Student #: _____ Student Name: _____

# Physics 11 Final Test (Take-Home)

**INSTRUCTIONS:** The is an open-book test, i.e. you are allowed to use any course material from Olympiads to help you. There are three sections in the exam; mark values for each question are shown beside the question. Try the easier questions first. Draw free-body diagrams and/or diagrams whenever necessary. In the first two sections, part marks may be awarded for partial solutions; **correct answers without showing work will not receive a passing mark.** Calculators are allowed. Please answer all questions to three significant figures. For clarity, please put a box around your final answer.

| Part A | Part B |
|---|---|
| /18 | /48 |
| **Part C** | **TOTAL** |
| /14 | /80 |

**PART A: Short Answer Questions**

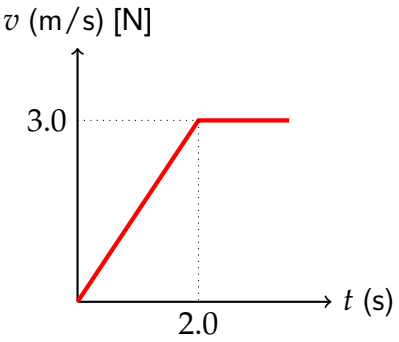
A1. **[6 marks]** State Newton's three laws of motion and, for each law, describe a *situation* that demonstrates its application.

A2. **[2 marks]** Describe an example to explain the difference between the definition of work used by physicists and that of the average "person on the street".

A3. **[2 marks]** Give *two* specific recommendations to race car designers based on Newton's second law of motion?

A4. **[2 marks]** Explain *how* you could determine the efficiency with which the mechanical energy of a ball bounce is conserved.

A5. **[6 marks]** The velocity vs. time graph below describes the motion of a car along a straight stretch of road. Provide qualitative information about the car's displacement, velocity and acceleration. Assume that the car started from the origin.




(a) Displacement:

(b) Velocity:

(c) Acceleration:

**PART B: Problem Solving**

B1. **[8 marks]** A receiver on a football team runs $43.5\,\text{m}$ [E] and then turns abruptly to run $9.0\,\text{m}$ [S]. If the entire motion takes $7.2\,\text{s}$, determine the receiver's:

(a) total distance travelled
(b) total displacement
(c) average speed
(d) average velocity

B2. **[8 marks]** Ms. Fizics pushed a large crate of textbooks ($125\,\text{kg}$) down the hall to her office. She pushed as hard as she could and the crate accelerated down the hall at a rate of $0.16\,\text{m/s}^2$. There was a coefficient of kinetic friction of $0.74$ between the crate and the floor.

(a) Draw a free-body diagram for the crate.
(b) Determine the net force on the crate.
(c) Determine the crate's normal force.
(d) Determine the force of friction on the crate.
(e) Determine the force exerted by Ms. Fizics.

B3. **[8 marks]** A $250\,\text{mL}$ cup of coffee is too cold to drink at $21\,^\circ\text{C}$, so it is poured into a $83.6\,\text{g}$ stainless steel container that had been previously heated up to $80\,^\circ\text{C}$. What is the final temperature of coffee? Assume that the cup and coffee are thermally insulated from its surroundings. The density of water is $1000\,\text{kg/m}^3$, and $1\,\text{m}^3 = 1000\,\text{L}$.

B4. **[8 marks]** A $55\,\text{kg}$ snowboarder (including equipment) heads down a ski hill starting at a height of $100\,\text{m}$, from an initial speed of $6.3\,\text{km/h}$ above the flat surface at the bottom. Determine the speed she could attain by the time she arrives at the bottom of the hill if there is no friction. If she only reaches a speed of $90\,\text{km/h}$, what was the energy lost to friction?

B5. **[8 marks]** A small high performance jet aircraft with a mass of $4500\,\text{kg}$, has *twin* jet engines. Each jet engine can develop $25\,500\,\text{N}$ of thrust.

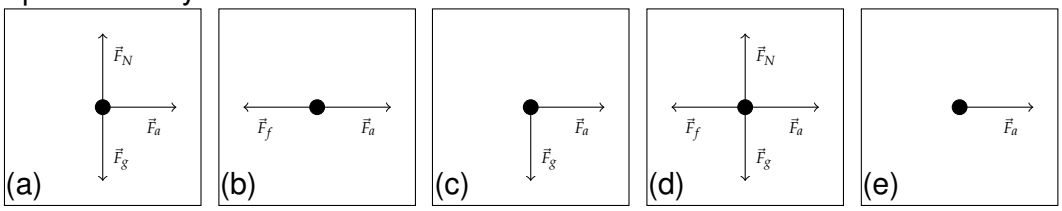
(a) What is the maximum acceleration the jet can sustain in a *vertical* climb?
(b) What is the distance travelled by the jet if it accelerates to a Mach number of $M = 3.0$ in a *horizontal* flight starting from $M = 0.4$, on a cool morning were the a temperature is $6\,^{\circ}\text{C}$? Assume that air resistance can be ignored.

B6. **[8 marks]** An organ technician is tuning an organ pipe that is supposed to produce a fundamental frequency of $440\,\text{Hz}$ at a temperature of $18.0\,^{\circ}\text{C}$, by adjusting the length of the pipe. The pipe is open on one end and closed at the other.

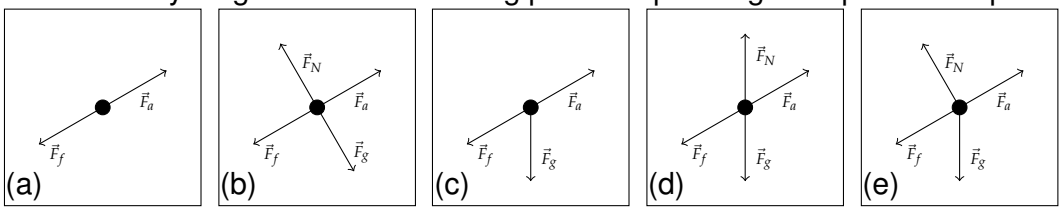
(a) How long is the organ pipe in order to produce the correct frequency at $18.0\,^{\circ}\text{C}$?
(b) The techncian's careless apprentice failed to notice that the concert hall was in fact a very cold $6.5\,^{\circ}\text{C}$. What is the length that the apprentice adjusted the pipe to produce the right frequency?
(c) The hall was finally warmed to $18\,^{\circ}\text{C}$. What is the wrong frequency that the organ pipe would now produce at this temperature?
(d) Draw a diagram to show the standing wave pattern of the pipe in its fundamental mode.

**PART C: Multiple Choice** (1 mark each)

_____ C1. The FBD of a wagon being pulled along a horizontal surface at a constant velocity is best at represented by




_____ C2. The free-body diagram of a block being pushed up a rough ramp is best represented by




_____ C3. A vector is different from a scalar because

(a) a vector has a number and a unit whereas a scalar has a number only.
(b) a vector has direction whereas a scalar does not have direction.
(c) a vector has mass whereas a scalar does not have mass.
(d) a vector measures speed whereas a scalar measures velocity.

_____ C4. Which of the following statements about motion graphs is *incorrect*?

(a) The slope of a position-time graph gives velocity.
(b) The slope of a velocity-time graph gives acceleration.
(c) The area under a velocity-time graph gives displacement.
(d) The area under a position-time graph gives velocity.

_____ C5. If a box has a weight of $1000$ N, its mass is:

(a) $1000$ kg
(b) $102$ kg
(c) $9800$ kg
(d) $1000$ kg [down]

_____ C6. A student lifts a $30$ kg box and carries it $15$ m across a classroom before setting it down on the floor again. The amount of work the student did is:

(a) $450$ J
(b) $4.4 \times 10^3$ J
(c) $46$ J
(d) $0$ J; no work done

_____ C7. If the amount of friction present in a moving machine decreases,

(a) the energy lost to heat decreases and the percent efficiency decreases.
(b) the energy lost to heat decreases and the percent efficiency increases.
(c) the energy lost to heat increases and the percent efficiency decreases.
(d) the energy lost to heat increases and the percent efficiency increases.

_____ C8. The force that ultimately lifts a basketball player upwards off the court in a slam-dunk jump is the:

(a) applied force
(b) tension
(c) torque
(d) normal force

_____ C9. A boy on a swing is pulled to a position $2.34\,\text{m}$ off the ground and released. At the fastest and lowest point of the swing the boy is $0.50\,\text{m}$ off the ground and travelling $3.0\,\text{m/s}$. The percent efficiency of this swing system is:

(a) $10\,\%$
(b) $25\,\%$
(c) $50\,\%$
(d) $70\,\%$

_____ C10. A ball is dropped from a height of $3.0\,\text{m}$. As it falls,

(a) its gravitational potential energy increases and its kinetic energy increases.
(b) its gravitational potential energy increases and its kinetic energy decreases.
(c) its gravitational potential energy decreases and its kinetic energy increases.
(d) its gravitational potential energy decreases and its kinetic energy decreases.

_____ C11. If done long enough, rubbing two sticks together can produce enough work to start a fire. If $150.0\,\text{J}$ of thermal energy is required to start the fire and the average frictional force between the sticks is $10.0\,\text{N}$, the distance the sticks must slide past one other is:

(a) $2.00\,\text{m}$
(b) $0.67\,\text{m}$
(c) $15.0\,\text{m}$
(d) $1500\,\text{m}$

_____ C12. The amount of energy used by a $60\,\text{W}$ light bulb in $1\,\text{h}$ is:

(a) $60\,\text{J}$
(b) $10\,\text{J}$
(c) $2.16 \times 10^5\,\text{eV}$
(d) $1.67 \times 10^{-2}\,\text{J}$
(e) $2.16 \times 10^5\,\text{J}$

_____ C13. Which of the following energy transformations best describes the operation of a battery powered flashlight?

(a) electrical energy $\rightarrow$ thermal energy $\rightarrow$ kinetic energy
(b) thermal energy $\rightarrow$ elastic potential energy $\rightarrow$ electrical energy
(c) radiant energy $\rightarrow$ electrical energy $\rightarrow$ chemical potential energy
(d) chemical energy $\rightarrow$ electrical energy $\rightarrow$ radiant energy

_____ C14. A person exerts a downward force on a $15\,\text{kg}$ curling stone resting on the ice. If the stone has experienced a normal force of $200\,\text{N}$ [up], how hard is the person pushing down?

(a) $0\,\text{N}$
(b) $53\,\text{N}$
(c) $147\,\text{N}$
(d) $200\,\text{N}$