right

9. One end of a horizontal rope is attached to a prong of an electrically driven tuning fork that vibrates at 120 Hz. The other end passes over a pulley and supports an object of mass 1.50 kg. The linear mass density of the rope is 0.055 kg/m. What is the wavelength of a transverse wave on the rope?

(a) 2.23 m (b) 0.136 m (c) 1.36 m (d) 0.223 m (e) 0.0223 m

10. A sinusoidal wave on a string is described by the equation

$$y = 0.15\sin(0.80x - 50t)$$

with x and y in meters and t in seconds. The linear mass density of the string is 0.012 kg/m. What is the average power transmitted by the wave?

(a) 21 W
(b) 2.5 W
(c) 5.4×10^{-3} W
(d) 1.4×10^{-6} W
(e) 2.5×10^{-7} W

11. An elevator repairman of mass 73 kg sits on top of an elevator cabin of mass 655 kg inside the elevator shaft in a skyscraper. A steel cable of length 61 m and mass 38 kg suspends the elevator cabin. The man sends a signal to his colleague at the top of the elevator shaft by tapping the cable from the side with his hammer. How long will it take for the wave pulse generated by the hammer to travel up the cable? Neglect the mass of the cable for calculating the tension.

(a) 0.60 s (b) 0.57 s (c) 0.63 s (d) 1.20 s (e) 0.005 s

12. If we do not neglect the mass of the cable when calculating the tension in the cable in the previous question, is the wave speed in the cable

(a) larger at the bottom than at the top
(b) larger at the top than at the bottom
(c) everywhere the same, such as calculated in the previous question
(d) everywhere the same, but larger than calculated in the previous question
(e) can't tell because it depends on the amplitude of the wave

13. A supersonic jet flies over an air show at Mach 1.5 and an altitude of 1500 m. How long after the jet was directly overhead does an observer on the ground hear the sonic boom?

(a) 4.4 s (b) 2.9 s (c) 4.9 s (d) 2.0 s (e) 3.3 s

14. A sound probe sends out a signal at 1000 Hz. The signal is reflected from an object moving at a speed of 10 m/s away from the probe. What is the shift in frequency between the signal sent out by the probe and the reflected signal received back by the probe?

(a) 0 Hz (b) 28.6 Hz (c) 29.4 Hz (d) 57.1 Hz (e) 58.0 Hz

15. A barking dog delivers 1 mW of power. If this power is uniformly distributed in all directions, what is the sound intensity at a distance of 5 m?

(a) 6.5 dB (b) 65 dB (c) 9 dB (d) 90 dB (e) 0 dB

16. By how much does the sound intensity level β change when we double the distance between a listener and a uniformly distributed source of sound?

(a) β decreases by 6 dB
(b) β is ½ as large
(c) β is ¼ as large
(d) β decreases by 40 dB
(e) there is no change in β

17. If you stand 20 m from a speaker tower generating 2500 W of power, how much energy per second impinges on each of your eardrums? Assume the surface area of the human eardrum is 55 mm^2 and that the speaker generates sound uniformly in a forward hemisphere in the direction of the audience.

(a) 1.0×10^{-6} W
(b) 5.5×10^{-2} W
(c) 5.5×10^{-5} W
(d) 1.0 W
(e) 55 W

18. What is the maximum amplitude of vibration of an eardrum when you hear sound of frequency 1000 Hz at an intensity of 1 W/m^2. Use ρ=1.2 kg/m^3 for the density of air.

(a) 7.9×10^{-6} m
(b) 2.1×10^{-4} m
(c) 7.0×10^{-5} m
(d) 1.2×10^{-10} m
(e) 1.1×10^{-5} m

19. A clarinet is a tube closed at one end and open at the other. A flute acts like a tube open at both ends. If both instruments have a length of 0.5 m, what are the lowest fundamental frequencies of each?

(a) 170 Hz (clarinet), 340 Hz (flute)
(b) 340 Hz (clarinet), 170 Hz (flute)
(c) 340 Hz (clarinet), 680 Hz (flute)
(d) 680 Hz (clarinet), 340 Hz (flute)
(e) 680 Hz (clarinet), 680 Hz (flute)

20. Two sound sources oscillate in phase at a frequency 500 Hz, and with the same amplitude s_0. At a point 5.00 m from one source, and 5.17 m from the other source, what is the amplitude of the resultant wave?

(a) s_0 (b) 2.00 s_0 (c) 1.41 s_0 (d) 0 (e) 0.71 s_0

THE END