Charles Darwin University

Final Examination

Family Name						
Given Name/s						
Student Number						
Teaching Period	Semester 2, 2018					

SPH141 – Concepts of Physics	DURATION	
	Reading Time:	10 minutes
	Writing Time:	180 minutes

INSTRUCTIONS TO CANDIDATES

The examination has TWELVE questions. Please answer ALL questions.

Note that all questions ARE NOT of equal value.

The total marks of this examination are 55 marks.

EXAM CONDITIONS

You may begin writing from the commencement of the examination session. The reading time indicated above is provided as a guide only.

This is a RESTRICTED OPEN BOOK examination

Any non-programmable calculator is permitted

One A4 sheet of handwritten double-sided notes permitted

No dictionaries are permitted

ADDITIONAL AUTHORISED MATERIALS	EXAMINATION MATERIALS TO BE SUPPLIED
No additional printed material is permitted	1 x 20 Page Book 1 x Scrap Paper

THIS EXAMINATION IS PRINTED DOUBLE-SIDED.

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Question 1: **(4 marks)**

A proton is travelling horizontally to the right at 4.70×10^6 m/s.

(1) Find the magnitude and direction of the weakest uniform electric field that can bring the proton to rest over a distance of 3.50 cm. (2 marks)

(2) How long does it take for the proton to stop after entering the electric field? (2 marks)

Question 2: **(4 marks)**

A 5.50 g bullet is fired horizontally into a 1.20 kg wooden block resting on a horizontal surface. The coefficient of kinetic friction between block and surface is 0.25. The bullet remains embedded in the block, which is observed to slide 0.270 m along the surface before stopping. What was the initial speed of the bullet?

Question 3: **(6 marks)**

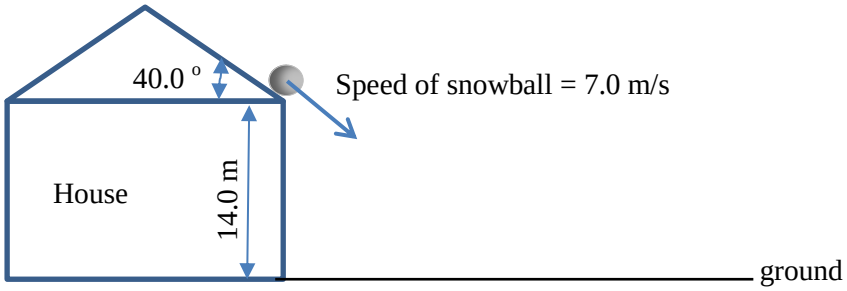
A 2.50 kg mass is pushed against a horizontal spring of force constant 31.0 N/cm on a frictionless air table. The spring is attached to the tabletop, and the mass is not attached to the spring in any way. When the spring has been compressed enough to store 20.0 J of potential energy in it, the mass is suddenly released from rest.

(1) Find the greatest speed the mass reaches and the time when it occurs. (3 marks)

(2) What is the greatest acceleration of the mass, and when does it occur? (3 marks)

Question 4: **(4 marks)**

A snowball rolls off the roof of a house that slopes downward at an angle of 40.0^o as shown in the figure below. The edge of the roof is 14.0 m above the ground. The snowball has a speed of 7.0 m/s when it rolls off the roof. How far horizontally from the wall of the house underneath the roof where the snowball rolling down will the snowball strike the ground if it doesn't strike anything else while falling? Ignore air resistance.



Question 5: **(3 marks)**

An object is placed between two plane mirror arranged at right angles to each other at a distance d_1 from the surface of one mirror and a distance d_2 from the surface of the other mirror. How many images are formed? Show the locations of the images in a diagram.

Question 6: **(6 marks)**

Wind turbines convert the kinetic energy of the wind into mechanical power, which can be used for grinding grain, pumping water or spinning a generator to create electricity. At the site of a wind farm in Australia, the average wind speed is 9.3 m/s and the average air density is 1.1 kg/m^3.

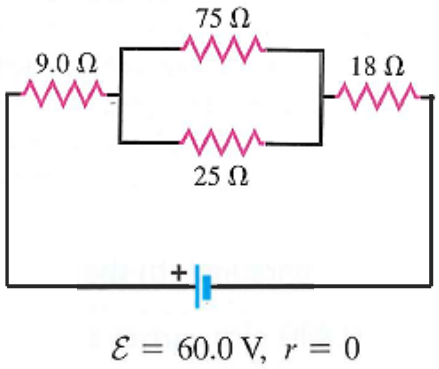
(1) Calculate how much kinetic energy the wind contains, per cubic meter, at this location. (3 marks)

(2) Wind turbine can only capture part of the energy contained in the wind. Suppose a particular turbine has blades with a radius of 41 m and is able to capture 38 % of the available wind energy. What would the power output of this turbine be, under average wind conditions? (3 marks)

Question 7: **(6 marks)**

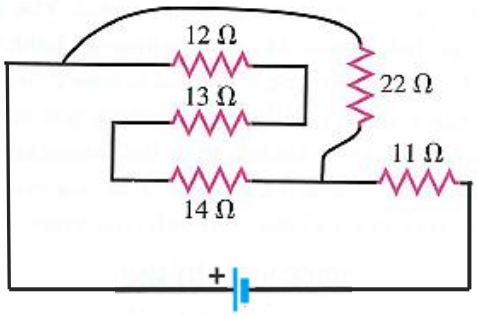
Find the equivalent resistance of each combination shown below and find the current in each resister.

(1)



(3 marks)

(2)



(3 marks)

Question 8: **(5 marks)**

A hollow plastic spherical ball is held below the water surface of a water tank by a cord anchored to the bottom of the tank. The ball has a volume of 0.65 m^3 and the tension in the cord is 900 N. The density of water is 1000 kg/m^3.

(1) Calculate the buoyant force exerted by the water on the plastic ball. (1.5 marks)

(2) What is the mass of the plastic ball? (1.5 marks)

(3) When breaking the cord, the plastic ball will rise to the surface. When the ball comes to rest, what fraction of its volume will be submerged? (2 marks)

Question 9: **(5 marks)**

Two small plastic spherical balls are given positive electric charges. When they are 10.0 cm apart, the repulsive force between them has a magnitude of 0.300 N. What is the charge on each plastic ball

(1) If the two charges are equal? (2.5 marks)

(2) If one ball has four times the charge of the other? (2.5 marks)

Constant k in Coulomb's Law = 8.99×10^9 N m^2 /C^2

Question 10: **(4 marks)**

You're holding a hose at waist height and spraying water horizontally with it. The hose nozzle has a diameter of 1.80 cm, and the water splashes on the ground a distance of 1.20 m horizontally from the nozzle. If you constrict the nozzle to a diameter of 0.750 cm; how far horizontally from the nozzle will the water travel before hitting the ground? Ignore air resistance.

Question 11: **(4 marks)**

While sitting in your car by the side of a road, you see your friend who is driving an identical car with an identical horn, approaching you. You blow your horn, which has a frequency of 260 Hz; your friend blows his horn as well and you hear a beat frequency of 6.0 Hz. How fast is your friend approaching you?

Tip: The speed of the sound is 344 m/s.

Question 12: **(4 marks)**

You are reviewing a design of an elevator. In this design, the elevator is supported by a steel cable. The mass of the elevator is 1350 kg. The designer used a steel cable with a cross-sectional area of 3.14 cm^2, which has an elastic limit of 2.70×10^8 Pa. According to the standard, the stress of the cable is not to exceed one-third of the elastic limit. Find the maximum upward acceleration that can be used for this elevator.

Fundamental Physical Constants*

Name	Symbol	Value
Speed of light in vacuum	c	2.99792458×10^8 m/s
Magnitude of charge of electron	e	$1.602176565(35) \times 10^{-19}$ C
Gravitational constant	G	$6.67384(80) \times 10^{-11}$ N·m^2/kg^2
Planck's constant	h	$6.62606957(29) \times 10^{-34}$ J·s
Boltzmann constant	k	$1.3806488(13) \times 10^{-23}$ J/K
Avogadro's number	N_A	$6.02214129(27) \times 10^{23}$ molecules/mol
Gas constant	R	8.3144621(75) J/(mol·K)
Mass of electron	m_e	$9.10938291(40) \times 10^{-31}$ kg
Mass of proton	m_p	$1.672621777(74) \times 10^{-27}$ kg
Mass of neutron	m_n	$1.674927351(74) \times 10^{-27}$ kg
Permeability of vacuum	μ_0	$4\pi \times 10^{-7}$ T·m/A
Permittivity of vacuum	$\epsilon_0 = 1/\mu_0 c^2$	$8.854187817\cdots \times 10^{-12}$ C^2/(N·m^2)
	$1/4\pi\epsilon_0$	$8.987551787\cdots \times 10^9$ N·m^2/C^2