

Name (be extremely neat) _____

UVA email handle (for example XXX5Y) (be extremely neat) _____
(Do not write your ID# on this test. There's a good reason for this.)

PHYS 106
University of Virginia
Midterm Exam, February 27, 2002

Useful information:

$$g = 9.8 \text{ m/s}^2 = 32 \text{ ft/s}^2 = 22 \text{ mph/s}$$

Make sure you have 35 questions.

Multiple Choice. Signify the one best answer by putting a CAPITAL letter in the margin of this test, and ALSO filling in the bubble sheet. Do not write in the margin of the bubble sheet.

1. My name and UVA email handle above are unbelievably neat. A grizzly bear could read them from 50 yards.

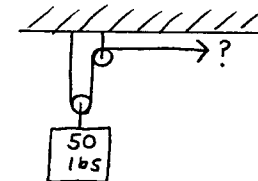
On the bubble sheet, I have bubbled in my ID#, all nine digits. I understand I will **LOSE 2 POINTS** if I fail to do this.

I have written my name on the bubble sheet.

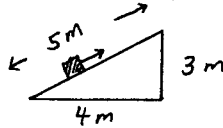
I will answer every multiple choice question. No penalty for guessing!

(a) true

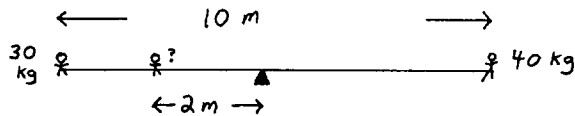
2. Which of the following is NOT a correct statement of the Law of Inertia (also known as Newton's First Law of Motion)?
- (a) Objects maintain their motion unless acted on by an outside force.
 - (b) All objects have mass, or "stubbornness", and therefore want to go in a straight line at constant speed.
 - (c) In order to keep an object moving at a constant velocity, an outside force must act upon it.
3. Which of the following statements about motion is NOT true?
- (a) It is possible to perform an experiment to distinguish between being *at rest* and *moving at a constant velocity*.
 - (b) It is possible to perform an experiment to distinguish between *undergoing acceleration* and *moving at a constant velocity*.
 - (c) Moving in a straight line while gaining speed constitutes acceleration.
 - (d) Moving in a circle, at constant speed, constitutes acceleration.
4. You go to The Lawn and throw a baseball vertically upward. It takes three seconds from the moment it leaves your hand to reach the top of its flight. Assuming air resistance is negligible, the ball left your hand with a speed of
- (a) 9.8 meters per second
 - (b) 19.6 meters per second
 - (c) 29.4 meters per second
 - (d) 58.8 meters per second
5. In an experiment done in class, two identical small steel balls were used. One was released and fell vertically. The other was launched horizontally at the same time and from the same height above the floor. What happened and why?
- (a) The vertically-falling one hit the ground first, because it had a shorter distance to travel.
 - (b) The horizontally-launched one hit the ground first, because it had a greater total speed.
 - (c) They hit the ground at the same time, because the greater distance travelled by the horizontally-launched ball was overcome by a larger gravitational acceleration.
 - (d) They hit the ground at the same time, because the greater distance travelled by the horizontally-launched ball was overcome by a greater total speed.
6. In the following experiment, assume negligible friction in the pulleys. The 50-lb weight is lifted at constant speed. With what force must you pull on the end of the string?
- (a) $16 \frac{2}{3}$ lbs
 - (b) 25 lbs
 - (c) 50 lbs
 - (d) 100 lbs
 - (e) 150 lbs



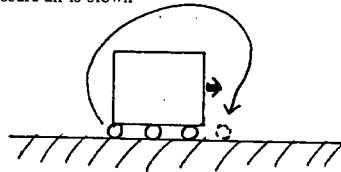
7. When the student volunteer was lifted in the chair by the rope and pulley system
- she went about 1 foot up, and then her hat fell off
 - she accidentally kicked the other volunteer in the face, and he let go of the rope
 - she went about 5 feet up, and hit the TV stand with her head
 - she went more than 5 feet up
8. Consider the ramp shown, with dimensions as indicated. If the ramp has negligible friction, what force must be exerted on the string to pull the 8-kg mass at constant speed?



- 47.04 Newtons
 - 58.8 Newtons
 - 62.72 Newtons
 - 78.4 Newtons
 - 130.67 Newtons
9. Within any object thrown across a room, there is a special point which will follow the same parabolic path that a point mass would under the same conditions. This point is called _____. In class this was demonstrated with _____.
- the center of torque; a piece of styrofoam with red and green lights
 - the center of mass; a piece of styrofoam with red and green lights
 - the mechanical center; a basketball with blue and orange streamers attached
 - the center of torque; a basketball with blue and orange streamers attached
 - the center of mass; a basketball with blue and orange streamers attached
10. Consider an ordinary seesaw with negligible friction at the pivot. It is a total of 10 meters long. With no children on it, it is perfectly balanced. With a 40-kg child on the right end and a 30-kg child on the left end, it is no longer balanced. However, you notice that a third child hops on and moves around until the seesaw is once again balanced. At that moment, the third child is 2-meters from the pivot. What must be the mass of that child?



- 10-kg
 - 12-kg
 - 15-kg
 - 18-kg
 - 25-kg
11. An easy way to move something across a room (a refrigerator for example) is to use a few metal dowels (cylinders). You place the object on top of the dowels, and roll the object on the dowels until it rolls off the back one. Then you move the back one to the front and continue this across the room. Very little energy is lost because only static friction is employed. The modern equivalent using the same principle is
- sliding the object with low-friction grease coated on the surfaces
 - a ball bearing axle
 - a surface with small holes through which high-pressure air is blown
 - a magnet hovering above a superconductor



12. You decide to climb all the stairs to the top of the Washington Monument. Suppose there are 672 steps, each with a vertical height of 0.25 meters. If your mass is 65 kg, how much work do you do in climbing? If it takes you exactly 10 minutes to do this, what is your average power output? [Pick the closest numbers.]
- 93,000 Joules; 9300 Watts
 - 11,000 Joules; 17 Watts
 - 12,000 Joules; 20 Watts
 - 39,000 Joules; 57 Watts
 - 107,000 Joules; 178 Watts
13. In class, when a two-liter soda bottle was partially filled with Aqua-Net hairspray
- the hairspray was ignited, to show conservation of momentum on a guiding string
 - the sealed bottle sank in a bucket of water, but floated in liquid nitrogen
 - the sealed bottle sank in liquid nitrogen, but floated in water
 - the bottle became magnetic, even though it's not magnetic without the hairspray inside
 - the escaping hairspray created a low frequency sound, close to 440 Hertz
14. Consider the collision between two identical carts on an air track. Each car has the same speed, but they are heading towards each other. Because of Velcro, the two cars are stuck together after the collision. During this collision
- the momentum of the carts is conserved, but the kinetic energy of the carts is not
 - the kinetic energy of the carts is conserved, but the momentum of the carts is not
 - both the momentum of the carts and the kinetic energy of the carts is conserved
 - neither the momentum of the carts nor the kinetic energy of the carts is conserved
15. The angular momentum of a system is conserved if
- there are no outside forces on the system
 - there are no outside torques on the system
 - all the surfaces in relative motion are frictionless
 - gravitational potential energy is constant
 - all the rotation angles are less than 90 degrees
16. Imagine sitting on a freely rotating (swiveling) stool with your entire body, including your feet, not touching the floor. You hold in one hand a bicycle wheel mounted on an axle, with the axis of the wheel along a line from the floor to the ceiling. As viewed from above, you use your other hand to start the bicycle wheel turning clockwise. What will happen?
- You will begin turning counterclockwise, and you'll stop when you stop the wheel.
 - You will begin turning counterclockwise, and you'll continue turning even when you stop the wheel.
 - You will also begin turning clockwise, because angular momentum must be conserved.
 - Nothing will happen to you, because there is no source of angular momentum unless your feet are able to push off against the floor.
 - Nothing will happen to you, because there is no external source of energy for the system.

17. Consider an ordinary 2 x 4 inch piece of wood, resting on a pivot so it's free to rotate. You bring a negatively charged plastic rod near one end. Which of the following is true about such an experiment?

- (a) If the wood has no net charge, it will be attracted to the rod and begin to rotate towards the rod.
- (b) If the wood has no net charge, it will be repelled from the rod, and begin to rotate away from it.
- (c) Only if the wood has an overall net charge will it feel a force from the rod, and the direction depends on the sign of that net charge. If the wood has no net charge, it will not feel a force, and remain at rest.
- (d) Only if the wood has an overall net charge will it feel a force from the rod, but the direction does not depend on the sign of that net charge. If the wood has no net charge, it will not feel a force, and remain at rest.

18. The purpose of a lightning rod is to

- (a) provide a place for lightning to strike, and works because charge builds up at sharp points on a conductor
- (b) provide a place for lightning to strike, and works because very little charge builds up at sharp points on a conductor
- (c) prevent lightning strikes from occurring, and works because charge builds up at sharp points on a conductor
- (d) prevent lightning strikes from occurring, and works because very little charge builds up at sharp points on a conductor

19. An ice skater is spinning on an ice rink with her arms extended. When she pulls her arms in

- (a) she will spin faster, because her angular momentum is increasing
- (b) she will spin faster, because her moment of inertia is increasing
- (c) she will spin faster, because her moment of inertia is decreasing
- (d) she will spin slower, because her angular momentum is increasing
- (e) she will spin slower, because her moment of inertia is increasing

20. The heart of a xerographic copier is the photoconductor. When an image of an original document is focused on the photoconductor

- (a) charge is created where the original was white
- (b) charge is created where the original was dark
- (c) charge is removed where the original was white
- (d) charge is removed where the original was dark
- (e) toner particles are created through a chemical reaction, and only where the original was dark

21. If all the parts of a xerographic copier are working properly except the fuser

- (a) the copies will look normal, but will smear when touched
- (b) the copies will be normal, but will not be ordered (collated) correctly
- (c) no copies will be made at all—the output will just be white paper
- (d) the copies will have all the printing inverted
- (e) the copies will have all the letters printed too large, so that only the center portion of the original will appear

22. A small fan is mounted to the top of a cart that is able to roll without friction along a level track (in our classroom for example). If the cart begins at rest, and the fan is switched on, the cart will

- (a) move with constant velocity, and this experiment will work on the Moon
- (b) move with constant acceleration, and this experiment will work on the Moon.
- (c) move with constant velocity, and this experiment will not work on the Moon.
- (d) move with constant acceleration, and this experiment will not work on the Moon.

23. In the device shown below, a small globe containing a magnet is suspended against its own weight by another magnet above it. This works because

- (a) the top magnet is a permanent magnet, chosen to have exactly the same strength as the one in the globe
- (b) the top magnet is an electromagnet, and is pre-set to the correct strength and then left alone
- (c) the top magnet is an electromagnet, with its strength continually adjusted by a feedback mechanism
- (d) the top magnet is a superconducting magnet, and must be cooled with liquid nitrogen

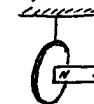


24. Consider a helix of wire wrapped in the shape of a cylinder (also known as a solenoid). If you insert a magnet inside and pull it out suddenly

- (a) an electric current will be induced in the wires only if they are made of an iron compound, and the direction of the current will reverse if you flip the poles of the magnet
- (b) an electric current will be induced in the wires only if they are made of an iron compound, and the direction of the current will stay the same if you flip the poles of the magnet
- (c) an electric current will be induced in the wires even if they are made of copper (which is non-magnetic), and the direction of the current will reverse if you flip the poles of the magnet
- (d) an electric current will be induced in the wires even if they are made of copper (which is non-magnetic), and the direction of the current will stay the same if you flip the poles of the magnet

25. Consider a ring made of aluminum, which is a conductor but non-magnetic. It is suspended from a string, and a magnet is inserted. When the magnet is suddenly removed

- (a) the ring will follow the magnet
- (b) the ring will move away from the magnet
- (c) the ring will do nothing since it's non-magnetic



26. A house is wired

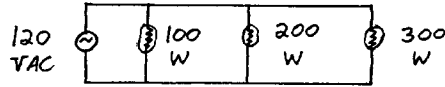
- (a) in parallel, so the voltages across all the devices in use are the same
- (b) in parallel, so the current through all the devices in use is the same
- (c) in series, so the voltages across all the devices in use are the same
- (d) in series, so the current through all the devices in use is the same

27. An ordinary 9-volt battery used in many transistor radios actually contains

- (a) a single 9-volt cell
- (b) two 4.5-volt cells
- (c) three 3-volt cells
- (d) six 1.5-volt cells
- (e) nine 1-volt cells

28. In the circuit shown, what is the total current supplied by the 120-volt source?

- (a) 0.2 Amps
- (b) 2.5 Amps
- (c) 3.5 Amps
- (d) 5.0 Amps
- (e) 6.5 Amps



29. A "step-down" transformer converts _____ and has more turns at the _____.

- (a) DC to AC; primary
- (b) AC to AC; primary
- (c) DC to AC; secondary
- (d) AC to DC; secondary
- (e) AC to AC; secondary

30. In order to transmit electric power over long distances, it is best to

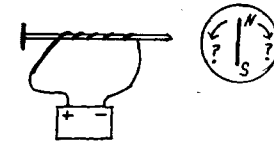
- (a) step-up the voltage at the beginning and step it down at the end; this gives low current through the middle
- (b) step-down the voltage at the beginning and step it up at the end; this gives low current through the middle
- (c) step-up the voltage at the beginning and step it up again at the end; this gives high current through the middle
- (d) step-down the voltage at the beginning and step it down again at the end; this gives high current through the middle
- (e) step-up the voltage at the beginning and step it down at the end; this gives high current through the middle

31. An ordinary loudspeaker uses

- (a) two permanent magnets, and can move only in (from the room towards the speaker cabinet)
- (b) two electromagnets, and can move both in and out
- (c) one permanent magnet and one electromagnet, and can move both in and out
- (d) one permanent magnet and one electromagnet, and can move only in
- (e) one permanent magnet and one electromagnet, and can move only out

32. Consider the electromagnet shown, consisting of wire wrapped around an iron nail. Which pole of the compass will the nail attract? Will the electromagnet still work without the iron nail?

- (a) the North pole; no
- (b) the South pole; no
- (c) the North pole; yes, but it will be weaker
- (d) the South pole; yes, but it will be weaker



33. The device in a DC motor which reverses the current direction is known as a(n)

- (a) reverberator
- (b) transformer
- (c) commutator
- (d) alternator
- (e) direct alternator

34. The magnetic tracks on an ordinary home video recorder (VHS) are slanted because

- I. There is a limit to how small the gap in the recording head can be made.
- II. To make the linear speed of the tape through the machine reasonably small.
- III. Much more information per second must be recorded than in an audio cassette recorder.

- (a) I only
- (b) I and III
- (c) II only
- (d) II and III
- (e) I, II and III

35. Which of the following circuits will send positive charge to the left side of the capacitor, during every part of the AC cycle?

