February 14, 2013 MIDTERM TEST
(7:00 pm – 9:00 pm)

PAPER NO.: **A** PAGE NO.: 1 of 5 (+ formula sheet)

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

EXAMINATION: Physics 2: Waves and Modern Physics EXAMINERS: G. Gwinner and J. Mammei

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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.

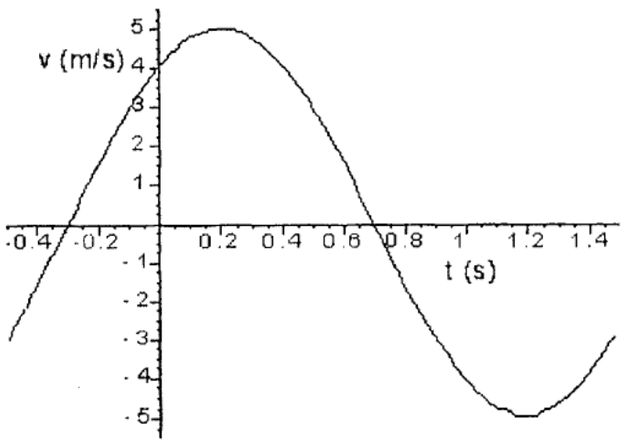
"n.o.t." denotes "none of these" choices.

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.

Questions 1-4 refer to the graph below. The graph below shows the velocity function, v_x versus t, for a particle of mass $m=2.0\ kg$ executing simple harmonic motion along the x-axis, where $x=x_m cos(\omega t+\varphi)$.



1. The total energy of the particle is:

   (a) 4 J (b) 5 J (c) 9 J (d) 16 J (e) 25 J

2. The amplitude x_m of the particle's motion is:

   (a) 0.5 m (b) 1.6 m (c) 3.2 m (d) 5.0 m (e) 10m

3. The time required for the particle to travel from $x = 0.8\ x_m$ to $x = 0$ as it heads back toward equilibrium from $x = x_m$ is:

   (a) 0.25 s (b) 0.64 s (c) 0.30 s (d) 0.93 s (e) 1.57 s

4. At time *t=0*, the location of the particle is at *x* =

(a) –1.3 m (b) 0.53 m (c) 0.96 m (d) -0.96 m (e) 1.3 m

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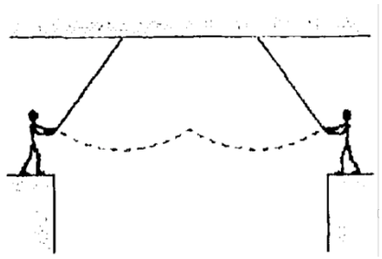
5. An object of mass 5.0 kg is suspended by a spring which stretches 9.8 cm when the mass is attached and gently lowered to its equilibrium position (*y=0*). Take the direction of *+y* to be upward. The object is then displaced downward an additional 5.0 cm and released from rest at *t=0*. Its position as a function of time is given by:

(a) y = 5 cm cos(10t)
(b) y = 5 cm cos(10t+π)
(c) y = 5 cm cos(10t+π/2)
(d) y = 5 cm cos(10t) +10 cm
(e) y = 5 cm cos(10t) - 10 cm

6. Two circus clowns (each of mass *m = 50 kg*) swing flying trapezes which can be modeled as inextensible ropes of length *L = 25 m*, as shown in the figure. At *t=0*, each clown steps off his platform and swings towards the other. At the peak of the swing, one clown grabs the other, and the two swing back to one platform together. The time taken from *t=0* to their landing on one platform is:



(a) 10 s (b) 12 s (c) 15 s (d) 20 s (e) 24 s

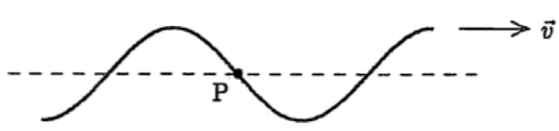
7. A traveling wave on a string is described by: y(x,t) = 5 cm sin(2(x-3t)), where x is in cm and t in s. The angular frequency ω is:

(a) 2 rad/s (b) 3 rad/s (c) 1.5 rad/s (d) 0.67 rad/s (e) 6 rad/s

8. A sinusoidal traveling wave on a string is given by: $y(x,t) = y_m \sin(kx - \omega t + \varphi)$. At $t = 0$, the point at $x = 0$ has zero displacement and is moving in the positive *y* direction. The phase constant φ is:

(a) 0 (b) π/4 rad (c) π/2 rad (d) 3π/2 rad (e) π rad

9. A snapshot of a transverse wave, traveling from left to right on a string, is shown below.



The direction of the instantaneous velocity of the string at point P is:

(a) vertically upwards
(b) vertically downwards
(c) no direction, as the velocity is zero
(d) to the right
(e) upwards and to the right

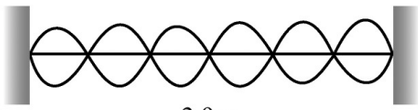
10. A source of frequency f sends waves of a wavelength λ traveling with speed v in a non-dispersive medium. If the frequency is changed from f to $2f$, then the new wavelength and new speed are, respectively:

(a) 2λ, v (b) $\lambda/2$, v (c) λ, $2v$ (d) λ, $v/2$ (e) $\lambda/2$, $2v$

11. Two traveling waves are identical in all respects except for a phase difference of $\varphi = \pi/6$ radians between them. Let $y_1 = y_m \sin(kx - \omega t)$ and $y_2 = y_m \sin(kx - \omega t - \pi/6)$. The sum of these two waves is a new wave with amplitude:

(a) $2\, y_m \cos\ \omega t$ (b) $2\, y_m \sin \omega t$ (c) $2\, y_m \cos(\pi/12)$
(d) $2\, y_m \cos(\pi/6)$ (e) $y_m \cos(\pi/12)$

12. A 2.0 meter long string is fixed at both ends and tightened until the wave speed is 78 m/s. What is the frequency of the standing wave shown in the figure?

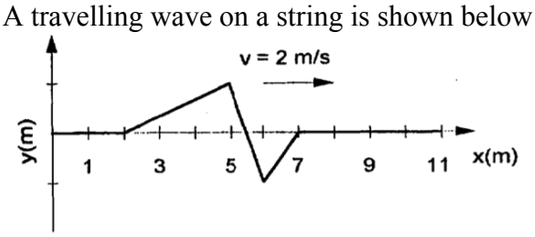


(a) 117 Hz (b) 234 Hz (c) 351 Hz (d) 468 Hz (e) 700 Hz

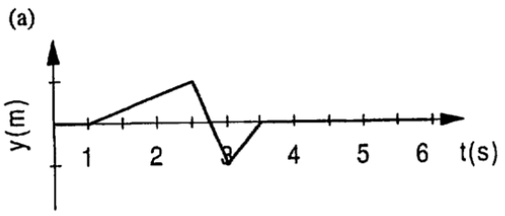
13. A 40 cm long string, under tension, with one end fixed and the other free to move transversely, is vibrating in its fundamental standing wave mode. The tension is adjusted so that the wave speed is 4.0 m/s. The frequency of the vibrating string under these conditions is:

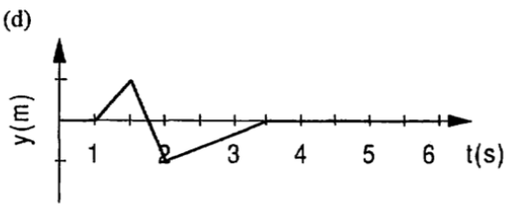
(a) 1.0 Hz (b) 2.5 Hz (c) 4.0 Hz (d) 5.0 Hz (e) 10 Hz

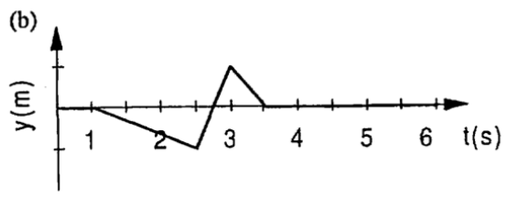
14. A travelling wave on a string is shown below at $t = 0$ as a function of x.

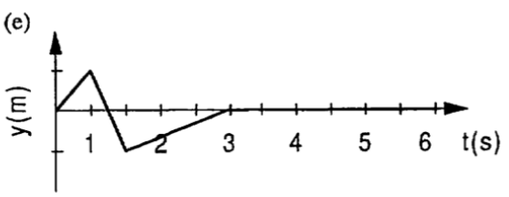


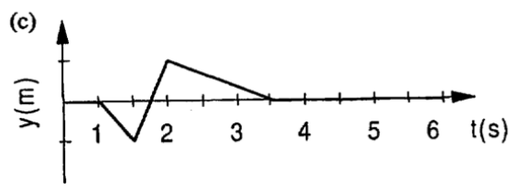
Which of the following figures shows the displacement of the particle at $x = 9.0$ m *as a function of time*?











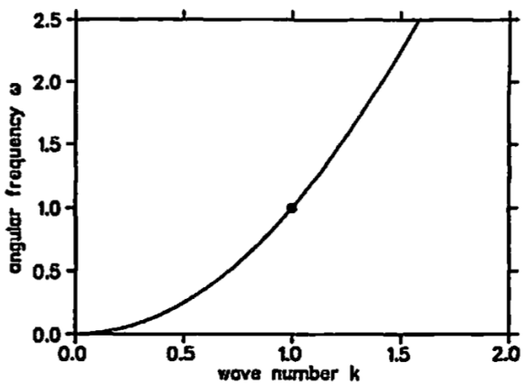
15. The sound level of a dog's bark is 50 dB. The intensity of a rock concert is 10,000 times that of the dog's bark. What is the sound level of the rock concert?

(a) 90 dB (b) 500,000 dB (c) 10,050 dB
(d) 2000 dB (e) 54 dB

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

(a) 0.0063 s (b) 0.0052 s (c) 0.0040 s (d) 0.0022 s
(e) none of these

17. A wave pulse is propagating in a medium with a dispersion relation $\omega = a\,k^2$ as shown in the figure where $a = 1$ m^2/s. The average wave number of the pulse is 1 rad/m. Determine the group velocity, with which the wave pulse is travelling, either from the expression above or graphically from the figure (where k is in rad/m and ω in Hz). The group velocity is:



(a) 1.0 m/s (b) 0.5 m/s (c) 3.0 m/s (d) 2.0 m/s (e) 4.0 m/s

18. Organ pipe A has both ends open and a fundamental frequency of 300 Hz. The 3rd lowest resonance of pipe B (which has one open end) has the same frequency as the 3rd lowest resonance of pipe A. How long is pipe B if the speed of sound is 340 m/s?

(a) 57 cm (b) 82 cm (c) 30 cm (d) 114 cm (e) 47 cm

19. The sound from a single source can reach point *O* by two different paths. One path is 20.0 m long and the second path is 21.0 m long. The sound destructively interferes at point *O*. What is the minimum frequency of the source if the speed of sound is 340 m/s?

(a) 340 Hz (b) 6800 Hz (c) 520 Hz (d) 680 Hz (e) 170 Hz

20. An ambulance sounds a siren at 440 Hz as it moves towards a wall at a speed of 100 km/h. At what frequency does the ambulance driver hear the siren's echo reflected by the wall? The speed of sound is 340 m/s.

(a) 374 Hz (b) 518 Hz (c) 440 Hz (d) 573 Hz (e) 312 Hz

THE END