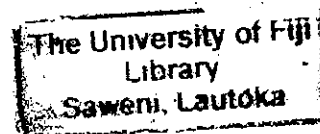




The University of Fiji

School of Science and Technology



PHYF12 Foundation Physics II

Final Examination 2012

Semester II

Time allowed: 3 hours

(Additional 10 minutes reading time)

Total marks: 100

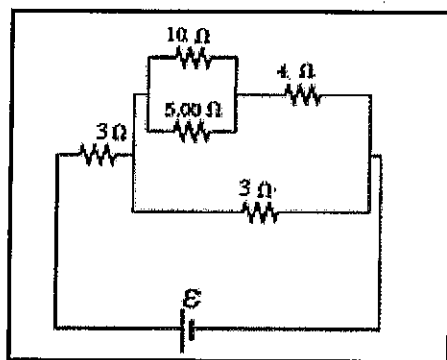
Instructions:

1. There are 8 pages.
2. There are two sections A and B.
3. **Section A** is **compulsory** and has 10 short answer questions (20 marks).
4. **Section B** is **compulsory** and has five questions – answer all (each question is worth 16 marks).
5. Answer each question on a new page of the answer booklet.
6. Candidates can use non programmable calculators.
7. Data: Acceleration due to gravity = 9.8 m s^{-2}
Coulomb's constant, $k = 8.99 \times 10^9 \text{ N m}^2\text{C}^{-2}$
Charge of electron, $e = 1.6 \times 10^{-19} \text{ C}$
Speed of light in vacuum, $c = 3.0 \times 10^8 \text{ m s}^{-1}$
Speed of sound, $v = 345 \text{ m s}^{-1}$

Section A: Answer ALL questions. (Each question is worth 2 marks)

[20 marks]

- a. A block-spring system undergoes simple harmonic motion with amplitude A . Does the total energy change if the mass is doubled but the amplitude is not changed?
- b. What happens to the period of a simple pendulum if the pendulum's length is tripled? Does the length increase or decrease and by what factor?
- c. Two light pulses are emitted simultaneously from a source. The pulses take parallel paths to a detector 6.20 m away, but one moves through the air and the other through a block of ice. Determine the difference in the pulses' times of arrival at the detector. Refractive index of ice = 1.309
- d. A diverging lens is to be used to produce a virtual image one forth as tall as the object. Where should the object be placed in order to achieve this magnification?
- e. A camera used by a professional photographer to shoot portraits has a focal length of 25.0 cm. The photographer takes a portrait of a person 1.50 m in front of the camera. Where is the image formed, and what is the lateral magnification?
- f. A ball dropped from a height of 4 m makes a perfectly elastic collision with the ground. Assuming that no mechanical energy is lost due to air resistance determine, determine the period of the motion.
- g. What is the difference between a longitudinal and transverse wave?
- h. A bat flying at 6.0 m/s emits a chirp at 50 kHz. If this sound pulse is reflected by a wall, what is the frequency of the echo received by the bat?
- i. A series circuit consists of a $0.050\ \mu\text{F}$ capacitor, a $0.100\ \mu\text{F}$ capacitor and a 400 V battery. Find the charge on each of the capacitors.
- j. Find the equivalent resistance of the circuit in the figure below.



Section B: The five questions in this section are **all compulsory**.
Each question is worth 16 marks

QUESTION 1

- (a) Explain the phenomena of *total internal reflection* and specify the condition which must be met for it to occur. Your answer should include a diagrammatic representation of the phenomena. [3 marks]
- (b) A load of 50 N attached to a spring hanging vertically stretches the spring 5.0 cm. The spring is now placed horizontally on a table and stretched 11 cm. [5 marks]
- What is the force constant of the spring?
 - What force is required to stretch the spring by 11 cm?
 - Plot a graph of force (on the y axis) versus spring displacement from the equilibrium position along the x axis.
- (c) A concave spherical mirror has a radius of curvature of 20.0 cm. Locate the images for object distances of; [4 marks]
- 40.0 cm
 - 20.0 cm
 - 10.0 cm
- In each case, state whether the image is real or inverted.
- (d) A block of mass M hangs from a rubber cord. The block is supported so that the cord is not stretched. The unstretched length of the cord is L_0 and its mass is m , much less than M . The spring constant for the cord is k . The block is released and stops at the lowest point. [4 marks]
- Determine the tension in the string when the block is at this lowest point.
 - What is the length of the cord in this "stretched" position?
 - Find the speed of a transverse wave in the cord if the block is held in this lowest position.

QUESTION 2

- (a) Faults in the components of the eye leads to incorrect focusing of images in the system. This causes two common eye defects. [6 marks]

- i. Name and explain these two eye defects together with its causes and corrections.
- ii. The near point of a certain eye is 50 cm in front of the eye. What contact lens should be used to clearly see an object 25 cm in front of the eye?
- iii. The accommodation limits for a nearsighted person's eyes are 18.0 cm and 80.0 cm. When he wears his glasses, he is able to see distant objects clearly. At what minimum distance is he able to see objects clearly?

- (b) A man 1.80 m tall stands in front of a mirror and sees his full height, no more and no less. His eyes are 0.14 m from the top of his head. [4 marks]

- i. What is the height of the man's image in the mirror?
- ii. Determine the magnification of the image in the mirror.
- iii. What is the minimum height of the mirror?

- (c) A particle moving along the x axis in simple harmonic motion starts from its equilibrium position, the origin, at $t = 0$ and moves to the right. The amplitude of its motion is 2.00 cm and the frequency is 1.50 Hz. [6 marks]

- i. Show that the position of the particle is given by

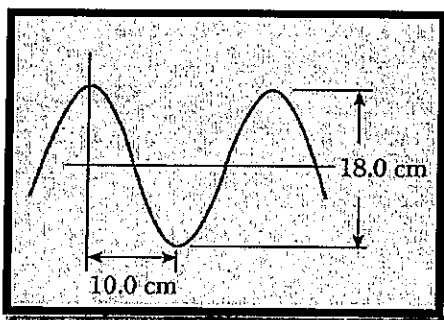
$$x = (2.00 \text{ cm}) \sin(3.00\pi t)$$

- ii. Determine the maximum speed and the earliest time ($t > 0$) at which the particle has this speed.
- iii. Determine the maximum acceleration and the earliest time ($t > 0$) at which the particle has this acceleration.
- iv. What is the total distance traveled by the particle between $t = 0$ and $t = 1.00 \text{ s}$?

QUESTION 3

- (a) A wave travelling in the positive x direction has a frequency of 25.0 Hz as in the figure below. Find the: [4 marks]

- i. Amplitude of the wave
- ii. Wavelength of the wave
- iii. Period of the wave
- iv. Speed of the wave



- (b) A wave of amplitude 0.30 m interferes with a second wave of amplitude 0.20 m travelling in the same direction. [2 marks]

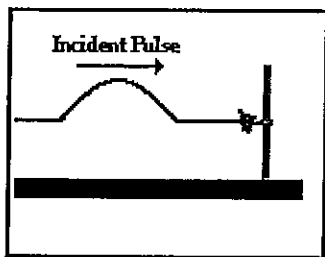
- i. What is the largest resultant amplitude that can result and under what condition?
- ii. What is the smallest resultant amplitude that can result and under what condition?

- (c) A phone cord is 4.00 m long. The cord has a mass of 0.200 kg. A transverse wave pulse is produced by plucking one end of the taut cord. The pulse makes four trips down and back along the cord in 0.800 s. [5 marks]

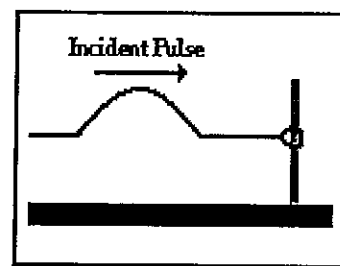
- i. Calculate the mass per unit length of the cord.
- ii. What is the total distance travelled by the transverse pulse?
- iii. Determine the velocity of the transverse pulse.
- iv. What is the tension in the cord?

- (d) Draw the reflected wave in each of the cases below. [2 marks]

i. Fixed end



ii. Free end



- (e) The area of a typical eardrum is about $5.0 \times 10^{-5} \text{ m}^2$. Calculate the sound power (the energy per second) incident on an eardrum at: [3 marks]

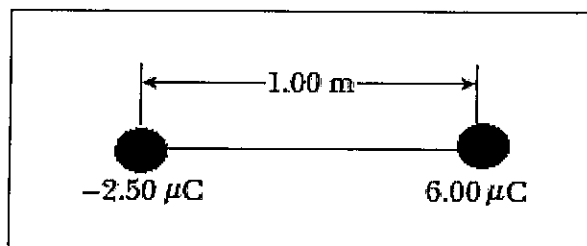
- The threshold of hearing.
- The threshold of pain.

QUESTION 4

- (a) A pair of oppositely charged parallel plates are separated by a distance of 5.33 mm. A potential difference of 600 V exists between the plates. [5 marks]
- What is the magnitude of the electric field between the plates?
 - What is the magnitude of the force on an electron between the plates?
 - How much work must be done on the electron to move it to the negative plate if it is initially positioned 2.90 mm from the positive plate?
- (b) A $25.0 \mu\text{F}$ capacitor and a $40.0 \mu\text{F}$ capacitor are charged by being connected across separate 50.0 V batteries. [5 marks]
- Determine the resulting charge on each capacitor.
 - The capacitors are then disconnected from their batteries and connected to each other, with each negative plate connected to the other positive plate. What is the final charge of each capacitor, and what is the final potential difference across the $40.0 \mu\text{F}$ capacitor?

- (c) The figure below shows two point charges separated by a distance of 1.00 m.

[6 marks]

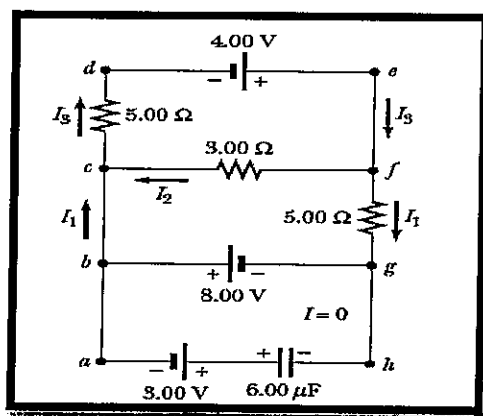


- Determine the electric field strength at a point midway between the two charges.
- Determine the point (other than infinity) at which the electric field is zero.

QUESTION 5

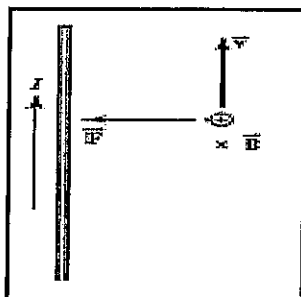
- (a) Use the circuit given below to answer the following questions.

[7 marks]



- Using Kirchhoff's Junction Rule, write the equations relating I_1 , I_2 and I_3 at junction C.
- Using Kirchhoff's Loop Rule, write the equations for loop *defcd* and loop *cfgbc*
- By solving the equations above simultaneously, find the values of I_1 , I_2 and I_3 .
- What is the charge on the capacitor?

- (b) A long, straight wire carries a current of 5.00 A as shown in the figure below. At one instant, a proton, 4.00 mm from the wire, travels at 1.50×10^3 m/s parallel to the wire and in the same direction as the current. [4 marks]



- i. Find the magnitude and direction of the magnetic field created by the wire.
 - ii. Find the magnitude and direction of the magnetic force the wire's magnetic field exerts on the proton.
- (c) Two parallel wires are 10.0 cm apart, and each carries a current of 10.0 A. [5 marks]
- i. Find the force per unit length exerted by one of the wires on the other if the currents are in the same direction.
 - ii. Do the wire experience a force of attraction or repulsion?
 - ii. Find the force per unit length exerted by one of the wires on the other if the currents are in different directions. Is this force attractive or repulsive?

The End