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.

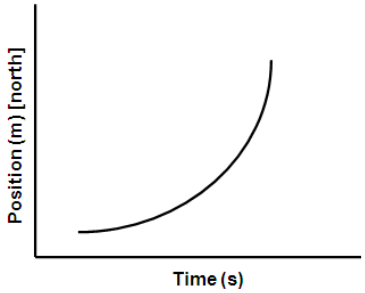
Part A	Part B
/22	/56
Part C	**TOTAL**
/22	/100

PART A: Short Answer Questions

A1. **[4 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]** Provide *two* pieces of information to describe the motion shown in the following graph, and give reasons to your conclusions.



1.

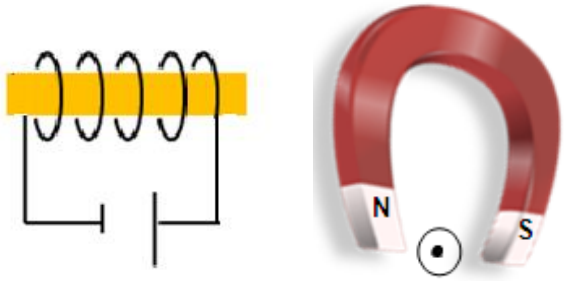
2.

A4. **[2 marks]** Give *two* specific recommendations to race car designers based on Newtons Second Law?

A5. **[2 marks]** Give the energy transformation *equation* for one complete ball bounce.

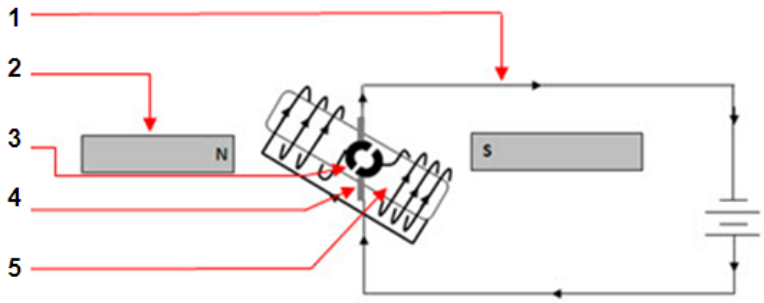
A6. **[2 marks]** Explain how you could determine the efficiency with which the mechanical energy of a ball bounce is conserved.

A7. **[1 mark]** Show the location of the north and south poles for the electromagnet below on the left side.



A8. **[1 mark]** Show the direction of force on the conventional current-carrying conductor on the above right figure.

A9. **[5 marks]** Label the parts of the DC motor.



A10. **[1 mark]** Which way, clockwise or counter-clockwise, will the motor in the previous question rotate?

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 $12.0\,\text{m}$ [S]. If the entire motion takes $9.5\,\text{s}$, determine the receiver's:

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

B2. **[10 marks]** Ms. Fizics pushed a large crate of textbooks $(65\,\text{kg})$ down the hall to her office. She pushed as hard as she could and the crate accelerated down the hall at a rate of $0.23\,\text{m/s}^2$. There was a coefficient of kinetic friction of 0.48 between the crate and the floor.

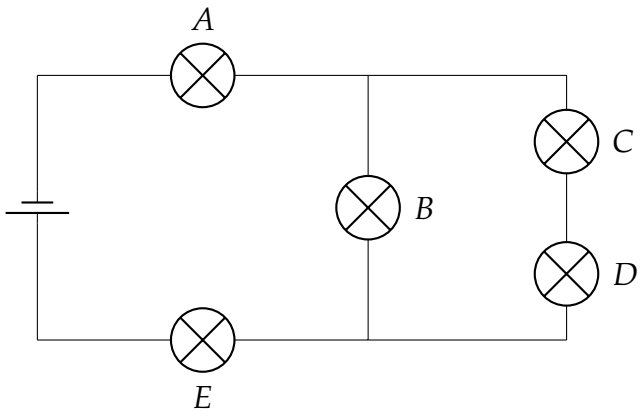
(a) Draw a free-body diagram for the crate.
(b) Determine the net force on the crate.
(c) Determine the crate's normal force.
(d) Determine the force of friction on the crate.
(e) Determine the force exerted by Ms. Fizics.

B3. **[8 marks]** A $125\,\text{mL}$ cup of coffee is too cold to drink at $21\,^\circ\text{C}$, so it is poured into an $83.6\,\text{g}$ aluminium container that had been previously heated up to $80\,^\circ\text{C}$. If the coffee and container end up at a temperature of $31\,^\circ\text{C}$, determine the specific heat capacity of aluminium. Assume the heat capacity and density of coffee are the same as water; and the cup and coffee are thermally insulated from the environment. The density of water is $1000\,\text{kg}/\text{m}^3$, 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 $1.75\,\text{m}/\text{s}$ above the flat surface at the bottom. Use the Law of Conservation of Energy to determine the speed she could attain by the time she hits the bottom of the hill if there is no friction. If she only reaches a speed of $90\,\text{km}/\text{h}$ what was the energy lost to friction?

B5. **[8 marks]** The diagram shown below is a mixed connection circuit. Use Kirchkoff's Law and fill in the following blanks:

	V (volts)	I (amperes)
Source	4.5 V	
Lamp E	2.0 V	2.0 A
Lamp B	1.5 V	
Lamp D		0.3 A
Lamp C	0.7 V	
Lamp A		



B6. **[8 marks]** A small high performance jet aircraft with a mass of $2850\,\text{kg}$, has twin jet engines. Each jet engine can develop $22\,500$ N of thrust.

(a) What is the maximum acceleration the jet can sustain in a vertical climb?

(b) How long would it take the jet to reach a Mach number of $M = 2.5$ (two and a half times the speed of sound) in a horizontal flight starting from $90\,\text{km/h}$? Ignore wind resistance and use the freezing point of water for the air temperature.

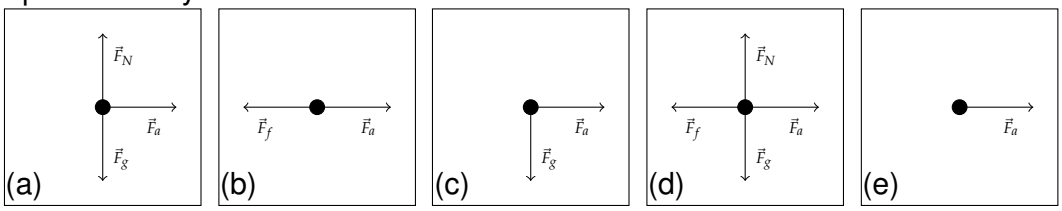
B7. **[6 marks]** A person uses a $512\,\text{Hz}$ tuning fork to find the first two resonant lengths of an old organ pipe (open on one end and closed on the other) in a very warm classroom ($30\,^\circ\text{C}$). The first length measured was $17.1\,\text{cm}$ and the second resonant length was $51.3\,\text{cm}$.

(a) Draw diagrams to show the standing wave pattern in each length and indicate the length in wavelengths.

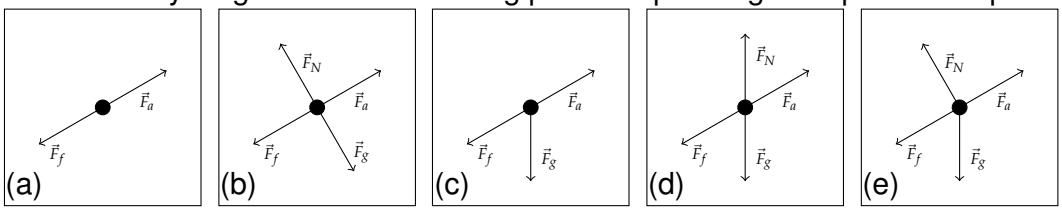
(b) Calculate the wavelength of the tuning fork at that temperature.

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) 4.4×10^3 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. If a $1.5\,\text{kg}$ chicken is running with a speed of $10.0\,\text{m/s}$, its kinetic energy is:

(a) $150\,\text{J}$
(b) $7.5\,\text{J}$
(c) $75\,\text{J}$
(d) $6.7\,\text{J}$

_____ C11. 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.

_____ C12. 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) $1500\,\text{m}$

_____ C13. 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) $2.16 \times 10^5\,\text{J}$

_____ C14. Which of the following energy transformations best describes the operation of a battery powered flashlight?

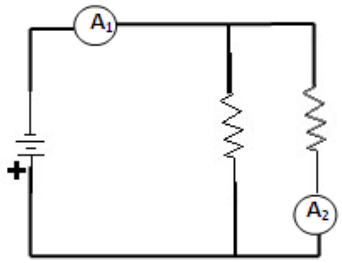
(a) electrical energy $\rightarrow$ thermal energy $\rightarrow$ kinetic energy
(b) thermal energy $\rightarrow$ elastic potential energy $\rightarrow$ electrical energy
(c) radiant energy $\rightarrow$ electrical energy $\rightarrow$ chemical potential energy
(d) chemical energy $\rightarrow$ electrical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

_____ C15. If two $100\,\Omega$ resistors are placed in *parallel*, their total resistance changes by what factor compared to the same two $100\,\Omega$ resistors placed in *series* with each other:

(a) the same
(b) twice
(c) half
(d) one quarter

_____ C16. How will the current in the first ammeter compare with the reading in the second?

(a) A_1 has a current reading while A_2 has a reading of zero.
(b) A_1 and A_2 are equal.
(c) A_1 is less than A_2.
(d) A_1 is greater than A_2.

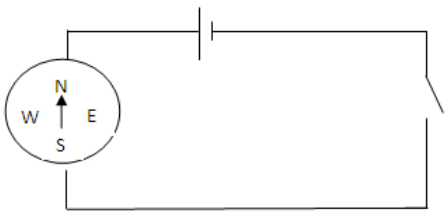


_____ C17. What is the direction of the magnetic field outside a bar magnet?

(a) Out of the north and off into space.
(b) Out of the south into the north.
(c) Out of the north into the south.
(d) Out of the south and off into space.

_____ C18. If the compass in the diagram below is placed directly *above* the conductor when the switch is closed, in what direction will the compass point?

(a) North
(b) South
(c) East
(d) West



_____ C19. In a single coil DC motor, when is the current direction in a coil reversed?

(a) after each 1/2 revolution
(b) after each 1/4 revolution
(c) after each 3/4 revolution
(d) after each revolution

_____ C20. When the cross-sectional area of a given length of copper wire increases, the resistance in the wire will:

(a) increase
(b) decrease
(c) stay the same
(d) change unpredictably

_____ C21. Which of the following substances would likely be most effective in cooling off a hot metal object?

(a) water
(b) cool honey
(c) warm honey
(d) vegetable oil

_____ C22. 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) $200\,\text{N}$