

Physics P221

Final Exam

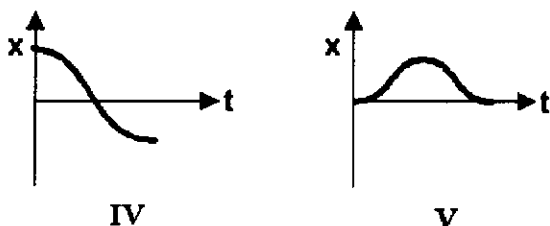
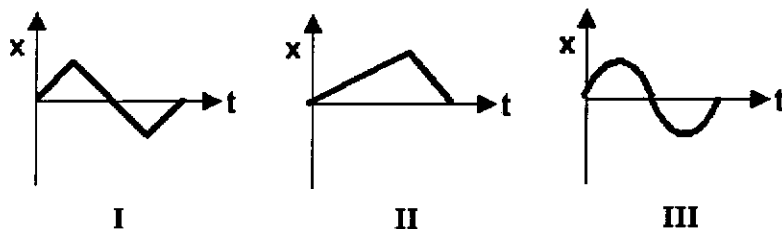
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Student Name _____ Student ID _____

Problems 1-7 are worth 5 points each; problems 8-11 are worth 20, 15, 20, and 25 points respectively. Show your work in problems 8-11. You may consult five sheets of personal notes and you may use the appendices in our HR&W text.

1. A car accelerates from rest on a straight road lying on the x axis. A short time later, the car decelerates to a stop and turns around. It immediately accelerates and then decelerates, coming to rest at its original position. Which of the five following graphs best describes the motion?



2. A Chevrolet of mass 1200 kg is heading North with a speed of 20 m/s. A Ford of mass 1500 kg is heading East with a speed of 25 m/s. They reach an intersection at the same time and cannot stop due to a layer of ice on the roads. They collide and stick together. What is their speed just after the collision?

- A) 16.5 m/s
- B) 19.3 m/s
- C) 21.2 m/s
- D) 24.1 m/s
- E) 28.7 m/s

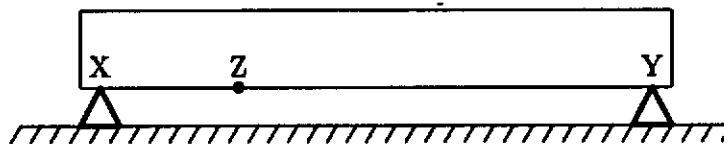
3. A 2.0 kg box is sitting on a merry-go-round at a distance of 1.5 m from its central axis. What is the maximum angular speed of rotation of the merry-go-round for which the box will not slide outwards if the coefficient of static friction is 0.3?

- A) 0.6 rad/sec
- B) 0.8 rad/sec
- C) 1.0 rad/sec
- D) 1.2 rad/sec
- E) 1.4 rad/sec

4. A source S generates circular outgoing waves on a lake. The wave speed is 5.0 m/s and the crest-to-crest distance is 2.0 m. A person in a motor boat heads directly toward S with a speed of 3.0 m/s. To this person in the boat, the frequency of these waves is

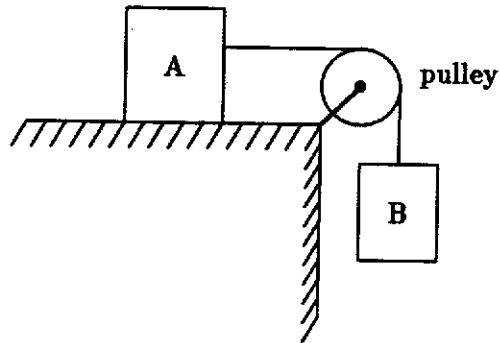
- A) 0.50 Hz
- B) 1.0 Hz
- C) 2.0 Hz
- D) 4.0 Hz
- E) 8.0 Hz

5. A uniform plank is supported by two equal 120-N forces X and Y, as shown. The support at X is then moved to Z (half-way to the plank center). The supporting force at Z then becomes:

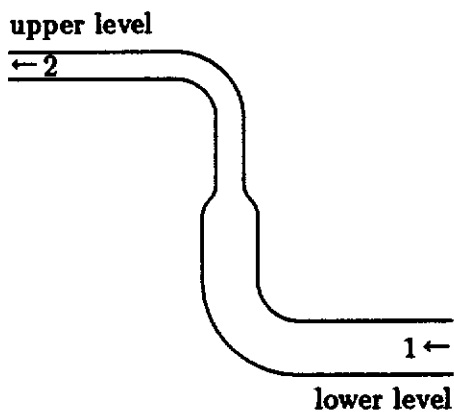


- A) 240 N
- B) 160 N
- C) 100 N
- D) 60 N
- E) 40 N

6. In the figure below block A has a mass of 20.0 kg, block B a mass of 10.0 kg, and the mass of the pulley and string may be neglected. If the system starts from rest and there is no friction what is the speed of block A after block B has fallen by 20.0 cm?

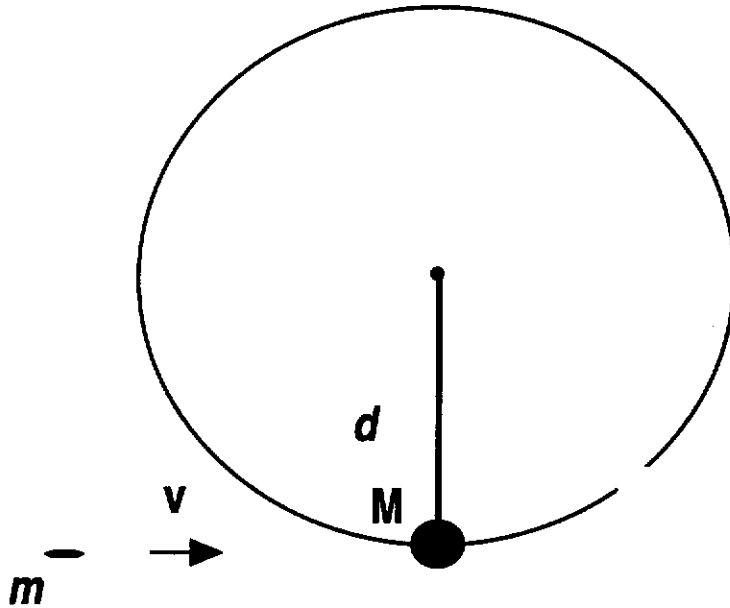


- A) 0.22 m/s
B) 0.50 m/s
C) 0.81 m/s
D) 1.14 m/s
E) 1.58 m/s
7. Water is pumped through a pipe of varying cross section, as shown below, from a lower level to an upper level. Compared to the water at point 1, the water at point 2:



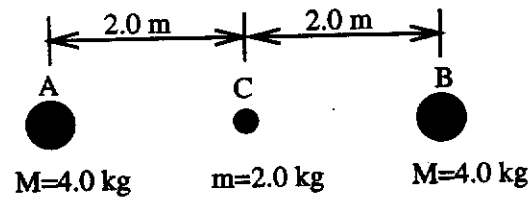
- A) has greater speed and greater pressure
B) has greater speed and less pressure
C) has less speed and less pressure
D) has less speed and greater pressure
E) has greater speed and the same pressure

8. As shown in the figure, a rubber bullet of mass $m = 20 \text{ gm}$ and speed $v = 750 \text{ m/s}$ strikes a metal block of mass $M = 3.0 \text{ kg}$ in an elastic collision. The rubber bullet bounces back in the direction it came from. The mass M rests on a frictionless, horizontal table. A string of length $d = 2.0 \text{ m}$, with one end fixed at point O , has its other end attached to M .



- A) What is the speed of the mass M *just after* the bullet bounces off of it? (You may assume that the string has not yet had an effect on M 's motion.)
- B) What is the magnitude of the angular momentum of M about O as M rotates in a circle of radius d ?
- C) What is the kinetic energy of M as M rotates in a circle of radius d ?
- D) The string suddenly breaks. Now what is the magnitude of the angular momentum of M about O as M moves in a straight line?

9. Three balls are arranged along a line as shown below.



A) What is the net gravitational force on ball C due to the other 2 balls?

B) What is the net gravitational force on ball A?

C) How much work must be done to move ball C by a distance of 20 km in a direction perpendicular to the line between balls A and B?

10.

Material	$c(\text{J/kg}\cdot\text{K})$	$k(\text{W/m}\cdot\text{K})$
Al	900	235
Cu	386	401
Pb	128	35

Use the information in the above table to answer the following questions regarding a 2.0 kg block of aluminum (Al) and a 10.0 kg block of copper (Cu).

- A) What is the heat capacity of each of the two blocks?
- B) How much heat is required to increase the temperature of the Al block from room temperature (25°C) to 150°C ?
- C) The Al block (at 150°) is put in contact with the Cu block (at 25°C) and then the two are isolated from any other heat source or sink. What is the temperature of the two blocks after thermal equilibrium is reestablished?
- D) If instead of being placed in direct contact the Al block and Cu block (at 150°C and 25°C respectively) were linked by a Pb rod of length 30 cm and radius 0.2 cm what would be the initial rate of heat flow through the Pb?

11. The equation of a transverse wave on a string (lying along the x axis) is

$$y_1 = (4.0 \text{ mm}) \sin[(12 \text{ m}^{-1})x - (600 \text{ s}^{-1})t].$$

The tension in the string is 15 N.

- A) What is the wavelength of this wave?
- B) What is the speed of this wave?
- C) What is the linear density of the string in grams/meter?
- D) What is the average rate at which energy is transmitted by this wave?
- E) If another wave y_2 is propagating on the same string, and
$$y_2 = (4.0 \text{ mm}) \sin[(12 \text{ m}^{-1})x + (600 \text{ s}^{-1})t],$$
find the position of the node with $x > 0$ which is closest to $x = 0$.
- F) Suppose another *almost* identical string has a standing wave on it as described by the equation

$$y' = (8.0 \text{ mm}) \sin (12 \text{ m}^{-1}x) \cos (603 \text{ s}^{-1} t).$$

What beat frequency would you hear from sound produced by these two vibrating strings?

Score

1-7	(35)	_____
8	(20)	_____
9	(15)	_____
10	(20)	_____
11	(25)	_____
Total	(115)	_____