Mid-Term Test

October 26, 2005 – Version B

Student Number: _____ Last Name: _____ First Name: _____ .

This test has 7 pages. The test should take no longer than 110 minutes. You may use a calculator and one 5"×3" index card with your own hand-written notes, if you wish. Good luck!

Multiple Choice:	/18
Written:	/21
Total:	/39

Multiple Choice Part (1 point per question)
Please fill your answers in on the provided bubble-sheet. Be sure to fill in the identifying information on the top. Contrary to the marking instructions *you may use pen or pencil* for the form. Ignore the box that says "Mark in Answer Sheet Number". IMPORTANT: There are multiple versions of this test. On your bubble sheet, please fill in **B** in the little pink box labelled FORM.

1. A rock is dropped from a great height. Ignore air resistance. If the acceleration due to gravity is 9.8 m/s^2, then after 3.0 s the rock's speed is
   A) 44.1 m/s
   B) 9.8 m/s^2
   C) 88.2 m/s
   D) 29.4 m/s

2. A carnival has a game which supposedly measures strength. When you pound on one end of a lever with a giant hammer, the lever tosses a metal ball up a tall, vertical track toward a bell located 15 feet above you. As the ball rises upward on the frictionless track, it experiences
   A) a constant upward force that depends only on the inertia of the ball as it rises toward the bell.
   B) no upward forces.
   C) an upward force that decreases steadily, but yet remains substantially greater than zero even when the ball hits the bell.
   D) an upward force that decreases steadily and reaches zero exactly at the moment the ball hits the bell.

3. You are standing on an elevator which is moving down at a constant velocity. Your apparent weight while descending is
   A) less than your actual weight.
   B) greater than your actual weight.
   C) equal to the net force on your body.
   D) exactly the same as your actual weight.

4. A car increases its speed from 30 km/hr to 60 km/hr. What happens to its kinetic energy?
   A) It increases by a factor of 2.
   B) It increases by a factor of 4.
   C) No change
   D) Not enough information is given to determine.

5. When a modern car crashes into a tree and comes to an abrupt stop, the driver's face and chest collide with an air bag rather than with the steering wheel. The driver's chances of serious injury are reduced by hitting the air bag rather than the steering wheel because the driver transfers

A) the same amount of momentum to the air bag as he would to the steering wheel, but he does it with smaller force due to the air bag.

B) more momentum to the air bag than he would to the steering wheel.

C) the same amount of momentum to the air bag as he would to the steering wheel, but he does it with larger force due to the air bag.

D) less momentum to the air bag than he would to the steering wheel.

6. When you jump while standing on a bathroom scale, it briefly reads more than your actual weight. During that moment, it's exerting an upward force on you that is greater than your weight and

A) your velocity is constant but upward.

B) your velocity is constant but downward.

C) you are accelerating downward.

D) you are accelerating upward.

7. As you ride on a merry-go-round, you feel a strong outward pull that feels just like the force of gravity. This fictitious force occurs because

A) you are accelerating away from the center of the merry-go-round and experience a fictitious force in the direction of your acceleration.

B) your velocity is toward the center of the merry-go-round and you experience a fictitious force in the direction opposite your velocity.

C) your velocity is away from the center of the merry-go-round and you experience a fictitious force in the direction of your velocity.

D) you are accelerating toward the center of the merry-go-round and experience a fictitious force in the direction opposite your acceleration.

8. You have always wondered how much one of your friends weighs and devise a scheme to measure his weight secretly. You have him sit in a tubular steel chair. This popular style of chair consists of a single steel tube that is bent into a frame and that supports a seat bottom and a back. The empty chair weighs 30 Newtons and is 30 cm tall. The frame acts as a spring and bends downward slightly when the chair is occupied. When you sit properly in the chair yourself, it bends downward 2 cm. When your friend sits properly in the chair, it bends downward 1 cm. From that observation, you know that your friend weighs about

A) half as much as you do.   B) 300 Newtons.

C) 150 Newtons.   D) twice as much as you do.

9. You are sitting on a park bench while your dog walks at the end of a spring-loaded leash. This leash emerges from a plastic container with a handle and can extend up to 5 metres if the dog pulls on it hard enough. As the leash extends outward, a spring in the container stretches. When the dog stops pulling, that spring then retracts the leash back into the container. As the dog pulls the leash outward, stretching the spring, she does work on the leash. During which metre of extension does the dog do the most work on the leash?

A) During the first metre—when the leash first begins to extend.

B) During the third metre—when the leash is at the middle of its extension.

C) During the fifth metre—just before the leash is fully extended.

D) The work the dog does is the same during each of the five metres of extension.

10. A fish floats motionless below the surface of a lake. What is the direction and amount of force the water exerts on it?
A) Zero
B) Up, equal to weight
C) Down, equal to weight
D) Not enough information is given to determine.

11. A capped plastic bottle is filled with water. Inside the bottle it is a glass vial with an open end, floating upside down. The glass vial is suspended by an air bubble inside it. When you squeeze the bottle,
A) there will be no noticeable effect on the vial.
B) the bubble will shrink in volume, decreasing the upward force on the vial.
C) the pressure in the bottle will increase, increasing the upward force on the vial.
D) the vial will flip over and sink.

12. A block of hardwood is floating easily on the surface of a lake. As a storm approaches, the density and pressure of the air above the lake begin to decrease. As a result of this decrease in air pressure and density, the block of wood
A) continues to float just as it did before.
B) moves upward slightly and floats higher in the water.
C) moves downward slightly and floats lower in the water.
D) sinks to the bottom of the lake.

13. Soil heats up much faster than water when the two are exposed to sunlight. Use that fact and your understanding of heat transfer to predict which way the wind will blow near the surface of the earth as the sun rises near the seashore.
A) The surface wind will blow from the land toward the water.
B) The surface wind will blow alternately back and forth along the shore, parallel to the boundary between land and water. It will reverse directions every few minutes.
C) The surface wind will blow from the water toward the land.
D) The surface wind will blow steadily in one direction along the shore, parallel to the boundary between land and water.

14. You are choosing the filament for a light bulb and want it to emit visible light as efficiently as possible when it becomes very hot. You should make that filament
A) shiny like a mirror.   B) white.
C) black.   D) gray.

15. A pedestrian bridge crosses a street. This bridge is entirely supported by columns from below. A gap at each end of the bridge separates the bridge's surface from the sidewalks leading to the bridge. The width of each gap changes with time. This width is smallest
A) at midnight.   B) on hot days.
C) at noon.   D) on cold days.

16. It is a warm summer day and you are having lunch outdoors on a patio. A window air conditioning unit hums quietly nearby as it cools an office inside the building. Your friend notices that the unit's outdoor part is emitting a considerable amount of heat and comments on how strange that is. You explain correctly that the air conditioner's outside part is emitting the heat

A) it produces from the electricity it consumes.

B) it removes from the inside air and the heat it produces from the electricity it consumes.

C) that is left over when it converts thermal energy from the inside air into electricity.

D) it produces during its defrost cycle; when it warms up its evaporator to remove ice that forms because of the humidity.

17. Two tones which are one octave apart differ in frequency by a factor of

A) 2   B) $2^{1/2}$ C) 3/2   D) 4

18. To improve a xylophone's appearance, the orchestra director decides to have it painted. Each xylophone bar is actually a harmonic oscillator that vibrates when struck by a wooden mallet. Painting the bar adds mass to the bar without affecting its stiffness, so the paint will

A) not affect the pitch or sound volume of the bar.

B) lower the bar's pitch.

C) raise the bar's pitch.

D) not affect the pitch of the bar, but will reduce its sound volume.

Written Answer Part

Please answer the following questions. Show all your reasoning and work legibly in the space provided, and draw a box around the final numerical or single-word answer where applicable. You may use the back of the page to continue an answer if needed, but be sure to indicate on the front that your answer is continued, and on the back which question you are continuing.

19. **(3 points)** Due to the gears on your bicycle, when you press the pedal with your foot, the pedal moves down a distance of 0.3 m as the bicycle is pushed forward a distance of 2.7 m. If the downward pushing force on the pedal is equal to 500 Newtons, and you and the bicycle have a combined mass of 100 kg, what is the acceleration of you and the bicycle?

20. (**2 points**) A common bolt-cutter has a long handle where you apply force far from the pivot, and short cutting blades, which cut the bolt or lock close to the pivot. When cutting a piece of metal,

    a. compare the torque applied to the handle to the torque applied to the piece of metal.

    b. compare the force applied to the handle to the force applied to the piece of metal.

21. (**2 points**) A ball is being swung at the end of a string in a horizontal circle. The sketch shows the ball and string as viewed from above. The dashed line represents part of its circular path. The ball is moving in the counter-clockwise direction in this sketch.

    a. Please add to the sketch an arrow, labelled "F", showing the direction of the centripetal force on the ball at the instant shown in the sketch.

    b. Imagine the string breaks at this instant. Please add to the sketch an arrow which indicates the direction the ball would go without the force from the string. You need not label this second arrow.
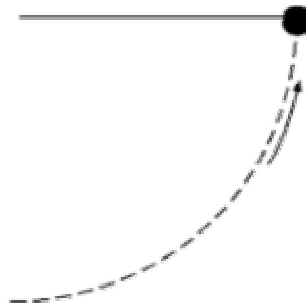
22. (**3 points**) A limestone sculpture of a dolphin normally sits at the edge of a swimming pool. One day it accidentally falls into the pool and sinks to the bottom. In the outside air, the sculpture weighs 400 Newtons. If you hold your breath and swim to the bottom, how much force will it take to lift the sculpture up when it is completely submerged in the water? Assume that the density of limestone is 2.5 times that of water.

23. (**3 points**) It is dinner time so you go to your electric stove and turn on the heating element, which glows red after a couple of minutes. You then place a glass pot of water on the heating element, and drop some noodles into the water. Briefly describe all the ways that heat can be carried from the heating element to the noodles.

24. (**3 points**) If you stretch a rubber band between you fingers and pluck it, it will vibrate and emit a tone. If you now stretch that rubber band to twice its original length and pluck it again, it will emit almost the same tone. Why doesn't the rubber band's pitch change very much when you stretch it?

25. **(5 points)** Please answer ONE OF the following two long questions (choose one). Circle the question you have chosen to answer.

Question A. Every object has weight, so why do some balloons go down when you release them, and some go up? How is the net force on a balloon calculated, and what is the physical cause of the upward force? Compare Helium balloons and Hot Air balloons. How does the mass density and particle density compare inside and outside each of these types of balloons?

Question B. What important forces and torques act on various parts of a car when it is accelerating away from a stop-sign? If the car gains kinetic energy as it accelerates, why doesn't this violate "conservation of energy"? Discuss what a "heat engine" is, and how it relates to the actual engine in a car. When heat energy is converted to motion, how is the total entropy of the system affected?