INSTRUCTIONS:

Except for the multiple choice questions 1–8, 13, you must show all your work. An answer will not be enough; understanding must be demonstrated as well. This can take the form of a clear calculation, a graph or, where appropriate, a clear written explanation.

For questions 9 – 12, you will receive partial credit for taking the right steps towards a solution, even if you make a mistake towards the end of your work.

No books or notes are permitted in this examination. Writing instruments and a calculator are the only items that you will need.

**** READ THE QUESTIONS CAREFULLY ****

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1. A disk, a hoop, and a sphere are released at the same time at the top of an inclined plane. They all roll without slipping. In what order do they reach the bottom?

   (a) disk, hoop, sphere
   (b) sphere, disk, hoop
   (c) hoop, sphere, disk
   (d) hoop, disk, sphere

   ANSWER[ ]

   (score) (4)

2. What is the length of a simple pendulum with a period of 2.00 s?

   (a) 0.763 m
   (b) 0.994 m
   (c) 1.13 m
   (d) 0.873 m

   ANSWER[ ]

   (score) (4)

3. A mass is oscillating on a spring with a period of 4.60 s. At t = 0 s the mass has zero speed and is at x = 8.30 cm. What is its speed at t = 2.50 s?

   (a) 10.9 cm/s
   (b) 3.06 cm/s
   (c) 3.32 cm/s
   (d) 1.80 cm/s

   ANSWER[ ]

   (score) (4)

4. A 1200-kg car whose springs have an effective force constant of 2.66×10^6 N/m is moving along the highway with its tires out of balance. The tires have a radius of 40.6 cm. At what speed will the driver experience large vibrations? (Hint: This happens when the rotational period of the tires equals the oscillation period of the car and springs at resonance.)

   (a) 19.1 m/s
   (b) 22.2 m/s
   (c) 18.9 m/s
   (d) 17.4 m/s

   ANSWER[ ]

   (score) (4)

5. A floating object oscillates up and down 3 complete cycles in 2 seconds as a water wave of wavelength 4 meters passes by. The speed of the wave is

   (a) 3 m/s.
   (b) 4 m/s.
   (c) 6 m/s.
   (d) 8 m/s.
   (e) 12 m/s.

   ANSWER[ ]

   (score) (4)

6. If the intensity level of one trombone is 70 dB, what is the intensity level of 76 trombones?

   (a) 146 dB
   (b) 76 dB
   (c) 82 dB
   (d) 89 dB

   ANSWER[ ]

   (score) (4)

7. If a 1000-Hz sound source moves at a speed of 50.0 m/s toward a listener who moves at a speed of 30.0 m/s in a direction away from the source, what is the apparent frequency heard by the listener? (Assume the speed of sound is 340 m/s here.)

   (a) 937 Hz
   (b) 947 Hz
   (c) 1060 Hz
   (d) 1070 Hz

   ANSWER[ ]

   (score) (4)

8. A 25.0-g string is stretched with a tension of 43.0 N between two fixed points 12.0 m apart. What is the frequency of the second harmonic?

   (a) 6.00 Hz
   (b) 12.0 Hz
   (c) 18.0 Hz
   (d) 24.0 Hz

   ANSWER[ ]

   (score) (4)

9. A 10.0m, lightweight (negliblible weight) ladder rests against a smooth wall. The coefficient of static friction between the ladder and the floor is 0.70, and the ladder makes a 50° angle with the floor. A person weighing 600 N climbs the ladder.

   (a) Draw a freebody diagram for the ladder, identifying all the forces that act on the ladder.

(score)	(4)

   (b) Write two equations that show the requirements for the ladder to be in translational equilibrium.

(score)	(6)

   (c) Write an equation that shows the requirements for the ladder to be in rotational equilibrium. Take the axis of rotation at the base of the ladder.

(score)	(4)

   (d) How far up the ladder can the person climb before the ladder starts to slip?

(score)	(6)

10. A disk-shaped merry-go-round of radius 2.63 m and mass 155 kg rotates freely with an angular speed of 0.641 rev/s. A 59.4 kg person running tangential to the rim of the merry-go-round at 3.5 m/s, jumps onto the rim, and holds on. Before jumping on, the person was moving in the same direction as the merry-go-round's rim.

    (a) Before the person jumps on, what is the angular momentum of the merry-go-round?

(score)	(4)

    (b) Before the person jumps on, what is the person's angular momentum with respect to the enter of the merry-go-round?

(score)	(4)

    (c) After the person jumps on, what is the final angular speed (rad/s) of the merry-go-round?

(score)	(8)

11. A violinist sounds a tuning fork of frequency 440 Hz and plays a string that should have the same frequency. A beat frequency of 2 Hz is heard.

    (a) What are the possible frequencies of vibration of the violin string?

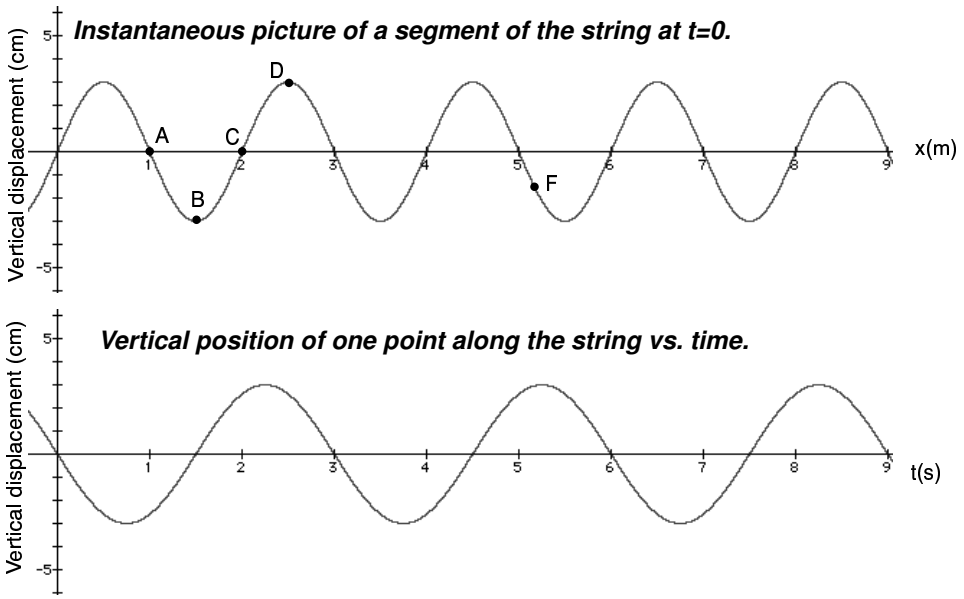
(score)	(5)

    (b) When the string is tightened, the beat frequency increases to 5 Hz. What is the only possible frequency of the violin string?

(score)	(5)

12. You are asked to construct an organ pipe that will resonate at room temperature at the following frequencies: $180\ Hz$ and $540\ Hz$, and at no other frequencies between $0\ Hz$ and $600\ Hz$. State whether this should be an open pipe or a closed pipe and determine the length of the pipe.

(score)	(12)



13. A wave is propagating to the right along a string. The first picture above shows a snapshot of a segment of the string at time, t=0. The second picture above is a graph of the vertical displacement of a point along picture the string as a function of time.

(a) What is the amplitude of the wave?
(circle one) 1/2 cm 1 cm 2 cm 3 cm 4 cm (score) (2)

(b) What is the period of the wave?
(circle one) 1/3 s 1/2 s 1 s 2 s 3 s (score) (2)

(c) What is the wavelength of the wave?
(circle one) 1/3 m 1/2 m 1 m 2 m 3 m (score) (2)

(d) Based on these two graphs, what is the speed at which the wave is propagating along the string?
(circle one) 1/3 m/s 2/3 m/s 1 m/s 2 m/s 3 m/s (score) (2)

(e) Of the points A, B, C, and D on the uppermost graph, which one could be represented by the lower graph? Assume that the wave is propagating to the right and that the upper picture shows the segment at time t= 0 seconds.
(circle one) A B C D (score) (2)