



The University of Fiji



School of Science and Technology Department of Science

FINAL EXAMINATION SEMESTER 2, 2017

QUESTION AND ANSWER BOOKLET PHYF 12: PHYSICS FOUNDATION II

Time Allowed: 3 hours

(An extra ten minutes is allowed for reading this paper)

Important Instructions to Students:

1. There are *14* pages. Read the questions, instructions carefully and answer the questions.
2. You are allowed an extra 10 minutes reading time (during this time, you are not allowed to write with pen) and 180 minutes (3 Hours) to complete this paper.
3. Silent, non-programmable calculators are allowed, but not supplied.
4. Write all your answers in this answer booklet. If you need extra sheets, please ask from the supervisor. Write your name, course code and student identification number in the answer booklet and in the attendance sheet.
5. This Final Course Examination Paper is worth 100 marks contributes 50% of the total course assessments.
6. There are *seven* questions in this paper. **Answer ALL.**
7. Write all your answers legibly. The marker has the right to award zero for answers that are not legible.
8. This is a closed book examination. The University views plagiarism, cheating and dishonest practice as serious offences and if found, offenders are penalized.

DATA

Coulomb's constant, $k_e = 8.99 \times 10^9 \text{ N m}^2\text{C}^{-2}$
Charge of electron, $e = 1.6 \times 10^{-19} \text{ C}$
Charge of proton $+e = 1.6 \times 10^{-19} \text{ C}$
Rydberg constant, $R_H = 1.097 \times 10^7 \text{ m}^{-1}$
Speed of light in vacuum, $c = 3.0 \times 10^8 \text{ m s}^{-1}$
Speed of sound, $v = 345 \text{ m s}^{-1}$
Permeability of free space, $\mu_0 = 4 \pi \times 10^{-7} \text{ T m/A}$
Permittivity of free space, $\epsilon_0 = 8.854 \times 10^{-12} \text{ C}^2/\text{N.m}^2$
Refractive index of air, $n = 1$
Planks constant, $h = 6.626 \times 10^{-34} \text{ J s}$
Mass of electron, $m_e = 9.1 \times 10^{-31} \text{ kg}$
Mass of proton, $m_p = 1.67 \times 10^{-27} \text{ kg}$
Avogadro's mass, $N_A = 6.02 \times 10^{23} \text{ particle/mol}$
Wien's displacement constant $= 2.898 \times 10^{-3} \text{ m.K}$
Acceleration due to gravity, $g = 9.78 \text{ ms}^{-2}$

There are eight questions in this section and **all are compulsory**.

Question 1: LIGHT: 16 marks

A. Light is said to be dualistic in nature. Explain the dual nature of light. [1 mark]

B. i. Explain the phenomena of *Total Internal Reflection* and specify the condition for it to occur. [2 marks]

ii. A beam of light is incident from air on the surface of a liquid. If the angle of incidence is 30° and the angle of refraction is 22° , find the critical angle for the liquid when surrounded by air. [4 marks]

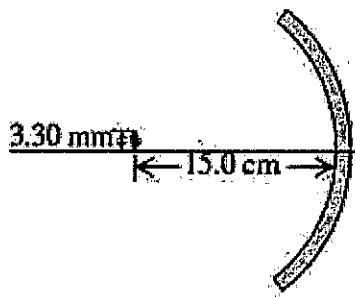
C. A ray of light is incident on a clear smooth surface of ice at an angle of 45.0° with the normal. Part of the light is reflected and part is refracted. Find:

i. the angle of reflection of the part of the light ray that was reflected [1 mark]

ii. the angle of refraction of the part of the light ray that was refracted [2 marks]

iii. the angle between reflected and refracted light [1 mark]
(Take the index of refraction of ice as 1.309)

D. The thin glass shell shown in the figure has a spherical shape (shown below) with radius of curvature of 12.0 cm and both of its surfaces can act as mirrors. A seed 3.30 mm high is placed 15 cm from the center of the mirror along the optic axis.



i. Calculate the location and height of the image of this seed. [2 marks]

ii. Suppose now that the shell is reversed. Find the location and height of the seed's image.

[2 marks]

E. 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.

i. What is the height of the man's image in the mirror? [1.5 marks]

ii. Determine the magnification of the image in the mirror. [0.5 marks]

iii. What is the minimum height of the mirror? [1 mark]

Question 2: WAVES: 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? [1 mark]

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? [1 mark]

C. A 10.0 g bullet is fired into and embeds itself in a 2.00 kg block attached to a spring with a spring constant of 1.6 N/m and whose mass is negligible. How far is the spring compressed if the bullet has a speed of 300 m/s just before it strikes the block, and the block slides on a frictionless surface? [3 marks]

D. A Simple Harmonic Motion has the equation:

$$y = 6.8 \sin\left(4t + \frac{\pi}{4}\right)$$

i. What is the initial phase angle of this motion? [1 mark]

ii. What is the displacement at $t = 0\text{s}$? [1 mark]

iii. Calculate the velocity at time 0. [2 marks]

iv. What is the maximum velocity? [1.5 marks]

v. Sketch a graph of the motion (phasor diagram). [1.5 marks]

E. A proud deep-sea fisherman hangs a 65 kg fish from an ideal spring having negligible mass. The fish stretches the spring 0.120 m.

i. Find the force constant of the spring. [2 marks]

The fish is now pulled down 5.00 cm and released.

ii. What is the period of oscillation of the fish? [1.5 marks]

iii. What is the maximum speed it will reach? [1.5 marks]

F. A child's toy consists of a piece of plastic attached to a spring (Figure below). The spring is pushed towards the floor a distance of 2.00 cm, and the toy is released. If the toy has a mass of 100g and rises to a maximum height of 60.0 cm, estimate the force constant of the spring.

[3 marks]

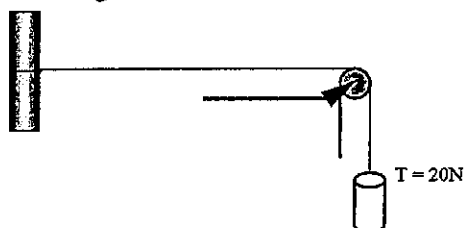


Question 3: SOUND WAVES: 17 marks

A. Sound waves fall into three categories covering different range of frequencies. List these three categories. [2 marks]

B. An alert physics student stands beside the tracks as a train rolls slowly past. He notes that the frequency of the train whistle is 442 Hz when the train is approaching him and 441 Hz when the train is receding from him. From this he can find the speed of the train. What value does he find? [4 marks]

C. A string vibrates in its fundamental mode with a frequency of 220 vibrations/s. The vibrating segment is 70.0 cm long and has a mass of 1.20 g.



i. Find the tension in the string.

[2 marks]

ii. Determine the frequency of the string when it vibrates in three segments.

[2 marks]

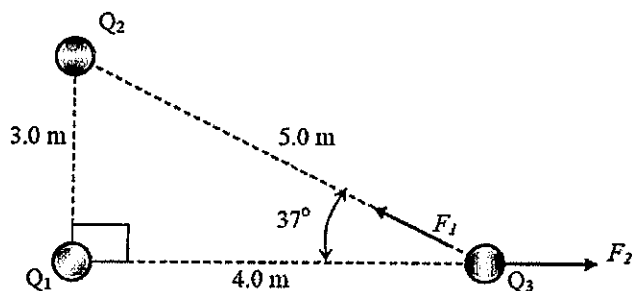
D. A uniform string has a mass of 0.3 kg and length of 6 m. Tension is maintained in the string as shown. Calculate the speed of the waves in the string. [4 marks]

E. A certain piano string is supposed to vibrate at a frequency of 4.40×10^2 Hz. In order to check its frequency, a tuning fork known to vibrate at a frequency of 4.40×10^2 Hz is sounded at the same time the piano key is struck, and a beat frequency of 4 beats per second is heard. Find the two possible frequencies at which the string could be vibrating. [3 marks]

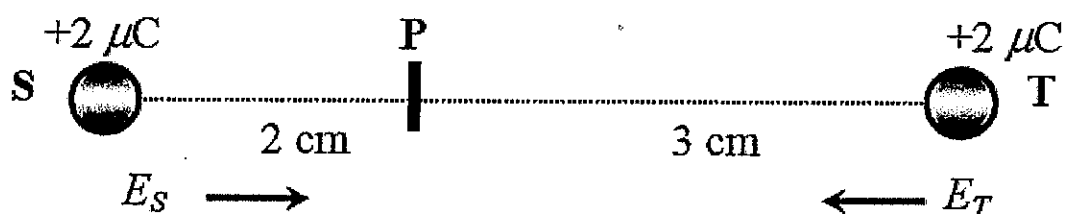
Question 4: ELECTRICAL FORCE AND ELECTRIC FIELDS: 18 marks

A. Explain and distinguish between charging by the process of conduction and by the process of induction. Use diagrams to explain. [3 marks]

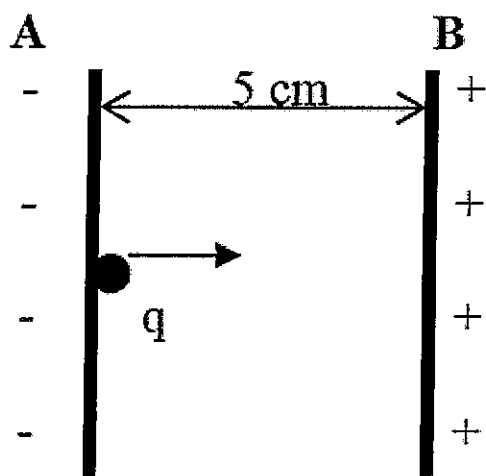
B. Consider three point charges at the corners of a triangle. The charges $Q_1 = 6 \text{ nC}$, $Q_2 = -2 \text{ nC}$ and $Q_3 = 5 \text{ nC}$. Find the resultant force on Q_3 by the other two charges. [5 marks]



C. Calculate the electric field generated at P by the charges S and T. [4 marks]



D. An electric charge q of mass 2×10^{-25} kg travels horizontally through an electric field between the charged plates A and B as shown.



Electric field strength
 $E = 1000 \text{ Vm}^{-1}$

If the charge has velocities of 5×10^6 m/s and 6×10^6 m/s at plates A and B respectively,

i. find the work done by the electric force on q by moving it from A to B [3 marks]

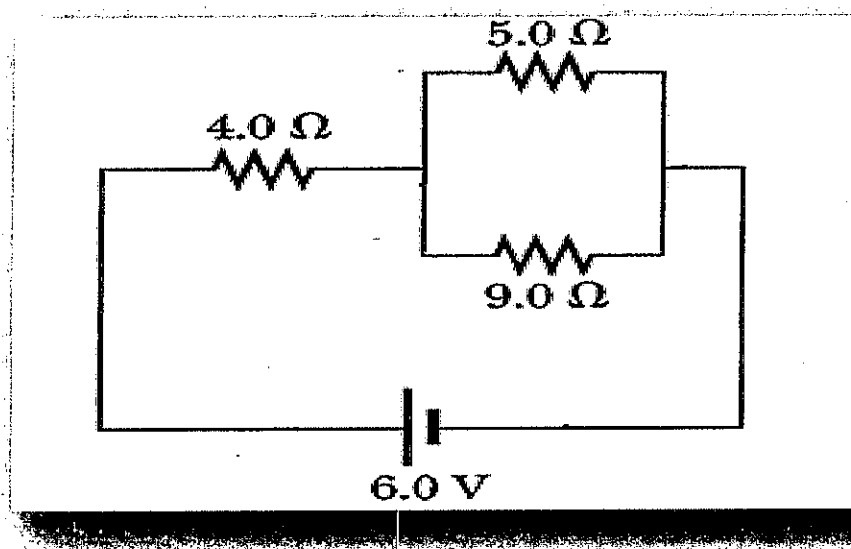
ii. calculate the electrical force experienced by the charge. [1.5 marks]

iii. hence determine the polarity and magnitude of the charge. [1.5 marks]

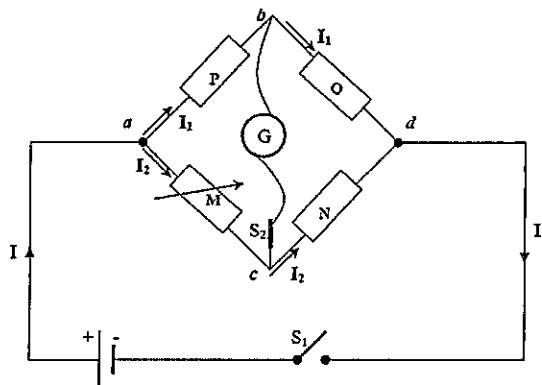
Question 5: CURRENT AND RESISTANCE: 12 marks

A. Determine the currents flowing through each of the three resistors in the circuit below.

[8 marks]



B. A bridge circuit is setup to determine the resistance of an unknown resistor. Three variable resistances are arranged and setup as shown below. These resistances are varied till the bridge is balanced. At balance point the resistance of Q, M and N are read to be 3Ω , 2.5Ω and 4Ω respectively. Calculate the value of P. [4 marks]



Question 6: MAGNETISM AND ELECTRICITY: 8 marks

A. A proton with mass $1.6 \times 10^{-27} \text{ kg}$ and charge of $1.6 \times 10^{-29} \text{ C}$ travels at $3.0 \times 10^6 \text{ m/s}$ in a magnetic field of strength $B = 0.03 \text{ T}$. Find the radius of its circular motion in the B field. [4 marks]

B. A 50 turn rectangular coil of dimensions 5.00 cm x 10.0 cm is allowed to fall from a position where $B = 0$ to a new position where $B = 0.500$ T and the magnetic field is directed parallel to the coil. Calculate the magnitude of the average emf that is induced in the coil if the displacement occurs in 0.250 s. [4 marks]

Question 7: MODERN PHYSICS: 9 marks

A. An electron makes a jump from the second energy level ($n=2$) to ground state ($n=1$). Calculate the wavelength and frequency of the emitted photon and identify which part of the electromagnetic spectrum the photon belongs to. [4 marks]

B. When light of frequency 7.5×10^{14} Hz is incident on a metal surface, the maximum kinetic energy of the emitted photoelectrons is 9.44×10^{-20} J.

i. Calculate the work function of the metal. [3 marks]

ii. Hence find the threshold frequency of the metal. [2 marks]

The End