Student #: _____ Student Name: _____

Physics 11 (Take-Home) Midterm Test

The is an open-book test, i.e. you are allowed to use any class material from Olympiads to help you. There are seven mandatory questions; mark values for each question are shown on the question. There are also two bonus questions. The maximum mark you can get is 115 out of 100. Try the easier questions first. Draw FBDs and/or diagrams whenever necessary. Calculators are allowed. Double check your answers for appropriate number of significant figures. **Please put a box around your final answer.**

Total mark:

/100

1. **[12 points]** A girl takes her dog for a walk. She walks $5.0\,\text{km}$ [N] and then turns left and walks another $12\,\text{km}$ [W].
   (a) What is the total distance that they travelled?
   (b) What is their displacement?
   (c) What displacement would they need in order to return to their starting point?

2. **[15 points]** A car is travelling on the highway at a constant speed of $90\,\text{km/h}$. The absented-minded driver misses the posted speed limit sign for a small town she is passing through. A police car that is stopped next to the sign accelerates immediately from rest at $3.5\,\text{m/s}^2$. From the time that the speeder passes the police car,
   (a) How long will it take the police car to catch up the speeder?
   (b) What distance will the cars travel in that time?
   (c) What is the speed of the police car when it catches up to the speeder?

3. **[16 points]** A physics teacher is on the west side of a small lake and wants to swim across and end up at a point directly across from his starting point. He notices that there is a current in the lake and that a leaf floating by him travels $4.2\,\mathrm{m}$ [S] in $5.0\,\mathrm{s}$. He is able to swim $1.9\,\mathrm{m/s}$ in calm water.
   (a) What direction will he have to swim in order to arrive at a point directly across from his position?
   (b) Calculate his velocity relative to the shore.
   (c) If the lake is $4.8\,\mathrm{km}$ wide, how long, in seconds, will it take him to cross?

4. **[12 points]** A piano technician slides a Steinway grand piano across a level floor at Carnegie Hall. The piano has a mass of $490\,\mathrm{kg}$.
   (a) Draw a free-body diagram, and calculate the normal force supporting the piano.
   (b) If the coefficient of static friction between the floor and the piano is 0.35, calculate the minimum amount of force needed to get the piano to move.
   (c) Once the piano is moving, a horizontal force of 1.1×10^3 N is necessary to keep it moving at a constant speed. Determine the coefficient of kinetic friction.

5. **[10 points]** I let go of a piece of bread from a balcony. A bird flying $5.0\,\mathrm{m}$ overhead sees me drop it, and starts to dive straight down towards the bread the instant I release it. She catches it after it falls $3.0\,\mathrm{m}$. Assuming she accelerates constantly from rest ($v_0 = 0$) at the time I let go of the bread, what is her acceleration?

6. **[15 points]** You are pushing a $53\,\mathrm{kg}$ crate at a constant velocity up a ramp onto a truck. The ramp makes an angle of 22° with the horizontal. If your applied force is $373\,\mathrm{N}$, what is the kinetic coefficient of friction between the crate and the ramp? Include a free-body diagram with your answer.

7. **[20 points]** There are 10 multiple-choice question in this part.

_____ 7.1. If a baseball and a cannonball are dropped from the same height at the same time, which ball will hit the ground first?

(a) The cannonball
(b) The baseball
(c) The balls land at the same time
(d) The ball with the larger volume

_____ 7.2. If an action force is created when a cue ball (white) hits another billiard ball (various colours) when playing pool, then the reaction force is

(a) Exerted on the table.
(b) Exerted on all the other billiard balls.
(c) Not present.
(d) Exerted by the billiard ball on the cue ball.

_____ 7.3. According to Newton's first law of motion, a moving object that is not acted on by an unbalanced force will

(a) Remain in motion.
(b) Change its momentum.
(c) Eventually come to a stop.
(d) Accelerate.

_____ 7.4. An ice skater at rest pushes against a sled at rest, causing both the skater and sled to move away from each other. This is an example best described by

(a) Newton's first law of motion for objects at rest.
(b) Newton's first law of motion for objects in motion.
(c) Newton's second law of motion.
(d) Newton's third law of motion.

_____ 7.5. Which of the following explains the difference between speed and velocity?

(a) One has motion, and the other does not.
(b) One has direction, and the other does not.
(c) One involves time, and the other does not.
(d) One involves acceleration, and the other does not.

_____ 7.6. The gravitational pull is greater between two objects that

(a) have greater masses.
(b) are farther apart.
(c) have rougher surfaces.
(d) are moving at greater speeds.

_____ 7.7. If a force of $26\,\mathrm{N}$ is exerted on two balls, one with a mass of $0.52\,\mathrm{kg}$ and the other with a mass of $0.78\,\mathrm{kg}$, which ball will have the greater acceleration?

(a) The one with a mass of $0.78\,\mathrm{kg}$ will have the greatest acceleration.
(b) The one with a mass of $0.52\,\mathrm{kg}$ will have the greatest acceleration.
(c) They will both accelerate at the same rate.
(d) Neither will accelerate.

_____ 7.8. Mass and weight

(a) both measure the same thing
(b) are exactly equal
(c) are two different quantities
(d) are both measured in kilograms

_____ 7.9. The acceleration due to gravity is lower on the Moon than on Earth. Which of the following is true about the mass and weight of an astronaut on the Moon's surface, compared to Earth?

(a) Mass is less, weight is same.
(b) Mass is same, weight is less.
(c) Both mass and weight are less.
(d) Both mass and weight are the same.

_____ 7.10. How does Newton's third law explain how a rocket takes off?

(a) The rocket's acceleration is positive, while the gasses acceleration is negative but the direction is the same. The motion is therefore both "equal and opposite"
(b) The rocket is at rest until ignition.
(c) The hot gasses move in one direction, while the rocket moves in the opposite direction but with equal force.
(d) The hot gasses cause global warming.

BONUS—The following are bonus questions—**BONUS**

8. **[5 points]** Crooked Olympic commissioners decide to buy and sell gold, hoping to set a new profit record. They conduct all their business in an elevator. They buy and sell at the same price per ounce, an archaic unit of force, which they measure with a vertical spring scale suspended from the ceiling. They always buy their gold when the elevator had a downward acceleration of $1.5\,\mathrm{m/s^2}$ and always sell it when the acceleration was $2.0\,\mathrm{m/s^2}$ upward. Evaluate their percentage profit, based on their buying price. Show a free-body diagram on the gold.

9. **[10 points]** Bob (mass $100\,\mathrm{kg}$) and Shelly (mass $50\,\mathrm{kg}$) are amateur stunt persons. They climb a $20\,\mathrm{m}$ pole pivoted at at ground, as shown in the figure. Shelly is at the very top, and Bob is exactly half way up. Unfortunately the pole falls over, starting from rest in the vertical position and swinging down through 90° about a friction-less fixed pivot point until it crashes onto the ground. Both Shelly and Bob hold on tightly and do not change their positions on the pole. Assume that the pole has a negligibly small mass but is still strong enough to stay straight as it falls. Calculate Shelly's speed just before striking the ground. Answer in $\mathrm{m/s}$.